

ENDANGERED AND THREATENED PLANTS AND ANIMALS OF VIRGINIA

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- Pleocorus rafinesquii* *Argopecten irradians* *Fondion halimolobos* *Speyeria digna*

Donald W. Linzey, Editor

Proceedings of the Symposium
on
ENDANGERED AND THREATENED PLANTS
AND ANIMALS OF VIRGINIA

held at

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Blacksburg, Virginia

May 19 - 20, 1978

Donald W. Linzey, Editor

Sponsored by

CENTER FOR ENVIRONMENTAL STUDIES
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

1979

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PROGRAM SCHEDULE

FRIDAY, MAY 19 - OPENING SESSION AND WORKSHOPS

- 10:00 a.m. Registration begins. (Lobby, first floor)
- 1:00 p.m. Opening Remarks, Introduction of Panel Members, and Assignment of Meeting Rooms
- 2:00 p.m. Workshop Sessions.
Activities and duration of each session will be determined by the panel chairman. Workshops are open to observers, but seating may be limited.
- 7:30 p.m. Illustrated program on the activities of the Office of Endangered Species. Presented by Dr. Paul A. Opler, Office of Endangered Species, Washington, D.C. (Auditorium)
- 8:30 p.m. Wine and Cheese Hour

SATURDAY, MAY 20 - GENERAL ASSEMBLY (Auditorium)

- 8:00 a.m. Registration continued. (Lobby)
- 9:00 a.m. Welcoming Address: Dr. William E. Lavery
President, Virginia Polytechnic Institute and State University.
- 9:10 a.m. Opening Remarks:
Dr. John Cairns, Jr., Director, Center for Environmental Studies, Virginia Polytechnic Institute and State University.
Dr. William J. Hargis, Jr., Director, Virginia Institute of Marine Science

Reports of Panels and Open Discussion

- 9:30-10:00 a.m. Plants
- 10:00-10:30 a.m. Freshwater and Terrestrial Molluscs
- 10:30-10:50 a.m. *Coffee Break*
- 10:50-11:20 a.m. Freshwater and Terrestrial Arthropods
- 11:20-11:50 a.m. Marine Invertebrates
Lunch
- 1:30-2:00 p.m. Fishes
- 2:00-2:30 p.m. Amphibians and Reptiles
- 2:30-3:00 p.m. Birds
- 3:00-3:30 p.m. Mammals
- 3:30-4:00 p.m. Geographic Areas of Special Concern
- 4:00- Closing Remarks
Adjournment

DEFINITIONS

Five categories have been developed and defined by the Steering Committee: *Endangered*, *Threatened*, *Special Concern*, *Status Undetermined*, and *Recently Extinct or Extirpated*. The terms "plant" and "animal" as used herein can include any species, subspecies, or smaller taxonomic unit.

ENDANGERED

A plant or animal whose prospects for survival are in immediate jeopardy; in danger of extirpation and/or extinction throughout all or a significant portion of its range in Virginia. Also includes those plants and animals on, or being considered for inclusion on, the *U.S. List of Endangered Fauna and Endangered and Threatened Plant Species of the United States*, as provided under the Endangered Species Act of 1973 (Public Law 93-205).

THREATENED

A plant or animal which is likely to become *Endangered* within the foreseeable future throughout all or a significant portion of its range in Virginia. Includes forms which have exhibited a considerable decrease in numbers beyond the limits of normal fluctuation, or documented range contraction, but not yet considered *Endangered*. Also includes those plants and animals listed under the provisions of Public Law 93-205.

SPECIAL CONCERN

A plant or animal which should be continually monitored (a) because it exists in only one or a few small geographic areas and/or is rare (low population density) over a relatively broad range; (b) because its existence may become *Endangered* due to the destruction, drastic modification, or severe curtailment of the habitat; (c) because certain characteristics or requirements make it especially vulnerable to specific pressures; or (d) because of other reasons identifiable by experienced researchers.

STATUS UNDETERMINED

A plant or animal that has been suggested as possibly *Threatened* or *Endangered* but about which there is insufficient data to accurately determine its status.

RECENTLY EXTINCT or EXTIRPATED

A plant or animal which recently occurred in Virginia but which no longer exists in the state, as determined by historical documents and/or knowledge of committee members. (Each committee shall establish its own definitions of "recently").

COMMITTEE CHAIRMEN

- PLANTS: Duncan M. Porter, Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.
- FRESHWATER AND TERRESTRIAL MOLLUSCS: David H. Stansbery, Museum of Zoology, The Ohio State University, Columbus, Ohio 43210.
- FRESHWATER AND TERRESTRIAL ARTHROPODS: Paul A. Opler, Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240.
- MARINE INVERTEBRATES: Marvin L. Wass, Department of Invertebrate Ecology, Institute of Marine Science, Gloucester Point, Virginia 23062.
- FISHES: Robert E. Jenkins, Department of Biology, Virginia Commonwealth University, Richmond, Virginia 23284.
- AMPHIBIANS AND REPTILES: Franklin J. Tobey, Box 1376, Leesburg, Virginia 22075.
- BIRDS: Mitchell A. Byrd, Department of Biology, College of William and Mary, Williamsburg, Virginia 23185.
- MAMMALS: Charles O. Handley, Jr., Division of Mammals, Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.
- GEOGRAPHIC AREAS OF SPECIAL CONCERN: Alicia V. Linzey, Department of Biology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

STEERING COMMITTEE

- Donald W. Linzey (*Chairman*), Center for Environmental Studies, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.
- Mitchell A. Byrd, College of William and Mary.
- Charles O. Handley, Jr., Smithsonian Institution.
- Robert E. Jenkins, Virginia Commonwealth University.
- Duncan M. Porter, Virginia Polytechnic Institute and State University.
- Alan R. Tipton, Virginia Polytechnic Institute and State University.

PREFACE

It is becoming increasingly important that the flora and fauna vulnerable to extinction or extirpation be identified. Knowledge of their distribution, habitat and biology is essential for assessing environmental quality and for land-use planning by various organizations and agencies. Furthermore, by identifying those forms about which little is known, it is hoped that significant future research efforts may be directed towards these species.

In view of these concerns, the primary purpose of this Symposium was to generate a carefully considered, well-documented list of Virginia's plants and animals deemed *endangered*, *threatened*, or otherwise *of concern*, on the basis of the best biological expertise available. This expertise was provided by the many conservationists, professional biologists, teachers, students and interested laymen who attended and participated. All data compiled form the basis of this comprehensive publication, which is available to resource-oriented State and Federal agencies, planners at a variety of levels, scientists, and the citizens of Virginia.

Compilation of the list of *Endangered* and *Threatened* plants and animals is intended to focus attention on these species and to stimulate corrective action wherever possible. Individuals, organizations, and interested agencies should employ all means available to them toward achieving greater security for all plants and wildlife. Only by united appropriate action will we prevent other species from joining the list of those now extinct.

Donald W. Linzey



INTRODUCTION

The idea for a Symposium on Endangered and Threatened Plants and Animals of Virginia was born in October, 1977, during discussions with several of my colleagues in the Center for Environmental Studies at Virginia Polytechnic Institute and State University. The Center agreed to sponsor the Symposium, which was given its full backing and support. The Virginia Commission of Game and Inland Fisheries, the Virginia Institute of Marine Science, and the Department of Fisheries and Wildlife Sciences at Virginia Polytechnic Institute and State University agreed to serve as co-sponsors.

A six-member steering committee planned and organized the symposium. The committee formulated the definitions for five categories: Endangered, Threatened, Special Concern, Status Undetermined, and Recently Extinct or Extirpated. In addition, the committee prepared a list of instructions and a suggested timetable for the chairmen and developed a format for the species accounts. These were mailed to each committee chairman on December 15, 1977. Copies are included in this publication as Appendices A and B.

My mid-February, five thousand (5,000) brochures had been printed and mailed. Our distribution list included all junior high and high school science teachers in Virginia; all colleges, universities, government agencies, and citizens groups in Virginia, North Carolina, Tennessee, Kentucky, West Virginia, Maryland, the District of Columbia, and Delaware; many national conservation organizations; Virginia's U.S. senators and representatives; and all Virginia extension personnel. Several computerized mailing lists provided by the Center for Continuing Education were also used. Many brochures were sent to individuals who had requested data or to those who had been recommended to us. These included representatives of federal agencies, consultants, members of garden clubs, students, and other interested citizens. Dr. Alan Tipton assumed responsibility for notifying the editors of all appropriate state, regional and national journals and other publications. Many of these carried a notice of the Symposium.

Most committee chairmen realized that much preliminary work had to take place prior to May 19 and 20. Preliminary species lists were compiled by them and circulated among committee members. Ideas and suggestions were circulated by mail and telephone. Some committees found it possible to meet one or more times prior to the Symposium.

The Symposium was attended by over 200 persons from 10 states (Virginia, Maryland, North Carolina, West Virginia, Kentucky, Tennessee, Ohio, Pennsylvania, New York and Massachusetts) and the District of Columbia, with 167 persons officially registering as participants. Registration began at 10:00 A.M. on May 19, and proceeded smoothly, due to the expertise of the personnel from the Center for Continuing Education. Dr. Gerald Cross convened a meeting of all chairmen at noon and discussed with them the format and procedures that would be followed. The opening session began promptly at 1:00 P.M. Dr. Cross and I welcomed the participants to the opening portion of the Symposium. The committee chairmen were introduced and they in turn introduced the members of their committees. Dr. Cross assigned meeting rooms, and by 2:00 P.M. the workshop sessions had begun.

The workshop sessions were tremendously valuable. In some cases, the chairman had in his possession most of the known data; thus, most of the session consisted of the chairman imparting this knowledge to those in attendance. In other cases, the chairman would speak briefly about a certain species. Then considerable

discussion would ensue, bringing forth new data such as previously unrecorded locality records and the names of graduate students and others who were currently working on that particular species. As Chairman of the Symposium, I visited each committee session for 20- to 30-minute periods. Although I was unable to participate in any one committee's complete deliberations, I was fortunate in obtaining an overview of the entire workshop session. In all cases, there was abundant discussion and exchange of ideas. All those in attendance had ample opportunity to present their data, to agree or disagree with the information at hand, and to make their opinions known.

The purpose of the workshop sessions was to complete the work that the committees had been engaged in for the several months preceding the Symposium, and to allow participation by persons not formally on the committees. Sessions varied from three to six hours in duration. Some committees reconvened later in the evening and met for several additional hours.

At 7:30 P.M. participants gathered in the auditorium to listen to an illustrated program on the activities of the Office of Endangered Species presented by Dr. Paul A. Opler, Acting Branch Chief, Biological Support, Office of Endangered Species, U.S. Fish and Wildlife Service. A question and answer period followed. At the conclusion of the program, everyone adjourned to the dining room for a wine and cheese social.

The General Assembly session began at 9:00 A.M. on Saturday with a welcome by Dr. William Lavery, President, Virginia Polytechnic Institute and State University, opening remarks by Dr. John Cairns and Dr. Marvin Wass - the latter representing Dr. William Hargis. The panel reports and open discussion began at 9:30 A.M. Each chairman was allotted 30 minutes to present his or her report.

The final committee report concluded at 4:00 P.M. At this time, Dr. Cross and I thanked all of the participants for sharing their time and contributing their talents and expertise in making this first Virginia symposium a very successful endeavor. Dr. Cross adjourned the Symposium at 4:30 P.M.

During the weeks and months following the Symposium, the chairmen found themselves with a heavy workload due to the quantity of information generated at the meeting. Some chairmen decided to write all of their species accounts and their committee report themselves and then have them reviewed by their committee members. Others asked committee members with expertise in specific groups or specific species to write these accounts. In these cases, the chairman was responsible for writing the introduction and for editing the entire committee report.

About 19 months have elapsed between the Symposium and this publication. During this time additional data has become available concerning several species. These data have been incorporated into the reports in an attempt to make these proceedings as current as possible. Thus, in Virginia, 142 species are recognized as Endangered, 86 are Threatened, 269 are listed as Special Concern, 252 are listed as Status Undetermined, and 27 species are Recently Extinct or Extirpated.

Since we live in a dynamic, ever-changing world, conditions affecting these species and their habitats are also changing - some for the better, some for the worse. The Virginia list of Endangered and Threatened species, like the Federal list, will be subject to continued revision as circumstances change and knowledge about the species increases. For this reason, a second symposium should be convened in several years to completely review and update all the data in these Proceedings. At that time, hopefully, the improving condition of some species will warrant their removal from the list.

Acknowledgments

This Symposium could not have been successful without the assistance of many individuals. Foremost among these would be Dr. John Cooper of the North Carolina State Museum. Having been Chairman of a similar symposium in North Carolina in 1975, John imparted to me his experiences and recommendations. I received a thick packet containing copies of correspondence, planning schedules, cost estimates, etc. John's advice was not helpful and, although our physical arrangements were handled in a different manner than was the case in North Carolina, many of John's recommendations were followed. His cooperation and assistance are greatly appreciated.

Dr. Linda Leffel, Associate Director for Program Planning for the Center for Continuing Education, did an excellent job of coordinating all of the physical arrangements for the Symposium. I worked closely with Linda from November through May. She was responsible for having the brochures printed, reserving all conference rooms and the auditorium, handling the entire registration procedure, having projectors and microphones available when needed, and making all arrangements for food. She made many helpful suggestions and recommendations during our planning sessions. Her efforts, together with those of her staff, were primarily responsible for the smooth running of the Symposium.

The chairmen and members of the committees put in many long hours before, during and after the Symposium. The results of their work form the bulk of this publication. Others who contributed to the success of these meetings include the members of the Steering Committee, who were responsible for planning; Alicia Linzey, who designed the cover of the brochure; Kenneth Thompson, who served as projectionist; and Alan Tipton, who recorded on tape the Opening Session and the General Assembly Session. Gerald Cross did an exceptionally fine job as Moderator and kept the symposium sessions running smoothly and on schedule.

In addition, I would like to especially thank Alicia Linzey, Duncan Porter, and Steve Croy for critically reviewing the Preface, Introduction and Legislation sections. Karen Moore was indispensable in assisting with the enormous job of editing and proofreading the manuscript. Mary Holliman and Linda Thompson prepared the manuscript for publication. Steve Croy, Georgia Minnich and Sharon Chiang assisted in the preparation of maps and plates. Judy Vest retyped extensive portions of the original manuscript, which at times got to the point where it was almost illegible due to changes by the authors and the editor. Carmen Fletcher did an excellent job of typing the final manuscript.

Finally, I wish to thank all those who participated in the Symposium. By taking time out from their busy schedules to attend this Symposium and by contributing in the workshop sessions, these individuals were instrumental in the success of the Symposium. My thanks are extended to each and everyone who attended.

Donald W. Linzey
Chairman

April 15, 1979

A REVIEW OF FEDERAL AND STATE LEGISLATION AFFECTING
VIRGINIA'S PLANTS AND ANIMALS

Donald W. Linzey

Species of animal and plant life have been evolving on earth for millions of years. Extinction, which is a natural phenomenon in a dynamic, ever-changing biotic world, accounts for the loss of a large number of these forms. Examples would include the many different kinds of trilobites, brachiopods, dinosaurs, primitive birds, saber-toothed tigers, mammoths, mastodons, and many more. The extinction of these forms was brought about primarily by the inability of many of them to adapt to changing climatic conditions and by the evolution of some species into more advanced forms.

The relatively recent appearance of man, together with the many changes he has wrought, has placed undue stresses on many species. Destruction of habitat through extensive clear-cutting and monocultural forestry practices; strip mining; road construction, dam construction and flooding of valleys; and water pollution caused by inadequate and over-burdened sewage treatment facilities, oil discharges and the many non-point sources such as runoff from fertilized and chemically-treated agricultural areas have been the main causes of stress for many of the species. Other activities, including commercial exploitation, widespread use of pesticides and herbicides (particularly those containing chlorinated hydrocarbons), air pollution, and noise pollution, also have affected many species.

This is not to say that all forms have been adversely affected by man's activities. One has only to look at the increasing numbers and expansion of ranges of such native animals as the white-tailed deer and coyote, which have benefitted from land-clearing operations. The list of species that have been adversely affected, however, far outweighs those which have benefitted from man's activities.

Efforts to regulate the taking of certain forms of wildlife in the United States can be traced back to the 1600's. The first major federal legislation in this area, however, came with the passage of the Lacey Act of 1900. This law, among other things, prohibited the interstate transportation of "any wild animals or birds" killed in violation of state laws. It also authorized the Secretary of Agriculture to adopt all measures necessary for the "preservation, distribution, introductions, and restoration of game birds and other wild birds" subject to the laws of the various states. In 1916, a Convention between the United States and Great Britain (for Canada) for the Protection of Migratory Birds produced a treaty adopting a uniform system of protection for certain species of birds which migrate between the United States and Canada. The Migratory Bird Treaty Act of 1918 implemented the treaty of 1916. The Act provides for regulations to control the taking, selling, transporting and importing of migratory birds, and it provides penalties for violations. This Act stopped the killing of birds for their feathers and played an important role in protecting many species such as the snowy egret.

The Migratory Bird Conservation Act of 1929 provided for the acquisition and development of land for migratory bird refuges. It also authorized investigations and publications on North American birds. The Act, however, provided no funds for

these purposes. Funding was not provided until 1934 when the Migratory Bird Hunting and Conservation Stamp Act (commonly known as the "Duck Stamp" Act) was passed. This legislation required all waterfowl hunters 16 years of age or older to possess a valid federal hunting stamp. The receipts from the sales of this stamp were set aside in a special account known as the Migratory Bird Conservation Fund, from which funds are appropriated for the acquisition and management of migratory bird refuges and waterfowl production areas. These two acts have played an important role in protecting such birds as the trumpeter swan and the whooping crane.

The Fish and Wildlife Coordination Act of 1934 was the first major federal statute to employ the strategy of compelling consideration of wildlife impacts. This forward-looking legislation authorized federal water resource agencies to acquire lands or interests in connection with water-use projects specifically for mitigation and enhancement of fish and wildlife.

In 1936, a Convention between the United States and Mexico for the Protection of Migratory Birds and Game Mammals was held. This meeting was similar to the Convention with Canada in 1916 and was similarly implemented by the Migratory Bird Treaty Act of 1918. This Convention was amended in 1972 to add 32 additional families of birds, including eagles, hawks, owls and members of the family Corvidae.

The federal Aid in Wildlife Restoration Act (commonly referred to as the Pittman-Robertson Act) was passed in 1937. Representative Robertson was a Congressman from Virginia, while Mr. Pittman was a Senator from Nevada. This Act provides federal aid to states for wildlife restoration work. Funds are raised by an excise tax on sporting arms and ammunition. Funds are apportioned to the states on a 75-25 matching basis and can be used for approved land acquisition, research, and development and management projects. Amendments in 1970 and 1972 added excise taxes on pistols, revolvers, bows, arrows, parts and accessories for use in wildlife projects or hunter safety programs.

The Bald Eagle Act of 1940 provided for the protection of the bald eagle and the golden eagle. The Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere produced a treaty in 1940 which states that the government of the United States and 11 other American republics express their wish to "protect and preserve in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds." This treaty covers the wintering grounds of many birds that nest in the United States.

The federal Aid in Fish Restoration Act (commonly referred to as the Dingell-Johnson Act) was passed in 1950. It provides federal aid to the states on a 75-25 matching basis for approved land acquisition, research, and development and management projects involving fish. Funds are obtained by means of an excise tax on certain items of sport fishing tackle.

The Fish and Wildlife Act of 1956 establishes a comprehensive national fish and wildlife policy. It directs a program of continuing research, extension, and information services on fish and wildlife matters of national and international importance. It designated a Fish and Wildlife Service (USFWS) made up of the Bureau of Sport Fisheries and Wildlife (BSFW) and Bureau of Commercial Fisheries. This Act was amended in 1970 to transfer the Bureau of Commercial Fisheries to the National Oceanic and Atmospheric Administration. A 1974 amendment redesignated the BSFW as the USFWS under the Assistant Secretary of Interior for Fish and Wildlife and Parks.

In an effort to accelerate the acquisition of migratory waterfowl habitat, Congress passed the Wetlands Loan Act in 1961. This authorized 100 million dollars to be added to the Migratory Bird Conservation Fund. Advances are to be repaid to the Treasury using "Duck Stamp" receipts.

The Wilderness Act of 1964 provides for the formal preservation of wilderness area. Areas within the National Wildlife Refuge System, as well as areas within the National Parks and National Forests, were to be reviewed for wilderness design-

nation and recommendations submitted to Congress. Several such areas are located in Virginia and contain suitable habitats for several rare Virginia plants and animals.

Additional environmental protection under such laws as the Wild and Scenic Rivers Act (1968), the National Environmental Policy Act (1969), and the Water Bank Act (1970) has helped preserve habitats of endangered species as well as other wildlife. However, this protection has been insufficient for some species.

In January, 1964, the Bureau of Sport Fisheries and Wildlife circulated a tentative list of rare and endangered fish and wildlife among some 300 knowledgeable persons and organizations. Comments and suggestions were solicited. A revised list based on these suggestions was further reviewed and the additional comments incorporated into the first edition of the "Red Book," as the Federal List of Rare and Endangered Fish and Wildlife of the United States was popularly known. This was issued in July, 1966, and revised in 1968. Species were classified as follows:

Endangered. An endangered species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy. Its peril may result from one or many causes -- loss of habitat, overexploitation, predation, competition, and disease. An endangered species must have help or extinction will probably follow.

Rare. A rare species or subspecies is one that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens. Close watch of its status is necessary.

Peripheral. A peripheral species or subspecies is one whose occurrence in the United States is at the edge of its natural range which is rare or endangered within the United States although not in its range as a whole. Special attention is necessary to assure its retention in our Nation's fauna.

Status Undetermined. A status-undetermined species or subspecies is one that has been suggested as possibly rare or endangered, but about which there is not enough information to determine its status. More information is needed.

A second revision of the "Red Book" in March, 1973 combined *endangered* and *rare* species into a single category termed *threatened*. This change was made primarily to indicate that the "Red Book" did not comprise the official list of *endangered* species. The official list is found in the U.S. Department of the Interior's list of endangered native fish and wildlife, published annually in the *Federal Register*.

In 1966, the Bureau of Sport Fisheries and Wildlife began a special research program for endangered species. This program was centered at the Patuxent Wildlife Research Center in Laurel, Maryland. It had two primary objectives: (1) to learn how to propagate certain species in captivity; and (2) to seek, through field studies, key factors that threatened the existence of certain species. With enactment of the Endangered Species Preservation Act of 1966, which authorized use of land and water conservation funds for the acquisition of endangered species habitat, refuge lands began to be purchased specifically for endangered species.

In 1969, Congress passed the Endangered Species Conservation Act (Public Law 91-135; 83 Stat. 275). This Act provided broad authority to the federal government to establish a comprehensive program for the conservation, restoration and propagation of selected fish and wildlife in the United States which are threatened with extinction. The Act also provided assistance on an international level for the preservation of foreign wild animals.

The Marine Mammal Protection Act of 1972 established a moratorium on the taking and importation of certain marine mammals and products made from them. All marine mammals on the official endangered list are included.

The Endangered Species Act of 1973 (Public Law 93-205; 87 Stat. 884) became effective on December 28, 1973, and thereby supplanted the Endangered Species Conservation Act of 1969. The new law seeks "...to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions..." in which the United States has pledged its support for the conservation of wild flora and fauna worldwide. This law encompasses all species of the animal kingdom and all species of the plant kingdom, with the term "species" including any species, any subspecies, and any smaller taxonomic unit of plant or animal, and also any viable population-segment thereof. Furthermore, the law established two categories of endangerment: (a) Endangered Species - those species in danger of extinction throughout all or a significant portion of their range; and (b) Threatened Species - those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. This law also emphasized the need to preserve critical habitats on which endangered species depend for their continued existence. Individual states were encouraged to establish guidelines to complement the goals outlined in the 1973 Act.

Also in 1973, the United States was one of 44 nations attending the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The treaty and species lists negotiated at the Convention were implemented by the United States on February 22, 1977. The scientific authority for the United States is an autonomous committee of representatives of six federal agencies. Known as the Endangered Species Scientific Authority (ESSA), this committee's primary responsibility is to establish biological criteria on which to base findings for individual species protected by the Convention, so that it may advise the management authority (Federal Wildlife Permit Office of the U.S. Fish and Wildlife Service) on the issuance of appropriate U.S. export and import permits.

In mid-1978, the U.S. Supreme Court handed down a decision upholding the applicability of the Endangered Species Act of 1973 in a case involving the Tennessee Valley Authority. Following this decision, Congress subsequently amended the Act (The Endangered Species Act Amendments of 1978) reauthorizing administration of the Endangered Species Act of 1973, and, among other things, providing for a review board and a cabinet-level committee to act as the final decision-making authorities in those cases where a seemingly irresolvable impasse has been reached regarding approval of a project which might destroy the habitat and last remaining members of an endangered species. Whether or not this amendment permitting exemptions from the Act's stringent requirements will seriously weaken the Endangered Species Act remains to be seen.

Section 12 of the Endangered Species Act of 1973 directed the Secretary of the Smithsonian Institution to prepare a list of species of plants which are now or may become endangered or threatened, to review methods of adequately conserving such species, and to report the Institution's recommendations to Congress one year from the date of enactment of the Act. The report (Ripley, 1975) utilized the following criteria:

Endangered Species. Those species of plants in danger of extinction throughout all or a significant portion of their ranges. Existence may be endangered because of the destruction, drastic modification, or severe curtailment of habitat, or because of over-exploitation, disease, predation, or even unknown reasons. Plant taxa from very limited areas, e.g., the type localities only, or from restricted fragile habitats usually are considered endangered.

Threatened Species. Those species of plants that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. This includes species categorized as rare, very rare, or depleted.

Recently Extinct or Possibly Extinct Species. Those species of plants no longer known to exist after repeated search of the type localities and other known or likely places. Some species may be extinct in the wild, but preserved by cultivation in gardens - such as the "Lost Franklinia."

The foregoing provides a synopsis of major federal legislation having a bearing on the preservation of Virginia's plants and wildlife and their habitats. Each of these laws affects one or more of the species included in this publication.

In 1972, the General Assembly of Virginia passed an Endangered Species Act which was amended in 1977. This Act states that certain species of fish or wildlife are threatened with extinction and are entitled to preservation and protection as a matter of general state concern. The Act states in part: "The General Assembly finds that by eliminating in this State the taking, sale, or offer for sale, of species threatened with extinction, their potential for continued existence will be strengthened." Fish or wildlife as defined in the Act means "any member of the animal kingdom, vertebrate or invertebrate, without limitation, and includes any part, products, egg, or the dead body or parts thereof." All species appearing on an officially adopted Federal or State list of endangered species are included. The provisions of the Act extend not only to those species native to Virginia, but also to those officially recognized as endangered which may be native to other parts of the world. In the event the federal lists are modified by additions or deletions, such modifications shall be accepted as binding under Virginia's Endangered Species Act. In addition, the Commission of Game and Inland Fisheries "may, on its own motion, declare by regulation that species not appearing on the Federal lists are an endangered or threatened species in Virginia."

The Federal Endangered Species Act of 1973 contained a provision concerning cooperative agreements with the states. The Act states: "In order for a State program to be deemed an adequate and active program for the conservation of endangered species and threatened species, the Secretary must find, and annually thereafter confirm such finding, that under the State program:

1. authority resides in the State agency to conserve resident species of fish or wildlife determined by the State agency or the Secretary to be endangered or threatened;
2. the State agency has established acceptable conservation programs, consistent with the purposes and policies of this Act, for all resident species of fish or wildlife in the State which are deemed by the Secretary to be endangered or threatened, and has furnished a copy of such plan and program together with all pertinent details, information, and data requested to the Secretary;
3. the State agency is authorized to conduct investigations to determine the status and requirements for survival of resident species of fish and wildlife;
4. the State agency is authorized to establish programs, including the acquisition of land or aquatic habitat or interests therein, for the conservation of resident endangered species or threatened species; and
5. provision is made for public participation in designating resident species of fish or wildlife as endangered or threatened."

As of October, 1978, twenty-two (22) states had entered into cooperative agreements. Virginia, through the Commission of Game and Inland Fisheries, entered into its agreement on December 23, 1976. The Commission currently recognizes the following Federal Endangered and/or Threatened species: three species of mammals (Indiana bat, Delmarva fox squirrel, cougar), five species of birds (brown pelican, bald eagle,

peregrine falcon, red-cockaded woodpecker, Bachman's warbler), four species of sea turtles (Atlantic ridley, loggerhead, hawksbill, leatherback), three species of fish (shortnose sturgeon, yellowfin madtom, spotfin chub), and ten species of molluscs (tan riffleshell mussel, Appalachian monkeyface pearly mussel, birdwing pearly mussel, Cumberland monkeyface pearly mussel, Dromedary pearly mussel, fine-rayed pigtoe pearly mussel, green blossom pearly mussel, rough pigtoe pearly mussel, shiny pigtoe pearly mussel, Virginia fringed mountain snail) that do or may exist in Virginia in an endangered status. Active field investigations are in progress to define the true status, distribution, and occupied habitat of many of these species in the state.

Virginia's General Assembly passed two bills during its 1979 session that are important to the State's *Endangered* species. The Virginia Cave Protection Act will hopefully provide much needed protection for caves as well as for cave-dwelling species. The portion of the Act dealing with biological policy states in part: "It shall be unlawful to remove, kill, harm, or otherwise disturb any naturally occurring organisms found within any cave, except for safety reasons..." The Endangered Plant and Insect Species Act provides the first legal protection for plants in Virginia. Only two plants are included: the round-leaf birch is designated an *Endangered* species, and wild ginseng is designated a *Threatened* species. Regulations governing the taking of wild ginseng are established, including an annual harvest season from August 15 to December 31. Plant or plant life is defined in the Act as "any member of the plant kingdom, including spores, leaves, stems, branches, flowers, seeds, roots, and other parts or products thereof." No endangered or threatened plants or insects may be "collected, picked, cut, dug up, or destroyed in any manner." Although no specific insects were included in the original Act, the mechanism now exists for their inclusion and protection when they are identified.

Until now, the only publication on *Rare* and *Endangered* species in Virginia has been an unpublished Master's Thesis by Russ (1973). This thesis contains range maps as well as considerable information on the vertebrate species. These data have been widely excerpted and used in various publications during the past five years.

With the publication of these Proceedings, Virginians now have the most accurate, up-to-date information about their *Endangered* and *Threatened* plant and animal life. It is hoped that the data contained in these pages will be used by responsible persons to ensure the continued survival of these species in Virginia. One vital step in this direction would be either the adoption by regulation of a list of the *Endangered* and *Threatened* species contained in this report by the Commission of Game and Inland Fisheries (molluscs, fishes, birds, mammals), the Board of Agriculture and Consumer Services (plants, arthropods), and the Department of Commerce (sea turtles and other marine species), or the submission of lists by these agencies to the next session of the General Assembly. Only by one of these two procedures will those species not protected under federal law be afforded legal protection in Virginia.

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WELCOMING ADDRESS

Dr. William E. Lavery, President
Virginia Polytechnic Institute and State University

Ladies and Gentlemen. It's good to see all the bright and shiny faces out there this morning, particularly after the workshops last night. It's good to see so many positive kinds of responses this morning. You know, they tell the story about Sir Winston Churchill and his way of thinking positively, particularly when there was a bad night before. They tell the story about him when one evening he was at a party and imbibing spirits just a little bit, and maybe he had a little bit more than he should have had. A lady at the party came up to him and said: "Why, Mr. Churchill, you're drunk!" He replied, "Yes, Madam, and you're ugly, but tomorrow I'll be sober."

We are delighted to welcome you to Virginia Tech, and particularly to this first and unique and exciting Symposium. Endangered species seems to be a buzz word around the country these days. Environmentalists and naturalists, and those in government, and even those of us in higher education and industry of all types, are expressing their concerns about the threatened loss of certain plants and animals, which indeed contribute a great deal to our well-being. Thus, it is good to get together. Books have been written on the subject and it has been the topic of conversation in scientific laboratories as well as at cocktail parties.

The problem indeed is before us, and what could be more natural than to get all those persons who are concerned, informed, and aware of the problem in this region of the country together here at the land-grant university in Virginia to explore this area as it pertains to the Commonwealth of Virginia, and indeed, to other areas of this country. It does seem that such a symposium as this is only natural with all the concerns and emphasis, and yet, as I understand it, it has never been done in Virginia. So, indeed, I would want to add my appreciation to all those who are involved in the sponsoring of this seminar. This symposium concerns a most important, timely, and appropriate topic. This is the first time in Virginia that people have been brought together from various disciplines and agencies around the state and around the region to talk about the areas that are so important to us, and those areas that are being threatened today. We are delighted to have you here. We're particularly pleased to have so many people from outside the Commonwealth of Virginia, and I also want to indicate our appreciation for those people from Virginia being here.

This University as a land-grant university has three major missions. It has not only the instructional program, but a strong commitment to research and to the public service dimension of continuing education. This Center that you are having this seminar in is part of that continuing education responsibility. We hope that you will take advantage of what we have here at Virginia Tech -- our resources, not only in terms of our faculty and personnel, but our laboratories and this facility, this Continuing Education Center.

I welcome you here and commend you for your participation on such a beautiful day when it would be more pleasant to be out on the links or at the lake. We are delighted to have you here, and I hope that you let us know if there is anything we can do to make your stay more productive or your conference more enjoyable. Thank you very much.



OPENING REMARKS

John Cairns, Jr.
Center for Environmental Studies
Virginia Polytechnic Institute and State University

Reverence for life is one of the most important characteristics of an enlightened society. The preservation of human life and improvement of quality of human life has steadily improved in many parts of the world during this century. Recognition of the rights of other species and the environment in general has markedly improved in many industrial societies, although it does not begin to approach the regard in which they were held by many earlier cultures. Ironically, we frequently refer to these as primitive cultures. Although our recognition of rights of other species has improved in many areas of the world, it would be a gross overstatement to indicate that most societies and their governments have anything approaching a reverence for life of species other than our own. In fact, the terrorist movements indicate that this reverence is diminishing even for human life.

We all recognize that species evolve, survive and even prosper for both long and short periods of time. Extinction for a variety of reasons is inevitable. However, many species have become extinct or may soon do so because of human activities. It is not overstating the case to say that the continued existence of large vertebrates and many other species depends primarily on actions of humans. That is what this symposium is all about - Human Action. What will it be in the State of Virginia? Hostile? Indifferent? Or Positive? It probably will be a combination of these, so we will need both educational efforts coupled with a scientific data base and a management plan to be successful. The following issues must be addressed at this symposium or at the meetings that follow.

1. How can reverence for life of other species than our own be instilled in entire societies?
2. What species are endangered, threatened, or of special concern in the State of Virginia?
3. Are the species suffering because of direct actions of man such as over-harvesting, or indirectly because their ecosystems are being destroyed?
4. In which cases is positive human intervention likely to produce satisfactory results?
5. Which species should have the highest priority for attention and resource allocation?
6. How should implementation of the plan be funded?

Obviously these cannot all be resolved in one meeting. Today we will define the problem for various taxonomic groups and provide through the Proceedings publication an information base for future deliberation and action.

By coming here you have demonstrated a reverence for life of other species. On behalf of the Center for Environmental Studies, I thank you for time generously given. Your contributions to this body of information should be of great value in calling attention to the general problem and an aid to those who develop state policy. Gatherings such as this are a heartening sign. Thanks for coming.

OPENING REMARKS

Marvin L. Wass
Virginia Institute of Marine Science

On behalf of Dr. William J. Hargis, Jr., Director of the Virginia Institute of Marine Science, commonly referred to as VIMS, I also wish to welcome you to this Symposium, as representing one of the three co-sponsors. In an area which saw the first English settlements introduced to the American Indians, conservative Virginians should be proud to hold this conference in a setting which has so much scarce flora and fauna.

While we, as naturalists, cherish stability, we must arm ourselves with knowledge and dedicate it to our posterity so that those who come after us may cherish and preserve our best attributes and entities, be they solid works of man or natural shrines.

Research on Chesapeake Bay began a century ago when the Johns Hopkins University established a research station at Fort Wool at the mouth of the great James River. A lingulate brachiopod larva was found there, so it may have been the first invertebrate extirpated from Chesapeake Bay, none having been reported since then.

The College of William and Mary instituted the Virginia Fisheries Laboratory at Yorktown in 1940. In 1948, following the completion of the bridge over the York River, the laboratory was moved to Gloucester Point, and in 1962 it became the Virginia Institute of Marine Science. VIMS now has 585 employees and graduate students. It is advantageously located, being 33 miles from the sea and 35 miles from the normal freshwater line.

The Eastern Shore Field Station at Wachapreague commenced in 1958. It now has facilities for culturing many species of marine molluscs, mainly hard clams and Virginia oysters. It has hosted a great many visitors, students, and a number of foreign scientists.

We are proud of our educational record, having graduated 182 students with advanced degrees. The first student was R. Winston Menzel, a native of Tidewater Virginia, and now a professor at Florida State University. His brothers operate a fish plant on the Chickahominy River, so they know the chemical hazards in the James. The next two graduates were women, both Virginia natives. Many VIMS students are now well known, most being scattered along the coasts, several having had a stay in Antarctica, Hawaii and Australia.

In Virginia it appears there may be as many rare species of organisms on the coast as in the mountains, and many less in the Piedmont, if one could easily capture specimens of all the invertebrates in Virginian estuarine waters. Twenty years ago nothing was said about endangered species, except that many could remember the demise of the bay scallop in Chesapeake Bay in 1931-32. From thence on, the system began to deteriorate more rapidly. Men now gone lamented the deteriorated quality and amount of oysters in the York River. The MSX disease dealt the worst blow to the higher salinity oysters in the Bay and lower rivers.

Bottom waters became anaerobic behind river sills as oxygen sagged too low for survival of some animals in summer. Blue crabs became moribund and often died quickly if taken from such waters. Certain investigations at Lynnhaven Bay, Hampton Roads area and elsewhere, indicated the situation by a paucity of invertebrate species, a continuing phenomenon.

In 1972, Tropical Storm Agnes drastically affected the eelgrass beds in lower salinity waters to the extent that many simply disappeared from much of the western shore of the Bay. A series of warm winters (1970-1977) didn't help the situation, and by 1974-75, no eelgrass washed ashore at Gloucester Point. Some scientists attribute low blue crab populations to the loss of eelgrass, a subject now under study.

Oil spills have obviously increased in the last two decades. Two of these were in winter, and apparently only affected waterfowl, but two others in the lower York River were very deleterious. Both occurred in the last week in June of 1975 and 1976. Since then, the once abundant dog whelk, mud snail, hermit crab and rapid isopod have been non-existent or seen only as juveniles.

In the years ahead, more species will be found in greater numbers as more areas are sampled, and it may be that many rare species are yet to be found. Hopefully, cessation of continuous deleterious effects will allow a resurgence of species whose populations are now low, so that more research on species needs can be determined.

PHYSICAL AND ENVIRONMENTAL GEOGRAPHY OF VIRGINIA*

Richard L. Hoffman

Introduction

From the standpoint of biogeography, the Commonwealth of Virginia enjoys an especially favorable position. In an east-west direction, the state embraces no less than five of the major physiographic provinces of the eastern United States, with a resultant diversity of topography and habitat types. Through the combination of latitudinal location (36.30 to 39.30° N) and a considerable range of vertical relief (sea level to 5,720 feet), a variety of biotic associations determined primarily by climatic factors is found within the political boundaries of Virginia. To a greater extent than in adjoining states, the surface drainage is shared among basically old and geographically important river systems. Yet, despite the long and venerable tradition of education and culture in Virginia, relatively little attention has been paid to the biota of the state -- we still know only very imperfectly what kinds of plants and animals occur here, to say nothing of the patterns and dynamics of their distribution.

So far, only a few groups of organisms have been surveyed as regards their occurrence in Virginia, namely the birds, mammals, and various small groups of vascular plants. For the State there exists a manual on the ferns and allied forms (Massey, 1944); a fairly detailed account of the butterflies (Clark and Clark, 1951); a checklist of the avifauna (Murray, 1952); and two popularized handbooks of the mammals (Bailey, 1946; Handley and Patton, 1947). Aside from these, one must turn to technical literature -- monographs and other systemically oriented papers -- for information on the occurrence of animal and plant life in our state.

We may envisage several categories of environmental influences that tend to affect the distribution of organisms at a local level. To a large extent these factors are mutually interacting; for example, the soil composition of a given region may be a function of both vegetation cover and rock type, and the relationship between elevation and temperature is well-known. It seems appropriate, therefore, to consider such lithospheric categories as geological and physiographic regions, and various climatic variables, in order to better understand the distributions of our *Endangered* and *Threatened* plants and animals.

Overall Geological Features

Briefly stated, the surface rocks now exposed in Virginia represent a nearly complete section from Precambrian to the present time, with deposits of the Permian and Jurassic ages omitted, and with only minimal traces of the Triassic beds remaining.

*Excerpted from *The Biotic Regions of Virginia* by Richard L. Hoffman. 1969. VPI&SU Research Division Bulletin 48:23-62.

West of the Blue Ridge, there are extensive formations of Paleozoic sedimentary rocks extending upward to about the middle Pennsylvanian, and scattered intrusions of volcanic origin, perhaps of Cretaceous age. East of the Piedmont, the so-called Coastal Plain is composed of poorly consolidated clastic sediments derived from the Appalachian region, and dating in age from upper Cretaceous to Pleistocene. The intervening regions, Piedmont and Blue Ridge, are largely crystalline volcanic and metamorphic rocks, often highly mineralized, and extremely variable in chemical composition. Much of the Piedmont has a characteristic appearance; the rocks, upon weathering, produce reddish lateritic clay that is often micaceous and tends to choke small streams with a glittering silt. The Blue Ridge is formed of considerably more resistant rocks; granites, schists, greenstone, and slates are common.

Geological History

The geological history of Virginia is common to that of the entire central Appalachian region. The area now included in the western third of the state was an active geosyncline during most, if not all, of the Paleozoic, during which time about four miles of sediments were accumulated from a source area (the so-called "Appalachia") presumably located on the present site of the Coastal Plain and the Continental Shelf. Up to and including part of the Mississippian, the deposition was entirely marine, but during the late Paleozoic, gradual emergence of the entire region permitted the formation of freshwater lacustrine and terrestrial formations, including carbonaceous shales and coal. Fossils of terrestrial organisms are frequent in Pennsylvania beds.

During the Permian the entire basin of deposition was subjected to lateral compression and general uplift, resulting in extensive folding and faulting along a northeast-southwest axis. This activity was strongest in the eastern part of the geosyncline, where the original width was reduced by more than half; in the western region (the area now occupied by West Virginia), folding was negligible and the Paleozoic beds remained basically horizontal. The structural deformation of this time largely set the stage for the eventual development of the present topography by erosional cycles millions of years later in the Tertiary.

Contemporaneously, the eastern source areas continued to be lowered both by continued erosion and by subsidence of its eastern part beneath the Atlantic. Erosion of the newly elevated western region was in progress, and by Triassic time, an extensive level plain (the so-called Fall Zone Peneplain) is thought to have developed, with its western margin located somewhere east of the present Virginia-West Virginia boundary. During this time, the region now included in the Piedmont of Virginia, Pennsylvania, and New Jersey developed basins of deposition accumulating chiefly terrestrial sediments, some of the latter being red sandstones with the footprints of small three-toed dinosaurs.

During the Jurassic, the entire area was above sea level, and erosion continued. In the early Cretaceous, sediment from the folded Appalachians was deposited along the shore line, corresponding roughly with the present boundary between Piedmont and Coastal Plain. Later, in the Cretaceous, there was a general uplift that rejuvenated the existing drainage systems and commenced a new cycle of erosion that continued for some millions of years to the Miocene time of late middle-Tertiary age. This erosional process resulted in the formation of the so-called Schooley Peneplain, thought by Fenneman (1938) to have been an undulant, poorly drained landscape with isolated knobs and ridges standing perhaps a thousand feet above the mean level. It is considered that many of the highest existing peaks and ridges of the folded Appalachians represent degraded remnants of the Schooley Peneplain surface.

An uplift of the region, perhaps during the late Miocene, initiated a new erosional period extending into the Pliocene, during which time the Harrisburg Peneplain was developed. This physiographic level is presently represented by the Shenandoah Valley and the Piedmont, as well as along larger rivers within the folded Appalachians. Further uplift since the Pliocene has caused a new erosional cycle which is

still cutting into the Harrisburg level and producing a number of small localized erosion surfaces.

Throughout most of the Tertiary, the Coastal Plain has been subject to gradual emergence, and its innermost surfaces were involved in the aforementioned erosional activities. At the present time, the Coastal Plain consists of a number of wave-cut terraces running parallel to the Fall Belt. The history of these terraces is involved with the sequence of glaciated periods during the Pleistocene when the shorelines receded drastically seaward, and deep gorges were cut by the major rivers across the Coastal Plain beds. At the present, the Coastal Plain appears to be in a period of submergence; its outer extent (including Chesapeake Bay and major estuaries) under many fathoms of water.

Physiographic Provinces

The land surface of any area may be classified into discrete regions on the basis of local homogeneity of topographic features. These, as might be expected, result from the interaction of erosional forces and subsurface lithologic units, and to a certain extent agree closely with the major geological provinces. However, the structural orientation and/or deformation of the rock types is as significant (or more so) in the origin of physiographic regions as their lithological composition, chiefly because of the resultant effect upon the behavior of both surface and ground water. The two major provinces, Ridge and Valley and Appalachian Plateaus, are developed from essentially similar upper Paleozoic sedimentary rocks, but the different degree of folding, thrusting, faulting, and so on, has influenced the totally different surficial form of these provinces.

The outstanding general reference upon this subject as it concerns our area is Fenneman's *Physiography of Eastern United States* (1938) which should be consulted for characterizations of the provinces and subprovinces and landform features endemic to each. Simplified maps are available in numerous textbooks of physiography and general geology. The following remarks pertain chiefly to the significance of the various regions as they occur in Virginia, and actually or potentially influence distribution patterns. Five provinces in two primary categories (Figure 1) may be outlined as follows:

- | | | |
|-------------------------|---|--------------------------|
| 1. Coastal Plain | } | Appalachian
Highlands |
| 2. Piedmont Plateau | | |
| 3. Blue Ridge | | |
| 4. Ridge and Valley | | |
| 5. Appalachian Plateaus | | |

The Coastal Plain is an essentially flat-lying region of sands and poorly-consolidated beds of clays, marls, and gravels. It corresponds very closely to the part of Virginia known as "Tidewater" since most of the larger streams that cross the coastal plain are essentially at base level and are subject to tidal movements. Geologically, the region consists of sediments ranging in age from Cretaceous to Upper Tertiary laid down unconformably upon a basement of crystalline rocks extending eastward from the Piedmont. During the Quaternary glacial periods, an appreciably lower sea level caused a greater seaward extension of the Coastal Plain than is now evident, although this fluctuation is commemorated by deep submerged river valleys that cut across the bottom of the Chesapeake Bay and some of the larger estuaries. From west to east, beginning at the base of the so-called Fall Belt that extends from Great Falls to Fredericksburg to Richmond and southward, a number of progressively lower wave-cut terrace levels are distinguishable and have been given names derived from areas of classical exposure. The larger rivers -- James, York, Rappahannock, and Potomac -- are bordered along much of their extent by prominent steep cliffs cut in the calcareous Yorktown beds (Miocene in age), but many other rivers that are less deeply entrenched, such as the Blackwater, flow slowly through broad and often swampy floodplain basins that duplicate habitats more characteristic

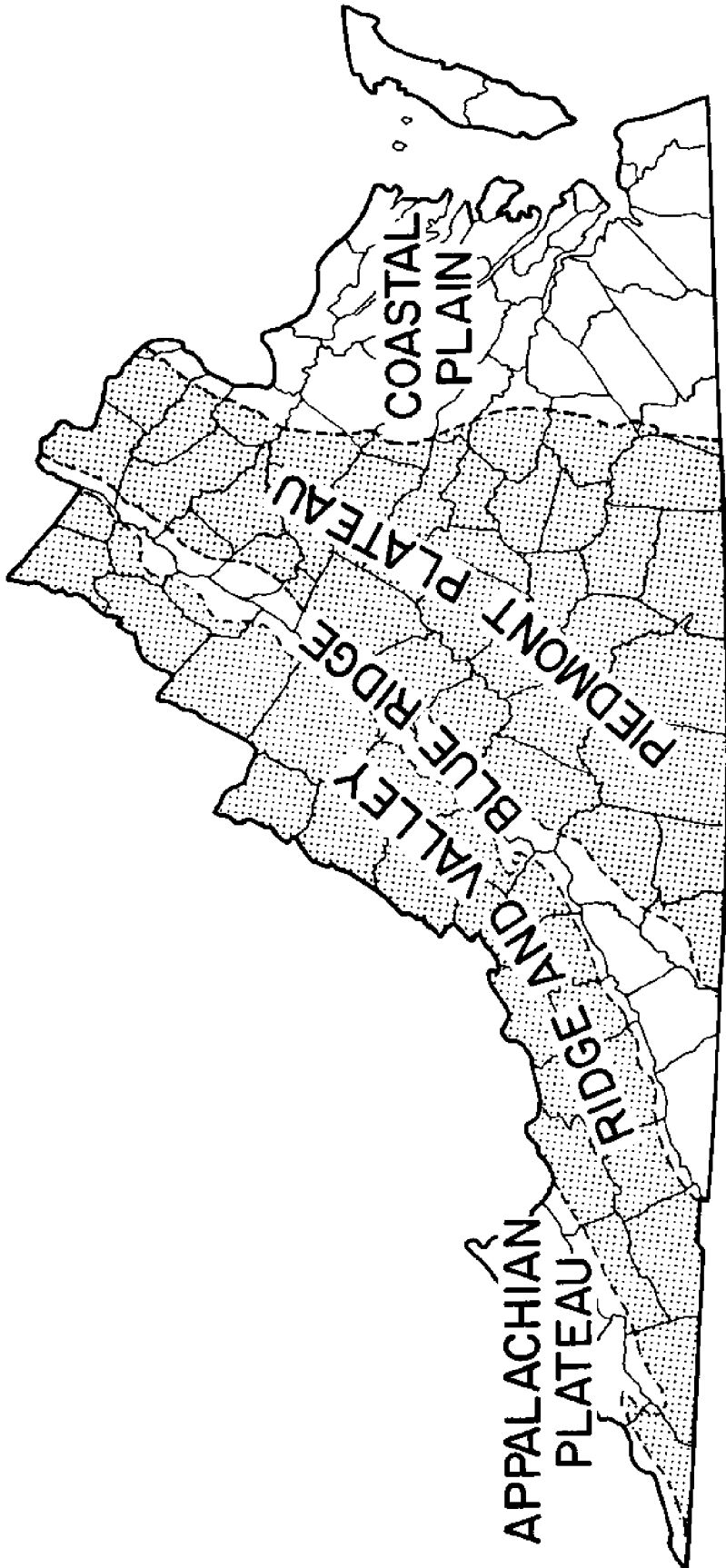


Figure 1. Physiographic Provinces of Virginia

of the southeastern states. Physiographically, the Coastal Plain has been divided into the Atlantic and Gulf regions. In Virginia it is not possible to readily distinguish subdivisions aside from the previously-mentioned terrace levels.

In the usage of Fenneman (1938), the Appalachian Highlands region is divided into six major provinces, four of which extend through a part of Virginia in a diagonal northeast-southwest direction. Aside from being components of the great mountain system of eastern North America, these provinces have little in common, either lithologically or structurally, and each has developed a very characteristic topography.

The Piedmont region extends from southeastern Pennsylvania to central-western Georgia, as a rolling peneplain established upon a base of crystalline metamorphic rocks. Entering Virginia from the north, it is a relatively narrow strip between Great Falls and Harper's Ferry; in going southward, the Piedmont widens strongly, and along the southern boundary of the state, occupies all of the region between Emporia and Stuart. Basically well-drained, the Piedmont nonetheless contains several lowlands in a central strip extending southward (the well-known Triassic Lowlands) in which lotic environments are developed. Running down the western third of the Province are a variety of hills and ridges essentially parallel to the Blue Ridge and averaging about 20 miles east of it. These outliers include Bull Run Mountains east of Warrenton, Carter's and Southwestern Mountains in Albemarle County, and Smith Mountain northwest of Chatham. Between this chain of ridges and the Blue Ridge itself, the Piedmont assumes a distinctly more hilly and diverse relief and is sometimes referred to as the "Inner Piedmont" in contrast to the more monotonous "Outer Piedmont" that rolls eastward to the Fall Belt. But this latter subregion itself shows sporadic higher relief; the somewhat surprising Willis Mountain in Buckingham County may be considered a monadnock.

The naturalist crossing Virginia from the east must be inspired with admiration upon his first sight of the majestic Blue Ridge. Rising a thousand feet from the rolling Piedmont, this grand and well-named range of sharp peaks and broad rolling crests divides the state into two radically different parts. From a relatively low and narrow mountain, cleft by the Potomac at Harper's Ferry, the Blue Ridge gradually gains in stature in going southward until south of Roanoke it becomes an elevated plateau nearly 3000 feet above the sea, upon which in turn stand the great fir-capped peaks of the Iron Mountains: Whitetop and Mount Rogers.

The Blue Ridge is composed primarily of metamorphosed igneous rocks (granites, granodiorite, slates, and green stone), although Lower Cambrian formations lie upturned all along its western slopes, both in Tennessee and Virginia. It is possible to distinguish two quite different regions in Virginia, referred to by Fenneman (1938) as the Northern and Southern sections, separated approximately at the Roanoke River. Between the Roanoke and Potomac water gaps, the Blue Ridge consists of a jumbled range of broad-topped ridges, some 3000 to 3500 feet in elevation, with frequent peaks extending nearly or quite to 4000 feet. This Northern Section, which extends on into eastern Pennsylvania, is here about five miles in average width, often becoming much narrower in the vicinity of major wind and water gaps. To the west lies the broad, flat Shenandoah Valley, to the east is the even lower Piedmont Plateau; the Blue Ridge is here clearly isolated, its exile still being enforced and increased by the progressive base-leveling of the Shenandoah, a process that commenced during the late Cretaceous, according to the studies of Watson and Cline (1913).

South of the Roanoke gap, the Blue Ridge begins to assume the increasing height and breadth that culminates in western North Carolina in the great ranges of the Blacks, the Balsams, and the Great Smokies, where dozens of peaks exceed 6000 feet in elevation. Driving south on U.S. Interstate Highway 81, as it passes Salem, Virginia, one gets an excellent view of the beginning of the Southern Section of the Blue Ridge, where this region terminates at Poor Mountain in Roanoke County, a prominence standing 3000 feet above the river that skirts its northern base. Southward, along the western edge of Franklin and Patrick counties, the Blue Ridge forms a high

escarpment, behind which lies the rather high, intermontane plateau drained by the upper New River and its two major tributaries, Little River and Big Reed Island Creek. This region, embraced chiefly in Floyd, Carroll, and Grayson counties, is bordered on the west by a series of essentially continuous ridges beginning with Poor Mountain and ending at the Tennessee-Virginia state line on Iron Mountain. Locally this range is broken into short segments by water gaps -- Pilot, Macks, and Poplar Camp are the successive unit names, although in actuality, all are synonymous with Iron Mountain. The relief of the Blue Ridge intermontane plateau in Floyd County is one of deeply dissected valleys and ravines, although a few notable elongated ridges stand above the plateau level: Alum Ridge, Indian Ridge, Willis Ridge, and Buffalo Mountain. In the vicinity of Buffalo Mountain (one of the scenic highlights of the region), many square miles lie above 3000 feet. Both Little River and Big Reed Island Creek have carved magnificent deep gorges across the Iron Mountain chain. The biota of both areas must be studied immediately, before they are destroyed forever by needless damming of these beautiful wild streams. The western third of Grayson County contains the tallest and most scenic mountains in Virginia, Mount Rogers and Whitetop, which together comprise the aptly-named Balsam Mountains. These two adjacent domes, separated by a pass 4000 feet above sea level, are clad with extensive forests of red spruce and Fraser fir, analogous to those of the northern evergreen biome.

West of the Blue Ridge extend the sedimentary formations of the Paleozoic age which are divided on the basis of structural factors into two provinces. In a broad belt ranging from New Jersey to Alabama occur the complexly folded and faulted beds of the Ridge and Valley Province, in which the original extent of the formations was reduced to less than half by lateral compression. The name of this physiographic unit derives from the topography of narrow, elongated, parallel ridges and intercalated valleys that developed upon this base following its peneplanation during the Cretaceous. The drainage today represents very strikingly the trellis pattern.

Within the Ridge and Valley Province it is possible to recognize two quite different topographic regions, which may be referred to as the Great Valley and the Alleghenies respectively. The first of these is a broad, gently undulant plain lying immediately west of the Blue Ridge, which it follows from Pennsylvania to Alabama, developed by the base-levelling action of various major streams upon chiefly limestone and shales of Cambrian and Ordovician age. In Virginia, the Great Valley is divided into several segments corresponding closely to local drainage systems; thus, we have from north to south the Shenandoah, Roanoke, New, and Holston Valleys in succession. The Shenandoah and Roanoke drain eastward into the Atlantic and range in average local elevation between 800 and about 1100 feet above sea level. The New and Holston contain the headwaters of west-flowing streams and are really high plateaus of 1000 feet up to 2500 feet in height. Because of this drastic difference in valley floor elevation, the Great Valley as it crosses southwestern Virginia is bordered on each side by relatively less distinct ridges, although these may actually be as high here as farther north. The Valley may be as much as 30 miles in width in northern Virginia, and yet narrows down to less than a mile in the vicinity of Buchanan, where it is largely closed off by ridges projecting in from the west. At such a place, the Valley obviously is scarcely the same zoogeographic barrier as elsewhere, and the same thing is true farther south, in the vicinity of Wytheville and Marion, where local peaks and ridges constitute a sort of higher-elevation "land-bridge" from the Iron Mountains across to the Alleghenies. The Great Valley connects with the Piedmont at two narrow water gaps, those of the Potomac River and James River, and one broad-low one where the Roanoke crosses the Blue Ridge. The Roanoke River passageway constitutes a major entry for lowland species making their way upstream.

The Valley of the Holston River, represented by three major headwaters, is again relatively broad and flat. From an eminence such as Mount Rogers, one can discern the outline of Clinch Mountain nearly 30 miles across the valley to the west.

Immediately along the western edge of the Great Valley the topography changes abruptly and dramatically for the entire length of western Virginia. Here begins a belt of alternating high narrow ridges and broader valleys ranging in width from about 35 miles in the latitude of Winchester, to about half that distance in southwestern Virginia. This region owes its characteristic relief almost entirely to the occurrence of a single geological formation, the Clinch (Tuscarora) sandstone of Silurian age. Although not especially thick, this bed of white marine sandstone is unusually resistant and uniform throughout the extent of the Alleghenies, and forms a protective cap supporting the tops of the highest ridges in the region. It is admirably shown in such outlying features as House Mountain near Lexington, and in the winter months may be seen like the ramparts of a castle at many places in western Virginia.

The ridges and mountains may be classified structurally into two chief types: synclinal and anticlinal; the latter perhaps the more frequent. Anticlinal ridges are formed by the removal of the domed or arched part of a large fold, leaving behind the two sloping sides which usually face each other across a valley of older formations comprising the interior of the original arch or fold. Usually the Clinch Sandstone is exposed along the upper edge and outer slopes of these ridges, subtended lower on the inner slopes by extensive outcrops of Ordovician shales. In several instances, the breached anticline may have been originally an elongated or lens-shaped dome, and the resultant erosion of its softer interior beds produces a rather high, narrow, "canoe-shaped" anticlinal valley, examples of which are Burkes Garden, Tazewell County; White Rock Valley, Alleghany County; and Bolar Valley in Bath and Highland counties. Usually, one end of the valley is produced into an exceptionally elevated part of the rim of the mountain top. At Burkes Garden the high point is Beartown Mountain (4,705 feet) on the southwest end of the bowl; in the base of Bolar Valley, it is Sounding Knob (4,390 feet) at the northeast end that comprises the highest place. In all three of the localities mentioned, the valley floor is nearly or quite 3000 feet above sea level, and such regions tend to remain relatively cool, even in midsummer. They usually contain extensive cave systems, sinks, and springs.

Synclinal mountains are formed by the preservation of resistant sandstone beds along the central axes of larger synclines; thus, both slopes of such mountains may be composed of shale deposits and the tops may be relatively broader and flatter than in the base of the rather sharp-crested anticlinal ridges.

Probably the most extensive synclinal systems in Virginia are to be found in the western part of Augusta and Rockingham counties: Great North Mountain attains a height of 4458 feet at Elliott's Knob, and Reddish Knob on the Virginia-West Virginia state line is nearly as high (4,397 feet), but such dimensions are somewhat exceptional. In southwestern Virginia, the impressive *vis-a-vis* prominences, Butt Mountain and Angel's Rest in Giles County, are part of a previously continuous synclinal mountain now breached by the New River at Pearisburg.

As remarked, the drainage pattern throughout the region is dominantly of the trellis type, with numerous and often impressive water gaps breaking the parallel ridges. Because of the relative depth and narrowness, these gaps often remain cool and damp throughout the year and afford local havens for the survival of various thermophytic species. Unfortunately, the same physical characters make water gaps attractive to dam-builders, and the naturalists must make haste to study these regions before they have all been inundated or otherwise despoiled.

The southwesternmost counties of Virginia (Lee, Dickinson, Wise, Scott, Russell, Buchanan, and Tazewell) lie partly or entirely within the Appalachian Plateaus Province, the surface features of which are developed on Upper Paleozoic sedimentary rocks that are virtually horizontal, and only rarely interrupted by faulting. As a result, the drainage pattern is dendritic, and has developed a great ramifying system of deep, narrow valleys draining to the west by way of the Big Sandy and Cumberland rivers. At many places the uppermost resistant sandstone beds may stand out

like great battlements, winding their way for miles along the contour of a particular elevation. Coal beds are abundant and have been exploited for decades by tunnel and strip mining, the latter process often resulting in vast, unsightly terraces following the coal seams along the mountainsides. In this region the province does not attain much height, and appears as a low plateau with rolling hills and valleys to an observer looking west from the summit of Clinch Mountain. As might be expected, the difference in relief and elevation results in rather striking differences in the biota of the Appalachian Plateau. From its easternmost limits (as at Sandy Ridge, forming the boundary between Russell, Dickenson and Buchanan counties), there is a gradual westward downslope virtually to the Kentucky state line, which follows Pine Mountain to its culmination at the Russell Fork River at Breaks. Northeast of this river there is no geographical demarcation between Virginia and Kentucky. In Lee County, the province is represented for the most part only by the eastern escarpment of Cumberland Mountain, although in the region of St. Charles and Pennington Gap, the state line curves westward to encompass some of the Black Mountain range, the latter being well represented in Wise County.

Climatic Factors

It is difficult to present detailed information about the distribution of temperature and precipitation in Virginia except in the most general terms. Despite the relatively good coverage of the state by recording stations, the fluctuations of climate, especially in mountainous regions, is often so localized as to escape detection or to be impossible to show on a map. Climatic information, both tabular and graphic, is available for Virginia in "Climate and Man: 1942 Yearbook of Agriculture" and more extensive and recent data of the same type in "A Handbook of Agronomy" (Bulletin 97, Cooperative Extension Service, Virginia Polytechnic Institute, 1966), from which the following notes have been abstracted.

Average Precipitation

Average annual precipitation in the state ranges from about 35 to 51 inches in a somewhat irregular pattern of high and low areas (Figure 2). In general we can recognize three areas of greater annual precipitation: in the central Blue Ridge from the Peaks of Otter north to Hawksbill Mountain; in the Dismal Swamp region; and in the extreme western half of Lee County. There are two areas of low precipitation: one in the western part of Rockingham, Shenandoah and Frederick counties; and a much smaller one centered in Pulaski County. Perhaps these two areas fall in a "rain shadow" of high mountains lying just to the west of them.

Snowfall records indicate that the southwestern Coastal Plain receives the lowest amount for the state (less than 10 inches per annum); it therefore receives a greater relative amount of rainfall than other parts of the state. The central Blue Ridge and the Burkes Garden region record the maximum snowfall according to the maps, but almost certainly the Mount Rogers region also must fall into this category.

Growing Season

To a considerable extent, the thermal characteristics of a given region are reflected by the number of frost-free days per annum or by the length of the effective growing season. For the great majority of Virginia's counties the growing season lasts from 150 to 200 days. In two local regions (the higher mountains in Tazewell and Smyth counties, and in parts of Bath and Highland counties), the figure drops considerably below 150 (only 136 at Burkes Garden - 3,000 feet). Three areas enjoy a growing season longer than 200 days: the Holston Valley near Bristol; a part of the inner Piedmont in Albemarle, Nelson, Campbell and Appomattox counties; and a large part of the outer Coastal Plain, where a state maximum of 254 days is recorded at the Norfolk Airport.

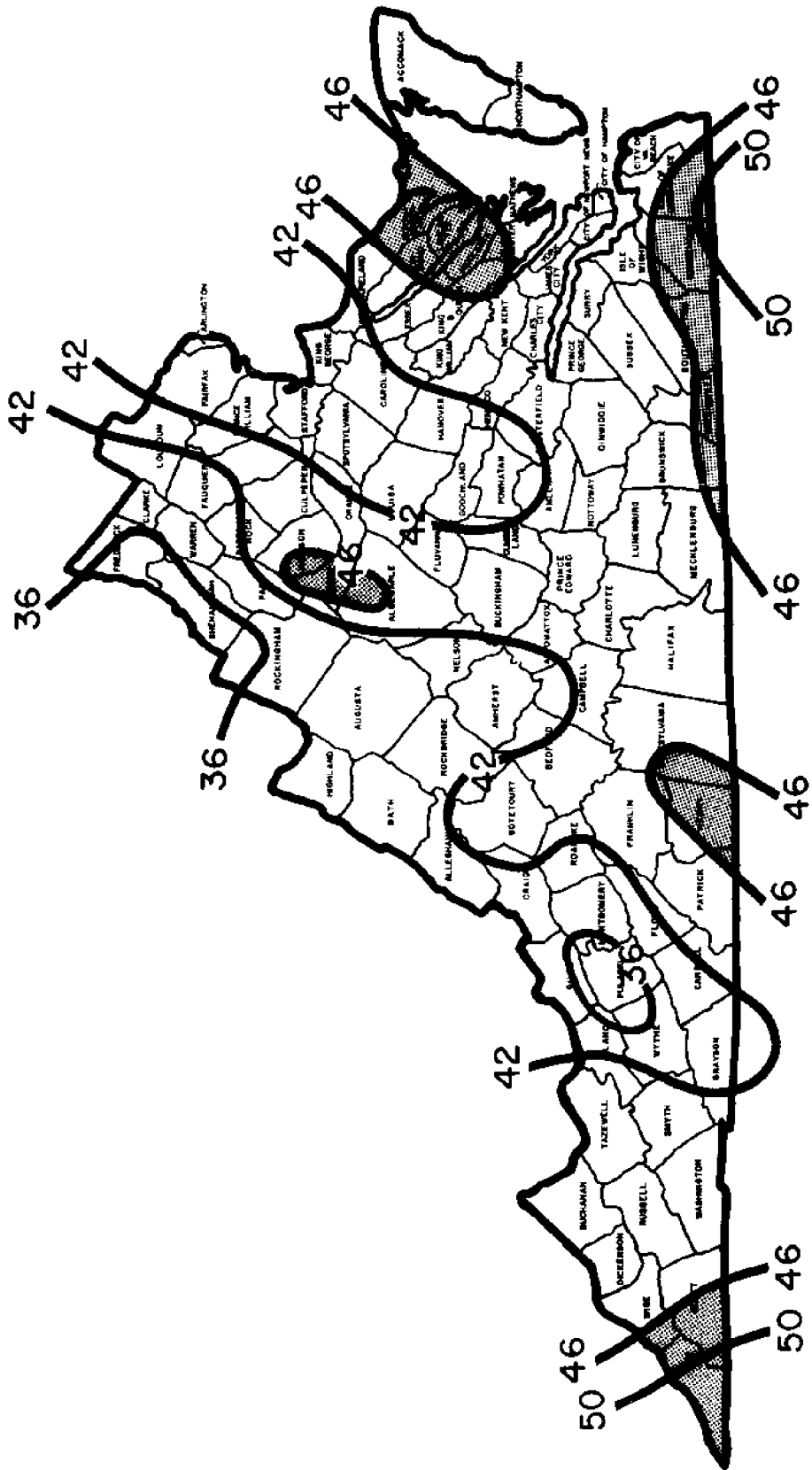


Figure 2. Average annual precipitation in Virginia. For clarity, only arbitrarily selected isophenes are mapped. Areas receiving over 46 inches of precipitation are shaded.

It must be emphasized that statewide maps of climatological data inevitably must be oversimplified, and fail to reflect local vagaries which may be quite pronounced within the space of one or two miles. Even in mountainous regions where such variation is most pronounced, most weather stations are located in the lower valleys, and we cannot rely on official records to show local patterns.

The effect of elevation upon temperature is well-known, and I need cite only one example that is already familiar to many biologists: the contrast between Blacksburg (in the Great Valley at 2,100 feet) and Mountain Lake (only 10 miles to the northwest but in the Ridge and Valley Province at 3,800 feet). Within the limits of my personal experience, the difference of 1700 feet vertically creates a thermal difference of about 20°F, perhaps even greater during the night. In the winter, snow appears on the higher ridges (above 3,500 feet) several weeks prior to the first fall in the valleys, and may persist an equally longer time in the spring. It is not unusual, as a corollary, for various flowers to be found in bloom at 4000 feet for 6 to 8 weeks after their season is over at 2000 feet or lower. Obviously, however, the accurate delineation of local weather patterns would require data from thousands of strategically-placed stations within a relatively small area.

Forest Types

The classic reference source on the forest cover of our region remains the exceptionally useful *Deciduous Forests of Eastern North America* (Braun, 1950), which provides additionally a wealth of information on physiography and forest ecology in general. Braun recognized nine major deciduous forest regions, of which four occur in Virginia:

1. Mixed Mesophytic Region
 - a. Cumberland Mountains
 - b. Allegheny Mountains
 - c. Cumberland and Allegheny Plateaus
2. Oak-Chestnut Region (Braun's 4th region)
 - a. Southern Appalachians
 - b. Northern Blue Ridge
 - c. Ridge and Valley
 - d. Piedmont Section
3. Oak-Pine Region (Braun's 5th region)
 - a. Atlantic Slope Section
4. Southeastern Evergreen Region
 - a. Mississippi Alluvial Plain

The majority of Braun's book is devoted to a detailed consideration of the characteristics and distribution of the various regions and sections. It is therefore possible to present here only a very brief outline of the situation in Virginia with the expectation that the interested student will have or find access to Braun's manual.

The definition of regions and smaller divisions is somewhat subjective and arbitrary. Braun remarks that "Even though a region is named for the climax association normally developing within it, it should not be assumed that the region is coextensive with the area where that climax can develop." As defined by her, a climax association is said to possess a unity throughout its geographic extent resulting from:

1. some uniformity in particularly the dominant floristic components,
2. essential uniformity in physiognomy (general appearance), and
3. common historical and/or genetic origin.

However, there exists considerable variation within any region or section as regards the composition of the flora or proportional representation of the dominant

species. Such variation can be geographical, altitudinal, local, or successional. In general, the various regions are defined primarily on the basis of their areas of most characteristic development, but this does not preclude the occurrence of localized pockets of a given region outside its mapped range. For instance, the Mixed Mesophytic Region, per se, occurs only along the very westernmost periphery of Virginia, yet it is possible to note the occurrence of fairly characteristic mixed mesophytic associations at suitable places in the Ridge and Valley and Blue Ridge physiographic provinces (where they are referred to as "cove forests").

Although the distribution of the various forest regions is largely determined by climatic factors, it is interesting to compare physiographic provinces and forest types to note an obvious relationship. Thus, the Mixed Mesophytic corresponds closely to the Appalachian Plateau province; the Oak-Chestnut to the Mountains and Northern Piedmont; and the Southeastern Evergreen to the Coastal Plain. Even a person who has little botanical knowledge can appreciate the obvious and characteristic facies produced by the combination of a particular forest association and a certain physiographic unit.

It must be recalled that on the basis of other criteria, quite different mapping of forest types will result. The map of Kuchler (1964) bears no resemblance to that of Braun, owing to the fact that its various forest regions are defined in different terms. Kuchler shows most of Virginia to be occupied by oak-hickory-pine forest; the Blue Ridge and southern half of the Ridge and Valley by Appalachian oak forest; and a few scattered areas by northern hardwoods, mixed mesophytic, and southern floodplain forest. As one who has lived and travelled in the region for decades with some awareness of vegetational cover, I feel partiality to Braun's arrangement.

The regions recognized by Braun may be very briefly summarized as follows:

Mixed Mesophytic Forest

The mixed mesophytic forest is characterized by the sharing of dominance among several species of trees, notably beech, tulip poplar, basswood, sugar maple, sweet buckeye, chestnut, red and white oak, and hemlock. This association develops only on moist but well-drained soils. Braun states: "It occupies a central position in the deciduous forest as a whole, and from it or its ancestral progenitor, the mixed Tertiary forest, all other climaxes of deciduous forest have developed." The importance of this region in the study of particularly humus-inhabiting organisms must therefore be emphasized, as it represents an environmental type of considerable antiquity and stability. In Virginia, the best development of this forest is to be seen in the far southwestern counties of Wise, Dickenson and Buchanan, although decades of promiscuous logging have considerably altered the original aspect of the association in most places. To be sure, small local pockets of this association are to be found in deep, cool watercourses along the Blue Ridge and in many waters gaps of the Alleghenies. A feature not emphasized by Braun is the frequency of magnolias of several species, notably, *Magnolia tripetala*.

Oak-Chestnut Forest

Braun defines the oak-chestnut forest region by "...the former dominance of oak-chestnut forest on most of its slopes, and by the dominance of white oak forest, particularly on the broad expanses of the Great Valley." This region and its several local sections occupy most of mountainous Virginia, and in fact, extend also to the east across the northern Piedmont. It must be recalled that within the region as mapped, there exists a complex mosaic of oak-chestnut (now largely oak-hickory) forest with pine forests in drier environments and mixed mesophytic in the damper. Often all three forest types may be seen in contiguous places along a given mountain range.

At higher elevations (chiefly above 4,500 feet in the Iron Mountains of Virginia), the oak-chestnut forest is replaced by a more boreal type of association in which sugar maple, yellow birch, beech, and buckeye are the dominant trees. This

"northern hardwood" forest is conspicuous on the eastern slope of Mount Rogers, for instance. It is in turn succeeded above by the spruce-fir stands with scarcely any intergradation. Along the streams the northern hardwood facies merges into cove forest with no intercalation of oak-chestnut.

Oak-pine Forest

The oak-pine forest is correctly considered by Braun as a sort of transitional region between the Appalachian forest and the evergreen region of the Southeast. The climax association is one of oak and hickory, but the abundance of pines in secondary forests and their general occurrence, even in the climax, justifies the recognition of a major regional type. It is best developed in Virginia in the southern Piedmont ("Southside Virginia").

Southeastern Evergreen Forest

In the usage of Braun, the southeastern evergreen forest region extends from the James River south and west as far as eastern Texas, and is distinguished by the preponderance of evergreens, particularly longleaf pine. It contains, however, abundant broadleaf forest representation.

Braun arbitrarily draws the northern limit of this region at the James, partly because of a major change in soil type there, and because the characteristic longleaf pine does not extend farther north. She emphasizes, however, the numerous other species characteristic of the region do occur sporadically as far northward as New Jersey.

Kuchler's map of "Potential Natural Vegetation" (1964) does not include a southern evergreen category; however, his "Southern Floodplain Forest," characterized by oaks, blackgum, and cypress, likewise terminates in Virginia south of the James.

Although the Coastal Plain is a relatively young surface as far as its availability as an environment is concerned, nonetheless the Southeastern Evergreen Region contains a number of ancient types of plants which are either endemic or else represented sporadically in the Appalachians or the interior of the continent. The Coastal Plain populations in these forms must be considered as migrant relicts (have survived fragmentation of their original distribution and moved into areas which have become available since that event). M. L. Fernald devoted many years to the flora of southeastern Virginia, but much field work remains to be done, and the speed at which the region is being urbanized or otherwise modified imparts a sense of urgency to such studies.

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VASCULAR PLANTS

Duncan M. Porter

Introduction

Virginia has been tardy in producing an authoritative list of its *Endangered* and *Threatened* plant species, having been preceded in this regard by several other southeastern states: Alabama (Thomas, 1976), Georgia (McCollum and Ettman, 1977), North Carolina (Hardin *et al.*, 1977), West Virginia (Fortney *et al.*, 1978), and Tennessee (Committee for Tennessee Rare Plants, 1978). Nevertheless, there has been a long history of concern regarding our botanical rarities. In 1957, the Garden Club of Virginia prepared a list of wildflowers that should be conserved, and in 1968, the Virginia Federation of Garden Clubs published a list of native plants needing protection in the Commonwealth. The former list was greatly expanded by colleague Leonard J. Uttal (Uttal, 1969), and an unpublished 1972 revision of this list served as the starting point for the Plant Committee. The Committee made many recommendations for additions and deletions, working through three further revisions of this list to produce that which follows. Comments from others at and following our May 1978 meeting also proved helpful. In all, about 500 vascular plant taxa were screened for the list, roughly 20 percent of Virginia's flora.

Only native plants were considered for inclusion by the Committee. All introduced, cultivated, or escaped and naturalized species were eliminated from the list. In addition, all uncommon native species which proved, on close examination, to be weedy (*i. e.*, they thrive under conditions of disturbance by man) also were eliminated.

Data on which the list is based were gathered from herbarium specimens, literature citations, and field observations. Collections were examined at the following herbaria: Catholic University, College of William and Mary, George Mason University, James Madison University, Old Dominion University, Randolph-Macon Women's College, the Smithsonian Institution, and Virginia Polytechnic Institute and State University. Several sizable collections remain to be examined. The publication of the first part of the *Atlas of the Virginia Flora* (Harvill *et al.*, 1977) has provided much useful information regarding the distributions of the monocotyledons of the state. This is the reason that they comprise such a disproportionate percentage of the *Special Concern* and *Status Undetermined* portions of the list. All species in the *Atlas* recorded from five or fewer counties were considered for inclusion. Publication of the second part on dicotyledons should add a larger number of them for consideration.

It should be obvious that more species remain to be added to the list, and anyone with suggested additions should contact the author. New collections undoubtedly will reveal additional plants in need of protection, while others will be found to be more common than present information indicates. Data are needed especially for those species currently in the category of *Status Undetermined*. Information on the distributions, habitats, and ecology of all species must continue to be accumulated, so that the list may be kept up-to-date. The present list is only the first step in protecting our valuable floral heritage.

A few taxa which had been thought to be *Endangered* or *Threatened*, upon more concentrated study were found merely to have been seldom collected. Further field study

may prove this to be true of others on the list, particularly those in the category of *Special Concern*. Our knowledge of the distribution, ecology, and life history of many taxa is still poor. In interpreting the distributions given in the list, it must be remembered that the ranges given consist of all recorded and/or verified county records for each taxon. Some may no longer be extant, and others surely remain to be discovered.

There are 47 Virginia taxa of vascular plants which have been proposed for official listing under the federal Endangered Species Act of 1973. The following plants on that proposed list were excluded from our list for the reasons stated:

- Isoetes virginica* N. E. Pfeifer (Virginia Quillwort) - synonymous with *Isoetes melanopoda* Gay & Durieu, a widespread species.
- Asplenium X ebenoides* R. R. Scott (Scott's Spleenwort) - a sterile hybrid.
- Asplenium X kentuckiense* McCoy (Kentucky Spleenwort) - a sterile hybrid.
- Scirpus flaccidifolius* (Fern.) Schuyler (Reclining Bulrush) - grows in man-disturbed, weedy habitats.
- Calamagrostis porteri* Gray (Porter's Reedgrass) - common in certain habitats.
- Panicum aculeatum* Hitchc. & Chase (Panic Grass) - no Virginia collections known.
- Oxypolis canbyi* (Coul. & Rose) Fern. (Canby's Hog-fennel) - no Virginia collections known.
- Eupatorium saltense* Fern. (Eupatorium) - synonymous with *Eupatorium mohrrii* Greene (Johnson, 1974), a weedy species.

The following were considered as being of *Special Concern* rather than *Endangered* or *Threatened*, for the reasons indicated:

- Trillium pusillum* var. *virginicum* Fern. (Dwarf Trillium) - more widespread and common than originally thought (see Roe, 1978).
- Platanthera flava* (L.) Lindl. (= *Habenaria flava* L.) (Pale Green Orchid) - not uncommon in Virginia.
- Platanthera peramoena* (Gray) Gray (= *Habenaria peramoena* Gray) (Purple Fringeless Orchid) - not uncommon in Virginia.
- Echinacea laevigata* (Boynton & Beadle) Blake (Purple Coneflower) - not uncommon locally in Virginia, some evidence that it is weedy.
- Cardamine longii* Fern. (Long's Bittercress) - apparently not uncommon in Virginia.
- Rhododendron bakeri* Lemmon & McKay (= *Rhododendron cumberlandense* E. L. Braun - (Red Azalea) - apparently not uncommon in Virginia.
- Anemone minima* DC. (Dwarf Anemone) - not uncommon in Virginia.
- Clematis addisonii* Britt. (Addison's Leather-flower) - not uncommon locally in Virginia.

Finally, the following were considered as being *Status Undetermined* rather than *Endangered* or *Threatened*, for the reasons indicated:

- Carex biltmoreana* Mackenzie (Biltmore Sedge) - no Virginia collections seen.
- Carex chapmani* Steud. (Chapman's Sedge) - no Virginia collections seen.
- Ilex amalancheier* M. A. Curtis (Sarvis Holly) - no Virginia collections seen.
- Hezastylis naniflora* Blomquist (Dwarf-flowered Heart-leaf) - no Virginia collections seen.

Pycnanthemum monotrichum Fern. (Mountain Mint) - perhaps a hybrid (Gleason and Cronquist, 1963).

Nestronia umbellula Raf. (Nestronia) - no Virginia collections seen.

Bacopa stragula Fern. (Water Hyssop) - perhaps not a distinct species.

Within historical times, two species of Virginia's vascular plants apparently have become extinct, and nine which at one time occurred in the Commonwealth have become extirpated from within its borders. These extirpated species also are rare elsewhere, being either *Extirpated*, *Endangered*, or *Threatened* where they occur in surrounding states. Our most up-to-date information indicates that there are 23 *Endangered*, 33 *Threatened*, 103 *Special Concern*, and 174 *Status Undetermined* taxa as well. Only those taxa in the categories of *Extinct*, *Extirpated*, *Endangered*, or *Threatened* are given detailed species accounts. For those under *Special Concern* and *Status Undetermined*, given in order are scientific name, common name, and known or reported distribution by physiographic region (Mountains, Piedmont, and Coastal Plain) and county (or city where appropriate). Taxa are arranged alphabetically by division, class, order, family, genus, and species under the various categories of endangerment. Fern allies (Equisetophyta and Lycopodophyta), ferns (Pteridophyta), conifers (Pinophyta), and flowering plants (Magnoliophyta) follow in that order.

The two *Extinct* species occurred in the Coastal Plain, while seven of the *Extirpated* species also were mainly Coastal Plain in distribution, three being in the Mountains. Fourteen of the *Endangered* taxa occur primarily in the Mountains, five (all monocots) in the Coastal Plain, and four in the Piedmont. Twenty-five of the *Threatened* taxa are primarily in the Mountains, six (all monocots) in the Coastal Plain, and one in the Piedmont. Of the 103 taxa of *Special Concern*, 52 are distributed primarily in the Mountains, 41 (including 23 monocots) in the Coastal Plain, and 10 in the Piedmont. Of the 174 *Status Undetermined* taxa, 93 (including 69 monocots) primarily occur in the Coastal Plain, 56 in the Mountains, and 16 in the Piedmont, while the ranges of 9 are unknown.

These ranges within Virginia reveal two important facts regarding our *Rare* and *Endangered* vascular plants. First, that the Piedmont is poor in such taxa. Indeed, Virginia's Piedmont is poor in number of species generally, being surrounded by areas which are much richer floristically (Harvill, 1965). Harvill hypothesizes that this situation is due to the areas of Mountains and Coastal Plain serving as refugia for large numbers of species during the Pleistocene glaciations, while such areas were rare or absent in the Piedmont. Positive evidence for this hypothesis is provided by the present study. Second, that the *Rare* and *Endangered* taxa of the Coastal Plain occur primarily in aquatic habitats. Most of the monocots, and many of the dicots, of the Coastal Plain which fit into our categories of endangerment are aquatics. As might be expected, taxa in the Mountains tend to occur either on isolated mountain tops or in rich, undisturbed forest habitats.

The phytogeographic relationships of our *Extinct*, *Extirpated*, *Threatened*, or *Endangered* species are overwhelmingly with the Eastern Deciduous Forest Province, 25 taxa being distributed primarily within this area. In addition, there are 13 Southern Appalachian endemics, five of these being endemic to Virginia. Six (6) taxa extend to Virginia from the Boreal Province. Seventeen (17) taxa are distributed primarily in the Coastal Plain Province, three being endemic to Virginia. Three species are distributed to the southwest, one is Cosmopolitan, and one is Pantropical in distribution.

Many of these taxa are at or near the limits of their ranges in Virginia; they are disjunct or peripheral in distribution. Others are widespread but scarce. All are restricted to habitats which are quite local or rare in the Commonwealth. Many of these habitats are becoming rarer because of the activities of man.

Both disjunct and peripheral taxa may be more abundant elsewhere, but this should not be used as an excuse to ignore their degree of endangerment in Virginia. Disjunct

taxa usually fare better in this regard. Peripheral taxa, on the other hand, often are given low priority for protection. This is a mistake. Fortney et al. (1978) have pointed out the importance of peripheral populations as genetic reservoirs for desirable characteristics usable by man. Members grow under more stringent environmental conditions than do those growing closer to the center of distribution. "Nearly all varieties of plants selected for drought and winter hardiness are derived from populations of species at their extreme geographic limits." (Fortney et al., 1978). Thus our peripheral and disjunct rarities potentially may have great economic value.

Virginia provides a diversity of habitats supporting a native flora of unusual richness. Some of these habitats (e.g., shale barrens, sphagnum bogs, fresh-water marshes, high-mountain rock outcrops) are restricted in distribution, and the species which grow in them in turn are restricted to such habitats. It is these species which are *Rare* and *Endangered* in Virginia. Most are *Endangered* because of habitat destruction or alteration by man, or his effluents and byproducts. *Endangered* species and endangered habitats are inseparable; one cannot be protected without protecting the other.

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*Those who have contributed species accounts.

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SPECIES ACCOUNTS

ENDANGERED (23)

1. WOODLAND HORSETAIL

Equisetum sylvaticum L.

Division: Equisetophyta

Order: Equisetales

Class: Equisetopsida

Family: Equisetaceae

Description: Differs from common horsetail, *Equisetum arvense* L., in having lateral branches branched again, thus producing a beautiful lacy, feathery appearance. Sheaths tend to have leaves fused together in groups. Strobilus borne upon slightly modified upright branch rather than on a wholly separate non-photosynthetic branch as in *Equisetum arvense*.

Present Range: Circumboreal, north of 40° North latitude for the most part. Virginia is the extreme southern limit in eastern North America.

Distribution in Virginia: Known only from single localities in Frederick and Shenandoah counties, respectively (Figure 1).

Habitat and Mode of Life: Major reproduction by rhizome propagation, forming extensive clones at edges of woods and within swampy woods.

Reproduction: Sexual reproduction pteridophytic: spores disperse into appropriate habitats (usually exposed soil banks) and form tiny pin cushion-like gametophytes. Fertilization occurs and young sporophytes, sometimes more than one, appear. However, rhizome propagation is practically the rule. New colonies formed by sexual reproduction are probably rare.

Status: *Endangered*. The Frederick County locality may be destroyed by lumbering.

Protective Measures Proposed: Usually well-established colonies are "immortal" so long as the surroundings remain the same. What this means is that the habitat and community should be preserved. Both known localities are within the boundaries of the George Washington National Forest.

Remarks: The records constitute terminal populations that represent the end of the diffusion of this species southward.

References: Fernald (1950); Wherry (1961); Faulconer (1973).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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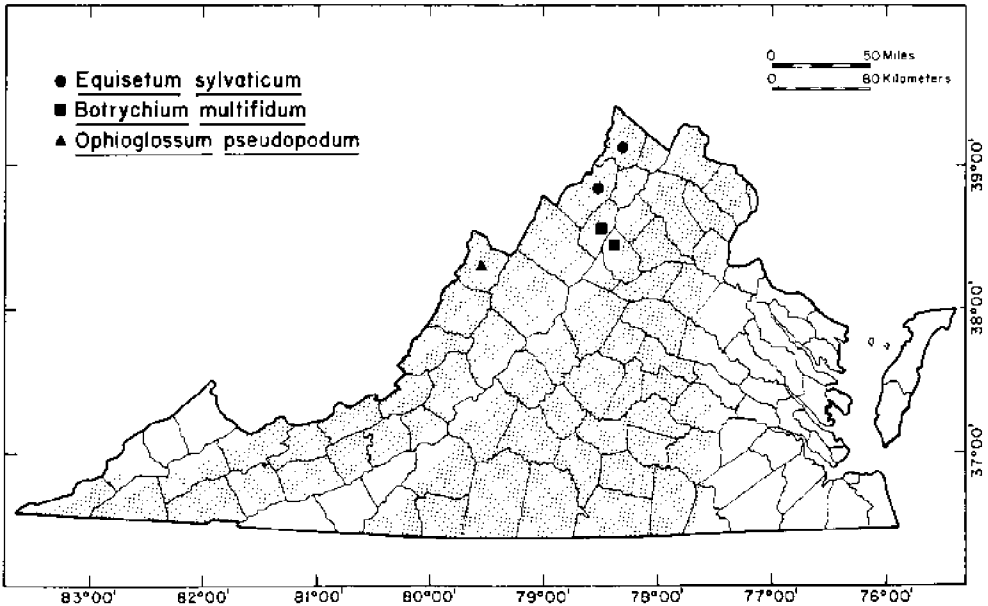


Figure 1. Distribution of *Equisetum sylvaticum*, *Botrychium multifidum*, and *Ophioglossum pseudopodium* in Virginia

2. LEATHER GRAPEFERN

Botrychium multifidum (Gmel.) Rupr.

Division: Pteridophyta
Class: Filicopsida

Order: Ophioglossales
Family: Ophioglossaceae

Description: Medium- to large-sized grapefern with thick-textured foliage. Evergreen (wintergreen), the year's single leaf lasting until the following spring, when it is replaced by a new leaf. Segments oblong or ovate, rounded.

Present Range: Reaches its known southern limit in Virginia. Primarily a boreal species, extending at higher latitudes around the globe. Becomes common in northern New England, the Great Lakes states, and Canada.

Distribution in Virginia: Very rare and local in the Shenandoah National Park, Page and Madison counties (Figure 1).

Habitat and Mode of Life: Grassy fields and woods edges especially. Often found around shrubs. Easily overlooked or confused with the much more abundant *Botrychium dissectum* Spreng.

Reproduction: Entirely sexual, so far as is known. Spreads by spores. The sexual plant is subterranean and mycorrhizal.

Cultivation: Not normally cultivated, except for research purposes. Even then, very difficult and usually not successful.

Status: *Endangered*. The peripheral populations in Virginia are small in size and could readily be eliminated by vandalism or destruction of the habitat.

Protective Measures Proposed: It is necessary to hold back succession at Big Meadows and similar places. If normal succession takes place, without fire or other factors to keep the habitats at status quo, the species will disappear.

Remarks: As is the case with all isolated populations at the edges of their range, the colonies of this species may prove to have considerable genetic interest.

References: Wagner (1943b).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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3. NORTHERN ADDER'S TONGUE

Ophioglossum pseudopodium (Blake) Farwell

Division: Pteridophyta
Class: Filicopsida

Order: Ophioglossales
Family: Ophioglossaceae

Description: Plant looks like a small terrestrial orchid in some respects; easily overlooked. The single leaf is divided into an elliptic sterile segment and a narrow stalk-like fertile segment; whole leaf rarely more than 30 centimeters high.

Present Range: Virginia north to Canada, west along the Great Lakes to Washington and north to Alaska.

Distribution in Virginia: Known only from meadows in Highland County (Figure 1).

Habitat and Mode of Life: Pastures, meadows, edges of marshes, grassy shores. If a single individual is found, the probability is very high that numerous other individuals will be found, as the plant is highly clonal, propagation being accomplished by root proliferations. The roots run out laterally and send up new plants at intervals of several centimeters.

Reproduction: Mainly by root propagation but rarely sexual reproduction occurs. The spores percolate down into the soil where they germinate in the absence of light and form narrow brown or tan gametophytes to one centimeter long. Fertilization occurs below ground on the non-photosynthetic gametophytes. Nutrition is provided by mycorrhizal fungi that exist in the tissues.

Cultivation: Rarely or never cultivated.

Status: *Endangered*. Well-developed in the meadows of Highland County, but easily overlooked. The species is much more common in New England and the Great Lakes area.

Protective Measures Proposed: The marshes and meadows of Highland County should be managed by cattle grazing and the like so that they do not return to forests. Not only are there interesting populations of this fern, but there are some unusual animals as well, including some southern outposts of northern butterflies.

Remarks: Traditionally associated with *Ophioglossum pycnostichum* Fern. Both taxa have been made varieties of *Ophioglossum vulgatum* L. *Ophioglossum pycnostichum* is already known from approximately 40 counties in Virginia and will probably be found to occur in all counties of the state. It differs from *Ophioglossum pseudopodium* in approximately a dozen characters.

References: Wagner (1971). (This paper discusses the southeastern and the northern species in more detail than any other.)

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

4. CHESTNUT LIP-FERN

Cheilanthes castanea Maxon

Division: Pteridophyta
 Class: Filicopsida

Order: Polypodiales
 Family: Adiantaceae

Description: Small scaly rock-fern with fronds 15-20 centimeters long; rachis and axis of pinnae provided with scales to 0.25 millimeters broad; lamina not densely tomentose beneath, only villous; trichomes chestnut-colored.

Present Range: Northern and central Mexico and southern Arizona and New Mexico to Texas and west of Oklahoma City (Knobloch and Lellinger, 1969).

Distribution in Virginia: Roanoke and Montgomery counties (Figure 2).

Habitat and Mode of Life: Epipetric on shale barrens.

Reproduction: Apogamous. The spores have the same chromosome number as the sporophyte. The gametophyte does not undergo fertilization; instead the sporophyte grows directly from the gametophytic tissue by conversion. This may be adaptive, a way of counteracting the problems of drought in rock habitats.

Cultivation: Not generally cultivated. It might make an attractive rock garden specimen.

Status: *Endangered*. Extremely local and known from only Montgomery and Roanoke counties. Also found in Grant County, West Virginia.

Protective Measures Proposed: Prevent destruction of the shale barrens on which the plants grow.

Remarks. A striking disjunction of over 1,000 miles from the metropolis for this species in the Southwest. Resembles *Cheilanthes tomentosa* Link, which is much more densely pubescent below, has gray trichomes and narrower scales on the axes.

References: Knobloch and Lellinger (1969).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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5. SPREADING MARGINAL WOODFERN HYBRID

Dryopteris campyloptera X *marginalis*

Division: Pteridophyta
 Class: Filicopsida

Order: Polypodiales
 Family: Aspleniaceae

Description: Very showy, large woodfern. Frond outline ovate, with exaggerated lower pinnules on the basal pinnae. Cutting 3X pinnate. Sori submarginal.

Present Range: So far only known from the mountains of Virginia.

Distribution in Virginia: Occurs in rich woods on slope above Mountain Lake in Giles County (Figure 2).

Habitat and Mode of Life: Rich sugar maple and hemlock forest on a steep slope. Parent *Dryopteris marginalis* is most common on the higher, drier, upper slope; parent *Dryopteris campyloptera* on the lower, moister slope.

Reproduction: Although a sterile triploid, this fern has the ability to form vigorous clones by vegetative propagation. Some of the colonies are more than 15 feet across and contain numerous plants. They may be very ancient.

Cultivation: Makes a beautiful garden plant, but this fact should not be advertised.

Status: *Endangered*. Due to the possibility of exploitation or vandalism. Destruction of the habitat would be tragic because there are many rare ferns at this locality, including the present one.

Protective Measures Proposed: Make the habitat a protected natural area and keep out all "developments."

Remarks: This plant has scientific importance because it has cytogenetic features that have contributed to unravelling the evolutionary relationships of woodferns.

References: Wagner and Wagner (1966); Wagner (1970).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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6. OSTRICH FERN

Matteuccia struthiopteris (L.) Todaro

Division: Pteridophyta
Class: Filicopsida

Order: Polypodiales
Family: Aspleniaceae

Description: Showy, tall fern, with narrowly oblanceolate fronds widest above middle (like ostrich plumes). Fronds borne in a crown. Pinnae linear, deeply pinnatifid. Fertile fronds short and borne in center of frond cluster, completely dimorphic; sporophylls turning dark chocolate-brown and waiting until early spring of following year before spore discharge.

Present Range: In North America from Alaska across to Newfoundland and down to Virginia and the mountains of West Virginia. Also a widespread garden plant in the northern United States and Canada.

Distribution in Virginia: Fairfax County (Figure 2).

Habitat and Mode of Life: Clone-former in alluvial soil with circumneutral pH. Habitats normally shady.

Reproduction: There are two types of stems: the uprights form the crowns and send out horizontal laterals which are very narrow and produce new uprights. This manner of growth enables the ostrich fern to form huge stands. The bulk of reproduction is thus by vegetative propagation. The sexual life cycle is similar to that of *Dryopteris* and *Athyrium*, the classical cycle illustrated by most texts.

Cultivation: Extremely popular as a hardy border plant. The most cultivated native fern.

Status: *Endangered*.

Protective Measures Proposed: So long as springy areas and floodplains where the species grows are maintained and preserved, there should be no reason for the ostrich fern to disappear.

Remarks: This extremely distinctive fern is reaching its southern limit in Virginia. One should be careful about new introductions from spores of garden-grown plants.

References: Lloyd (1969).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

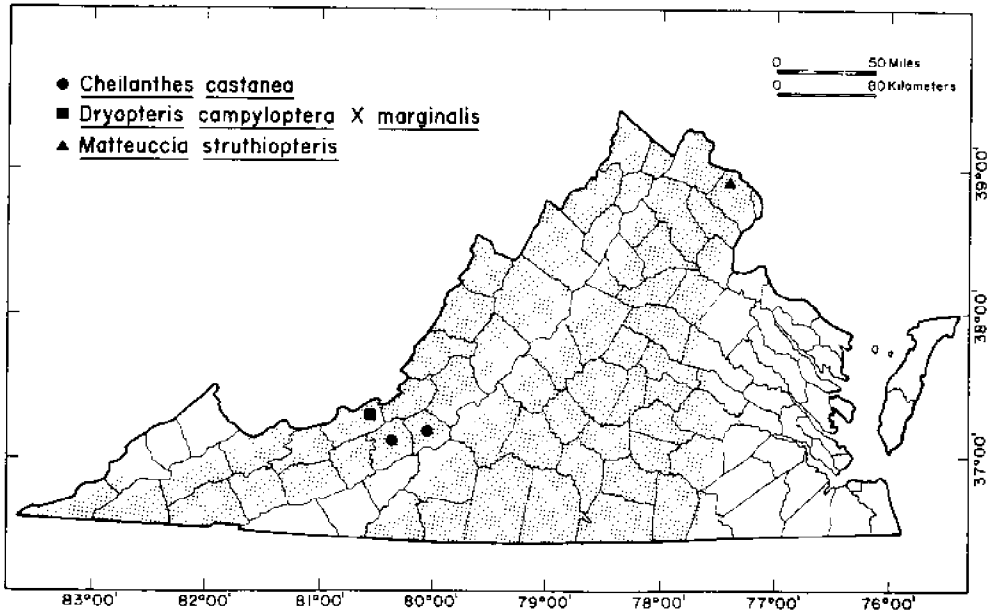


Figure 2. Distribution of *Cheilanthes castanea*, *Dryopteris campyloptera X marginalis* and *Matteuccia struthiopteris* in Virginia

7. INTERRUPTED ROYAL FERN

Osmunda X ruggii R. Tryon

Division: Pteridophyta
Class: Filicopsida

Order: Polypodiales
Family: Osmundaceae

Description: A large, showy fern of damp places. Intermediate in morphology between the Interrupted Fern, *Osmunda claytoniana* L. and Royal Fern, *Osmunda regalis* L., of which it is a natural hybrid.

Present Range: Known at present from only one natural population in the mountains of Virginia.

Distribution in Virginia: Potts Mountain, Jefferson National Forest, Craig County, Virginia, where it is well-known to botanists and foresters (Fig.3).

Habitat and Mode of Life: The single large colony known occupies an area of approximately 16.5 x 6.1 meters at the bottom of a rocky ravine, growing in association with three *Osmunda* species -- *Osmunda cinnamomea*, *Osmunda claytoniana*, and *Osmunda regalis*.

Reproduction: Only by vigorous vegetative propagation by rhizome growth and fragmentation. At present about 70 plants are known. They are probably all derived from an original mother plant, and the colony is estimated to be greater than 1100 years old. There is no reason why the colony should not continue to expand for thousands of more years.

Status: *Endangered*. Destruction of the surrounding forest might totally wipe out the colony. Also, vandalism or removal of plants for horticultural purposes could seriously threaten the colony.

Protective Measures Proposed: This is the responsibility of the United States Forest Service authorities, who have been fully informed of the unique nature of this plant.

Remarks: A plant of phylogenetic significance for demonstrating relationships within the genus *Osmunda*. Also of significance for being the solitary known population of this fern.

References: Wagner *et al.* (1978).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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8. BULRUSH

Scirpus anastrochaetus Schuyler

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Cyperaceae

Description: Tufted perennial herbs with short, tough, fibrous rhizomes; lower leaves to 8-10 millimeters wide, 40-60 times as long as wide; flowering stems 8-12 decimeters high; spikelets ovate, 3-5 millimeters long, 2-3 millimeters wide, in numerous glomerules at apices of arching rays of inflorescences; floral bracts 1.5 to 2.5 millimeters long, elliptic, slightly mucronate, brown or blackish-brown; perianth bristles 6, firmly attached to well-developed receptacles, about as long as achenes, densely covered almost to base with thick-walled, sharp-pointed, retrorse teeth; achenes mostly obovate, about 1-2 millimeters long. (after Schuyler, 1962, 1967).

Photographs: Schuyler (1962).

Illustrations: Schuyler (1962).

Present Range: Massachusetts, Vermont, New York, Pennsylvania, and Virginia.

Distribution in Virginia: Mountain counties of Alleghany and Rockingham (Fig.3).

Habitat and Mode of Life: Shallow acidic ponds.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status: *Endangered*. Known from only two localities in Virginia, and the distribution to the northeast is scattered. Considered *Endangered* throughout its range by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: The two ponds in which this species is known to occur should be protected from pollution and development. The Alleghany County locality is within the boundaries of the Jefferson National Forest.

Remarks: This species is thought to be a relict (Schuyler, 1962). In Virginia it is disjunct from Pennsylvania and at the southern limit of its range.

References: Schuyler (1962, 1964, 1967); Harvill (1976); Ripley (1975).

Author: Duncan M. Porter.

9. MAIDEN CANE

Panicum hemitomon Schult.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Cyperales
 Family: Poaceae

Description: An aquatic or semiaquatic perennial with creeping rhizomes; culm 5-15 decimeters high. The very narrow, elongate panicle, sessile glabrous spikelets, and numerous sterile shoots with overlapping, usually densely hirsute sheaths are the major distinguishing characteristics. Leaf blades of fertile shoots scabrous on upper surfaces and glabrous beneath; spikelets 2.2 to 2.7 millimeters long; first glume 3-nerved, second 5-nerved.

Present Range: Overall, the species is distributed on the Coastal Plain from New Jersey to Texas. Also reported from Tennessee.

Distribution in Virginia: Reported from the City of Chesapeake and Isle of Wight and Sussex counties in the southern Coastal Plain (Figure 3).

Habitat and Mode of Life: Swamps, ponds, ditches, marshes, and pools.

Reproduction: Unknown.

Status: *Endangered*. Draining of swamps and marshes has destroyed populations of this plant, especially around the City of Chesapeake.

References: Fernald (1950); Hitchcock and Chase (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); and Mayes (in press).

Author: Richard A. Mayes.

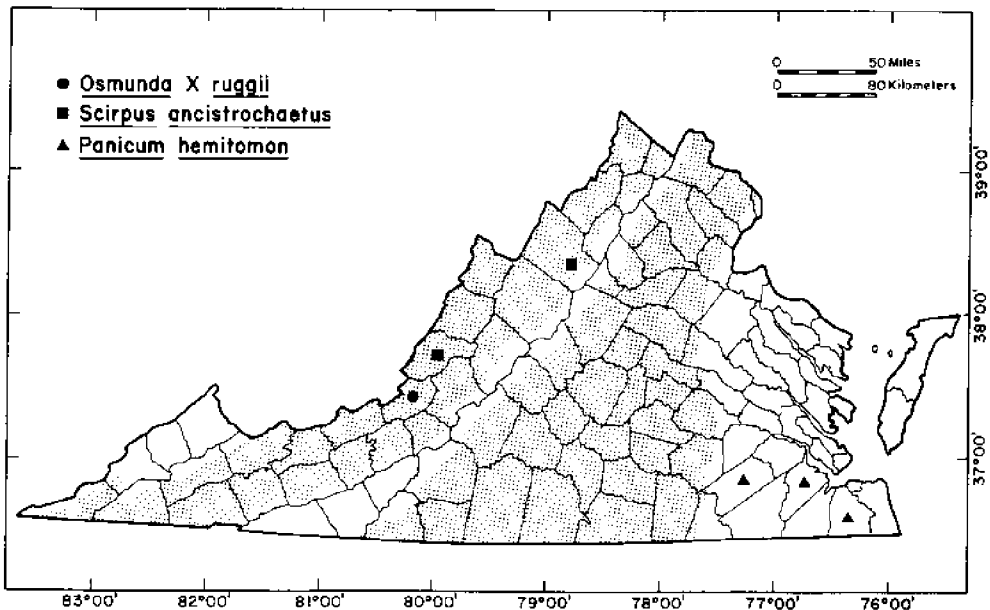


Figure 3. Distribution of *Osmunda X ruggii*, *Scirpus ancistrochaetus*, and *Panicum hemitomon* in Virginia

10. PANIC GRASS

Panicum mundum Fern

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Cyperales
 Family: Poaceae

Description: A perennial with vernal and autumnal forms; culms densely cespitose, erect, 5-14 decimeters high in vernal phase. The small ovoid to ellipsoid, densely pubescent spikelets, glandular-spotted sheaths, and 7 to 9 nerved lemmas are the major distinguishing characteristics. Leaf blades generally glabrous but papillose-ciliate basally; spikelets 1.8 to 2.2 millimeters long.

Present Range: Overall, the species is reported from southeastern Virginia and Durham County, North Carolina.

Distribution in Virginia: Known only from the cities of Chesapeake and Virginia Beach and the county of Sussex in the southern Coastal Plain (Figure 4).

Habitat and Mode of Life: Swamps and marshes.

Reproduction: Unknown.

Status: *Endangered*. Development, especially in the urban areas of its range, has destroyed populations of this species; future development is threatening others.

References: Fernald (1950); Hitchcock and Chase (1950); Gleason and Cronquist (1963); and Mayes (in press).

Author: Richard A. Mayes.

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11. ALKALI-GRASS

Puccinellia fasciculata (Torr.) Bicknell

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Cyperales
 Family: Poaceae

Description: A weakly perennial species with stout culms, 2-5 decimeters high. The ellipsoid, compact and extremely short panicle with fascicled branches, densely-flowered spikelets, small ovate glumes, and coriaceous, faintly-nerved lemmas are the major distinguishing characteristics. Spikelets terete, 3-4 millimeters long.

Present Range: Overall, the species is distributed from Nova Scotia to Delaware and south to Virginia; it is also reported from Utah, Nevada, and Arizona.

Distribution in Virginia: Reported from Accomack County in the Coastal Plain (Figure 4).

Habitat and Mode of Life: Salt marshes.

Status: *Endangered*.

References: Fernald (1950); Hitchcock and Chase (1950); Gleason and Cronquist (1963); and Mayes (in press).

Author: Richard A. Mayes.

12. LONG'S RED LILY

Lilium catesbaei Walter var. *longii* Fern.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Liliales
 Family: Liliaceae

Description: Bulb scales without long linear leaves arising from their tips. Stem leaves alternate, erect or appressed, those of the lower and middle stem blunt and oblong, the upper progressively smaller. Flowers 1 (-2) erect, bright red and spotted toward the base; sepals and petals loosely ascending, their slender claws rounding to blades with barely recurving tips, larger blades about twice as long as claws; capsule broadly rounded at summit (mostly taken from Fernald, 1940).

Lilium catesbaei var. *catesbaei* (pine lily) has linear basal leaves arising from its bulb scales, stem leaves acute to long-attenuate; sepals and petals with blades about three times as long as claws, tips prolonged and recurving, and capsule narrowed gradually to a beak.

Illustrations: Small (1933); Radford *et al.* (1968).

Photographs: Fernald (1940).

Present Range: Local on the Coastal Plain and Piedmont from Florida to Alabama and southeastern Virginia, whereas the pine lily is known from no farther than southern North Carolina and ranges west to Louisiana.

Distribution in Virginia: Coastal Plain, City of Suffolk and James City County. Fernald (1940) cites one Virginia collection in his publication of var. *longii*, this from "sphagnous savannah-like swale east of Cherry Grove, south of South Quay, Nansemond County (= City of Suffolk), July 21, 1939, Fernald and Long no. 10,582 ... (Figure 4).

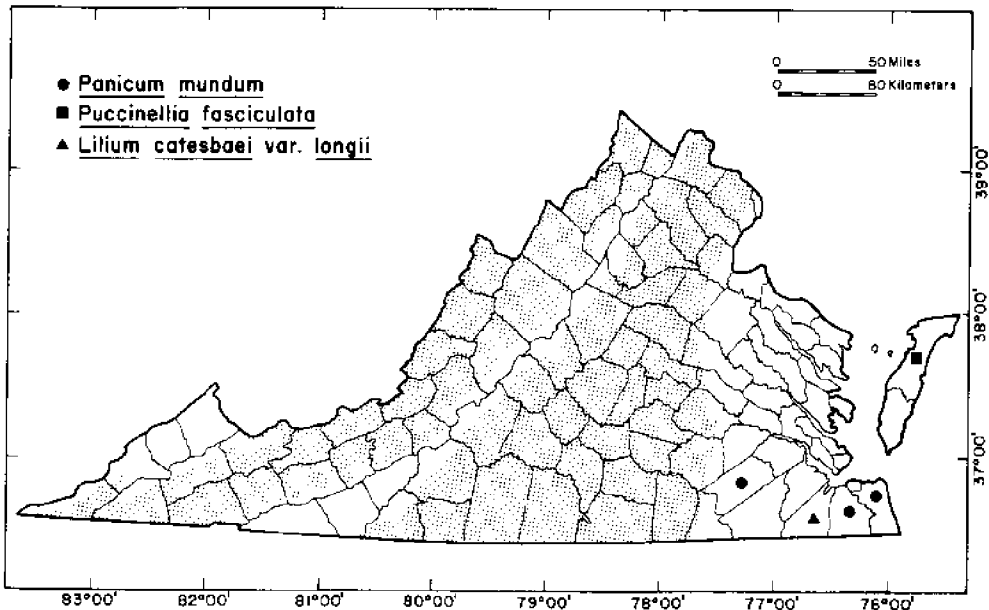


Figure 4. Distribution of *Panicum mundum*, *Puccinellia fasciculata* and *Lilium catesbaei* var. *longii* in Virginia

Habitat and Mode of Life: Pinelands, savannas, swamps, and bogs.

Reproduction: Flowers in July in Virginia.

Status: *Endangered* (peripheral). This species is not listed as *Endangered* or *Threatened* in North Carolina.

References: Crandall-Bliss, D. (pers. comm., 1978); Fernald (1940, 1950); Fox and Godfrey (1949); Gleason and Cronquist (1963); Harvill *et al.* (1977); Johnson (1969); Massey (1961); Radford *et al.* (1968); Small (1933).

Author: Donna M. E. Ware.

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13. NODDING TRILLIUM

Trillium cernuum L. var. *cernuum*

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Liliales
Family: Liliaceae

Description: Stems to 6 decimeters high. Leaves not mottled, broadly rhombic to rhombic-ovate, and obscurely petiolate. Flower on a recurved peduncle 5-25 millimeters long, nearly hidden beneath leaves; sepals lance-acuminate, straight; petals with ascending bases and reflexed apices, white to rosy pink, 5-9 millimeters wide; filaments stout, more than half as long as lavender anthers which range from 2.5 to 4.5 millimeters long; ovary white or pale, stigmas short, stout, and recurved.

Species that might possibly be confused with *Trillium cernuum* include *Trillium flexipes* (*Trillium gleasoni*), *Trillium erectum*, and *Trillium catesbaei*. *Trillium flexipes* is distinguished by leaves sessile, peduncles 3-12 centimeters long, and anthers white and longer than filaments; *Trillium erectum* by leaves sessile, petals spreading from base and occurring in several colors, and ovary purple; *Trillium catesbaei* by leaves ovate to widely elliptic, sepals falcate, and anthers yellow.

Illustration: Gleason (1952).

Present Range: Newfoundland and Quebec to Wisconsin south to Nova Scotia, New England, Delaware, Maryland and Virginia. According to Johnson (1969), the specimens from the Carolinas that have previously been attributed to *Trillium cernuum* are actually *Trillium rugelii*. *Trillium cernuum* L. var. *macranthum* Eames and Wieg. has a more westerly distribution, ranging from Vermont to Saskatchewan and Mackenzie, south to Pennsylvania, Tennessee, Ohio, Indiana, Illinois and Iowa.

Distribution in Virginia: Fauquier and Rockbridge counties (Figure 5).

Habitat and Mode of Life: Alluvial forests, rich slopes, and other moist to wet woodlands.

Reproduction: Flowering April to early May.

Status: *Endangered* (peripheral).

References: Allard and Leonard (1943); Crandall-Bliss, D. (Pers. comm., 1978); Eames and Wiegand (1923); Fernald (1950); Harvill (1970a); Gleason (1952); Gleason and Cronquist (1963); Johnson (1969); Radford *et al.* (1968); Strausbaugh and Core (1970).

Author: Donna M. E. Ware.

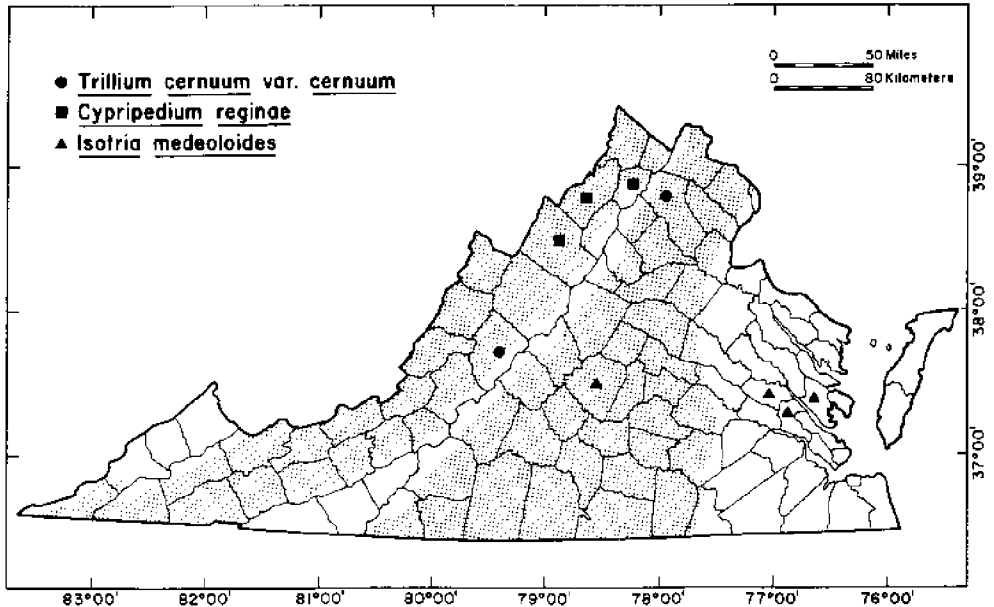


Figure 5. Distribution of *Trillium cernuum* var. *cernuum*, *Cypripedium reginae* and *Isotria medeoloides* in Virginia

14. QUEEN LADY'S-SLIPPER

Cypripedium reginae Walt.

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Orchidales
Family: Orchidaceae

Description: Perennial terrestrial herbs from a stout rhizome with fibrous roots, densely pubescent, to 9 decimeters high; leaves 3-7, cauline, ovate-lanceolate, 10-25 centimeters long, 6-16 centimeters wide, spirally sheathing stems; flowers 1-2 (3-4), large and showy; floral bracts leaf-like, ovate-lanceolate, to 13 centimeters long and 6 centimeters wide, sheathing ovary; upper sepal ovate-orbicular, white, 3 to 4.5 centimeters long, 2.5 to 4 centimeters wide; lateral sepals connate behind lip, white, 3-4 centimeters long, 2-4 centimeters wide; petals oblong-elliptic, spreading, 2.5 to 7 centimeters long, 1-2 centimeters wide; lip a subglobose sac, margins of aperture infolded, rose streaked with white (to mostly white), 2.5 to 5 centimeters long, 1.5 to 3.5 centimeters wide; staminode ovate, white streaked with purple spots 1.5 centimeters long, about 2 centimeters wide; capsule ellipsoid, erect, 4 centimeters long, 1.5 centimeters in diameter; flowering May through August (after Luer, 1975).

Photographs: Duncan and Foote (1975), Luer (1975).

Illustrations: Gleason (1952), Luer (1975).

Present Range: Southeastern Saskatchewan to Newfoundland, south to Missouri, Illinois, Indiana, Ohio, Maryland, and New Jersey, and in the Appalachians to Tennessee, Georgia, and North Carolina.

Distribution in Virginia: Mountain counties of Rockingham, Shenandoah, and Warren. Such a spectacular orchid is unlikely to occur elsewhere without yet having been discovered (Figure 5).

Habitat and Mode of Life: Wet, open areas near bog margins.

Reproduction: Presumably sexual.

Status: *Endangered*. Such a large and showy orchid is easy prey for the wild-flower enthusiast. Unfortunately, like most Lady's-slippers, it does not easily survive transplanting. Considered to be *Endangered* or *Extirpated* in North Carolina (Hardin *et al.*, 1977). Restricted in West Virginia (Fortney *et al.*, 1978), where it is found in only three counties, and *Endangered* in Tennessee (Committee for Tennessee Rare Plants, 1978), where found in only one county.

Protective Measures Proposed: Habitats in which this species is known to grow must be protected from development, and the plants themselves must be protected from collectors of flowers and rhizomes.

Remarks: As Fernald (1950) was the first to point out, and many have echoed: "Plant liable to extinction through raids by nurserymen and would-be cultivators."

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Duncan and Foote (1975); Luer (1975); Hardin *et al.* (1977); Committee for Tennessee Rare Plants (1978); Fortney *et al.* (1978).

Author: Duncan M. Porter.

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15. SMALL WHORLED POGONIA

Isotria medeoloides (Pursh) Raf.
Syn. *Pogonia affinis* Austin

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Orchidales
Family: Orchidaceae

Description: Scapose perennial, stem greenish-white, glaucous, bearing two small alternate leaves at base. Involucral leaves borne in a single whorl of five or six, whorl soon reflexing. Flowers one or two greenish-yellow, terminating stem; peduncle shorter than ovary; sepals linear-lanceolate, as long as petals to 1.5 times as long.

The whorled pogonia, *Isotria verticillata*, sometimes occurs with *Isotria medeoloides*, but it can be distinguished by the absence of the two small leaves near the base of the scape, sepals usually brown-purple, 2-3 times as long as the petals, and the peduncle longer than the ovary.

Illustration: Hardin *et al.* (1977). Illustration and photographs: Luer (1975).

Present Range: Maine south to North Carolina; also southeast Missouri, Illinois, and Michigan.

Distribution in Virginia: Piedmont - Buckingham County; Coastal Plain - Gloucester, James City, and New Kent counties (Figure 5).

Habitat and Mode of Life: Dry, open, deciduous or mixed pine-deciduous woodland.

Reproduction: The flowering period begins in mid-May in the South, approximately two weeks later than *Isotria verticillata*. In certain localities *Isotria medeoloides* is known to bloom annually, but in others it reportedly remains dormant for a period of years, perhaps as long as 20 years, between blooming seasons.

Status: *Endangered*. This species is considered the most local and rare native orchid of eastern North America. In 1924, only seventeen stations were known, and over recent years more stations have been destroyed than new stations discovered. Classed as *Endangered* by the Smithsonian Institution (Ripley, 1975).

Remarks: This orchid is extremely difficult to transplant because even slight root injury renders it highly susceptible to damaging fungus infection.

Isotria medeoloides was first found in Virginia by E. J. Grimes in 1921 in open white oak woods near Williamsburg. Over the years other faculty members of the College of William and Mary have visited the site, noting degrees of abundance year-to-year that have varied from one plant to fifteen to "several colonies," or occasionally none observed at all. The species was last seen in this locality in the early 1970's by the late J. T. Baldwin, Jr., who had been monitoring the site since 1939. Although a search made in the spring of 1978 revealed only *Isotria verticillata*, there is reason to believe that *Isotria medeoloides* still occurs at this site. There is encroachment on this area by a housing sub-division, a golf course, a state mental hospital, and potentially by one of the alternative routes for the proposed extension of Virginia Route 199; but to date the habitat has not been destroyed.

B. J. Harvill discovered the Buckingham County station in the late 1960's. The New Kent County and Gloucester County occurrences are reported in Massey (1953 and 1961).

References: Baldwin (1957, 1968); Correll (1950); Fernald (1947, 1950); Gleason (1952); Gleason and Cronquist (1963); Grimes (1921); Harvill (1965, 1969b, 1970a); Harvill *et al.* (1977); Henry *et al.* (1975); Luer (1975); Massey (1953, 1961); Ripley (1975); Steyermark (1963); Taylor (1934).

Author: Donna M. E. Ware.

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16. ROUND LEAVED CATCHFLY

Silene rotundifolia Nutt.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Caryophyllales
Family: Caryophyllaceae

Description: A short, slender, usually branched perennial with lower leaves that are round to ovate. Flower superficially like that of *Silene virginica* L., though on the average the calyx is longer and the petals are shorter. Habitat requirements provide further differences between the two species.

Present Range: West Virginia and southern Ohio to Georgia and Alabama.

Distribution in Virginia: Dickenson and Wise counties (Figure 6).

Habitat and Mode of Life: Dry sandstone or occasionally limestone cliffs.

Status: *Endangered*. The two colonies known in Virginia consist of ten plants on sandstone cliffs under a power line and near a railroad tunnel. If these areas were cleared with herbicide spraying (which would be the most feasible method in both areas) it would easily eliminate the colonies.

Protective Measures Proposed: The power company and railroad operating in the vicinity should be notified of the location and status of the plant, and an agreement should be reached to prevent spraying. As soon as this is accomplished, the status could change to *Threatened*. The plant would maintain itself without interference in the isolated localities.

Remarks: A literature record of Smyth County is found in the *Virginia Flora*, but examination of the herbarium at Virginia Polytechnic Institute and State University and a conversation with A. B. Massey gave no indication of a specimen or locality.

References: Fernald (1950); Massey (1961).

Author: Douglas W. Ogle.

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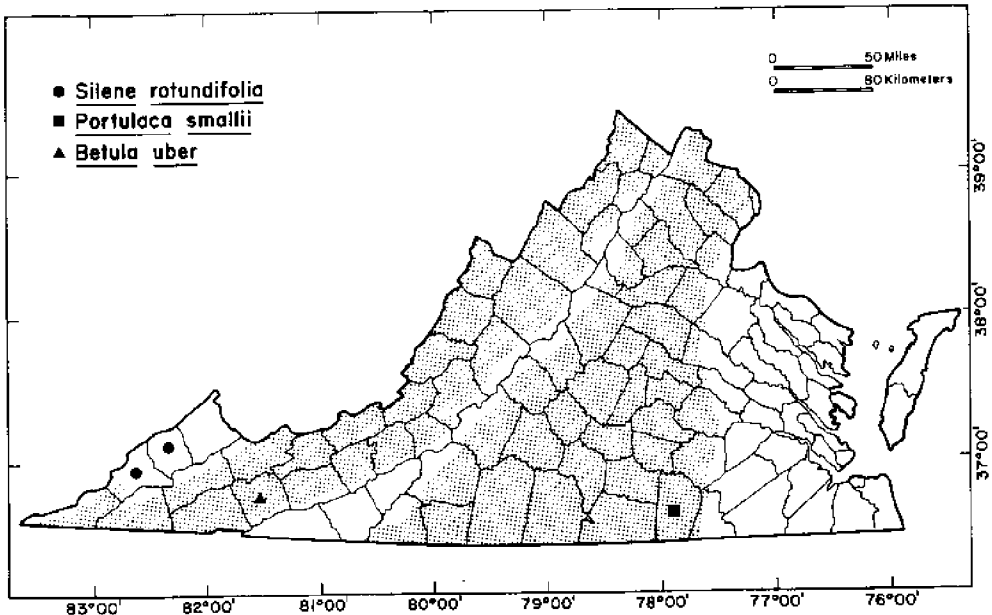


Figure 6. Distribution of *Silene rotundifolia*, *Portulaca smallii* and *Betula uber* in Virginia

17. SMALL'S PORTULACA

Portulaca smallii P. Wilson

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Chenopodiales
Family: Portulacaceae

Description: An erect, spreading, or prostrate annual bearing tufts of trichomes in the axils of alternate, fleshy, linear to spatulate leaves to 8 millimeters long. Flowers terminal, surrounded by erect trichomes and a circle of leaves. Petals five, pink. Stamens 8-12; capsule subglobose, seeds silvery-black and tuberculate.

Illustration: Hardin *et al.* (1977).

Present Range: Piedmont of Virginia (Brunswick County), North Carolina (five counties) and Georgia (De Kalb County).

Distribution in Virginia: Piedmont - Brunswick County, where discovered by A. M. Harvill, Jr., in 1974 (Figure 6).

Habitat and Mode of Life: Granite outcrops.

Reproduction: Flowering and fruiting June-October.

Status: *Endangered*. This rare endemic is known from relatively few localities throughout its range. Quarrying is a particular threat to its habitat. Some quarrying has taken place at the Gasburg locality, plus impacts of dumping and the construction of a gravel road across the outcrop.

References: Cotter and Platt (1959); Hardin *et al.* (1977); Harvill (1976); Murdy (1968); Radford *et al.* (1968); Small (1933); Ware, A. (pers. comm., 1978); Wilson (1932).

Author: Donna M. E. Ware.

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18. VIRGINIA ROUND-LEAF BIRCH

Betula uber (Ashe) Fern.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Fagales
Family: Betulaceae

Description: A small deciduous tree averaging about 10.5 meters high with bark indistinguishable from *Betula lenta* L. The leaves are used as the major distinguishing characteristic. The largest leaf blades are approximately 5 centimeters wide, and 6 centimeters from apex to petiole, suborbicular-cordate, and have 3-6 pairs of lateral veins. Leaf margins are coarsely dentate, and the apex is broadly rounded. Smaller leaves (2 centimeters) of fertile branches are often elliptical. Pistillate aments are erect, and are shorter (1 to 1.5 centimeters) than those of *Betula lenta*.

Present Range: Smyth County, Virginia, is the only known locality. The entire population is distributed along one-half mile of stream bank and flood plain of Cressy Creek east of Sugar Grove.

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Other than the stream association, there seem to be no special habitat requirements. The locality is similar to many other areas in the immediate vicinity.

Reproduction: Natural reproduction is occurring only in one limited site, and all size classes are present in the population. The reproductive biology is unknown, although successful propagation has been accomplished by rooting cuttings of the seedling stock.

Number in Captivity: There are approximately sixty cultivated specimens, mostly at the U.S. National Arboretum. A specimen was recently given to the Bonn Botanical Garden, West Germany, and another is growing at the University of Michigan Arboretum. Some of these individuals will be returned to the original site, some are to be outplanted, and a program to distribute other arboretum material is underway.

Status: *Endangered*. An endemic plant, *Betula uber* is now restricted to only one locality that might easily be destroyed. All individuals and public agencies having interests in the area have been notified, and almost all the population is protected by fencing. Extensive searches in the surrounding area have not found additional sites.

Protective Measures Proposed: A committee to coordinate all activity (protection, research, education, etc.) concerning the plant have made specific and general proposals to help insure the continued existence of the site.

Remarks: The plant has been known by several common names, Ashe or Ashe's birch, and the Virginia birch. Much of the danger to the plant comes from collectors. Almost all the seedlings have been cut back, large bark samples have been taken from the mature specimens, and without further control, damage will continue.

References: Ogle and Mazzeo (1976).

Author: Douglas W. Ogle.

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19. FRINGED GENTIAN

Gentiana crinita Froel.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Gentianales
Family: Gentianaceae

Description: Biennial or annual herbs, stems 1-10 decimeters high; lowest leaves spatulate, middle and upper ovate to ovate-lanceolate and broadly rounded to subcordate basally, 7-25 millimeters wide; calyx 4-lobed, 1.6 to 4 centimeters long, tube and lobes sharply keeled, lobes unequal; corolla 4-lobed, violet-blue (rarely white), 3.5 to 6 centimeters long, lobes cuneate-obovate, wide-spreading in sunshine, conspicuously fringed apically with slender teeth 2-6 millimeters long; capsule with a short stipe; flowering in late fall.
(mainly after Fernald, 1950)

Illustrations: Fernald (1950), Gleason (1952).

Present Range: Southern Manitoba to Maine, south to northern Iowa, Indiana, Ohio, and Pennsylvania, and locally in the Southern Appalachians to North Carolina and perhaps Georgia.

Distribution in Virginia: Known only from a single locality in the mountain county of Montgomery (Figure 7).

Habitat and Mode of Life: Wet meadow.

Reproduction: Presumably sexual. "Seeds often all blowing to new areas and the plants disappearing from former stations." (Fernald, 1950).

Status: *Endangered*. The one small population is in danger from the area being developed for housing. Also *Endangered* in North Carolina (Hardin *et al.*, 1977), and *Extirpated* from West Virginia, where once known from one locality (Fortney *et al.*, 1978).

Protective Measures Proposed: The locality, which is on private land, must be protected from development. The plant must be protected from collectors.

Remarks: This attractive gentian has become very rare through being collected by would-be wildflower gardeners. Unfortunately, being an annual or biennial, it rarely survives transplanting, let alone sets seed.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Radford *et al.* (1968); Hardin *et al.* (1977); Fortney *et al.* (1978).

Author: Duncan M. Porter.

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20. PETERS-MOUNTAIN MALLOW

Iliamna corei (Sherff) Sherff

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Malvales
 Family: Malvaceae

Description: Perennial herbs from woody rhizomes, stems erect, branched, densely stellate-pubescent, to 1 meter high; leaves maple-like, 5-7 lobed, less than 1 decimeter wide, lobes prolonged, terminal oblong-lanceolate margins dentate-serrate, with acute sinuses; flowers clustered in axils of upper leaves, fragrant, to 5 centimeters in diameter; calyx densely pubescent, 5-lobed, lobes 1 to 1.5 centimeters long; petals 5, rose; flowering in July and August (mainly after Fernald, 1950).

Photographs: Strausbaugh and Core (1932), Sherff (1946).

Present Range: Endemic to Virginia.

Distribution in Virginia: Known only from Peters Mountain, Giles County (see under Remarks below) (Figure 7).

Habitat and Mode of Life: Soil-filled pockets and crevices in sandstone outcrops; growing in full sunlight in open woods.

Reproduction: Presumably sexual and asexual (by rhizomes).

Cultivation: Seeds have been collected, and progeny grown, by several botanists interested in the taxonomy of the genus.

Status: *Endangered*. The habitat in which this species lives is in danger of destruction: "Area looked highly disturbed due to a hiking path (well worn along edge of contour of slope). Many plants may have perished for this reason. The trail was laid out by the U.S. Forest Service and marked accordingly." (William Pusateri, pers. comm.). Listed as *Endangered* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: The Forest Service should reroute this hiking trail immediately.

Remarks. In the past, some botanists have considered the Peters-Mountain Mallow to be conspecific with the Kankakee Mallow (*Iliamna remota* Greene) of Illinois and Indiana, or a variety of the latter (*Iliamna remota* var. *corei* Sherff). However, the two do appear to be specifically distinct, although closely related. *Iliamna* has been collected along railroad rights-of-way and a highway in the Mountain counties of Botetourt (Keener, 1964) and Alleghany (Pusateri, pers. comm.). These collections appear to represent *Iliamna remota* rather than *Iliamna corei*. Seeds of the former at one time were spread along railroads in the Middle West in an attempt to spread this narrowly-distributed species (Sherff, 1949). Perhaps at this time the species was spread to Virginia as well.

References: Strausbaugh and Core (1932); Sherff (1946, 1949); Fernald (1950); Keener (1964); Harvill (1969a); Wood (1970); Ripley (1975).

Author: Duncan M. Porter.

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21. LEATHERFLOWER

Clematis viticaulis Steele

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Ranunculales
 Family: Ranunculaceae

Description: Differs from *Clematis ochroleuca* in its prevailing narrower leaves, peduncles shorter than subtending leaves, mature styles 2-3 centimeters long covered with deep-brown trichomes.

Present Range: Western Virginia.

Distribution in Virginia: Restricted to only a few shale barrens in Bath, Rockbridge and Augusta (?) counties (Figure 7).

Habitat and Mode of Life: Shale barrens (and just a few of these).

Status: *Endangered*.

Protective Measures Proposed: Encourage preservation of some of the shale barrens.

References: Keener (1975).

Author: Gwynn W. Ramsey.

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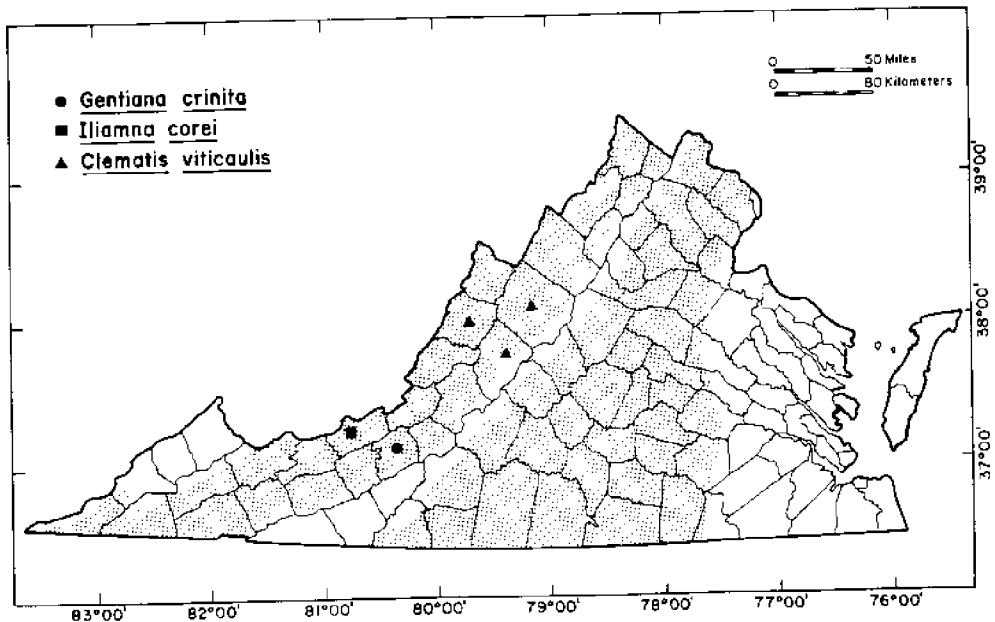


Figure 7. Distribution of *Gentiana crinita*, *Iliamna corei* and *Clematis viticaulis* in Virginia

22. SMALL'S STONECROP

Diamorpha smallii Britt.Syns. *Diamorpha cymosa* (Nutt.) Britt.,
Sedum smallii (Britt.) AhlesDivision: Magnoliophyta
Class: DicotyledoneaeOrder: Rosales
Family: Crassulaceae

Description: Diminutive winter annual generally occurring in dense aggregations. Erect or spreading-ascending, to 10 centimeters tall. Stems and leaves succulent, usually red. Leaves cylindrical-spatulate, 3-6 millimeters long. Flowers in compound, sparsely bracteate cymes; sepals four, petals four or five, white, 2-3 millimeters long. Pistils four, united for about one-third of their length.

This species has frequently been confused with *Sedum pusillum* Michaux which can be distinguished by its generally longer bluish-green leaves, longer petals, and by the pistils being separate to the base. The northernmost known range for *Sedum pusillum* is southernmost North Carolina.

Illustrations: Radford *et al.* (1968; under *Sedum smallii*). Small (1933; under *Diamorpha cymosa*).

Photographs: McCormick and Platt (1964, under *Diamorpha cymosa*).

Present Range: Piedmont - Virginia to Alabama, and Ridge and Valley of Alabama and Tennessee.

Distribution in Virginia: Piedmont - Brunswick County. Discovered by A. M. Harvill, Jr., in the early 1970's (Figure 8).

Habitat and Mode of Life: On mineral soil in or around vernal pools that form in shallow depressions on granite outcrops. This species is also known from sandstone substrate in other parts of its range.

Reproduction: Flowering April-May.

Status: *Endangered*. Extensive areas of exposed granitic substrate are rare in the Piedmont of Virginia, and the Gasburg outcrop has been under some adverse pressures due to quarrying, dumping, and road-building.

References: Harvill (1976); McCormick and Platt (1964); Murdy (1968); Radford *et al.* (1968); Small (1933); Sherwin and Wilbur (1971); Wilbur (1964); Ware, S. A. (pers. comm., 1978); Wiggs and Platt (1962).

Author: Donna M. E. Ware.

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23. FALSE or STAR VIOLET, ROBIN-RUN-AWAY, DEW DROP

Dalibarda repens L.Division: Magnoliophyta
Class: DicotyledoneaeOrder: Rosales
Family: Rosaceae

Description: Small perennial herb, with cordate evergreen leaves pubescent on both sides, to 5 centimeters long. Petioles to 6 centimeters long from slender rhizomes. Flowers of two types: white-petaled, upright, and generally sterile; and small, apetalous, cleistogamous, fertile ones on short peduncles. Calyx deeply 5 to 6-parted, petals sessile, deciduous, stamens many. Fruits are hairy, dry drupes.

Present Range: Transylvania County, North Carolina; three counties in West Virginia; New Jersey and scattered New England localities into Canada.

Distribution in Virginia: Recently discovered in Carroll County by C. E. Stevens (Figure 8).

Habitat and Mode of Life: Low areas along a small meandering stream in deciduous woods for Virginia. Boggy area in North Carolina.

Reproduction: The population in Carroll County is reproductively viable, but limited by habitat conditions from expansion.

Status: *Endangered*. Listed as *Endangered* in North Carolina because of its rarity and geographic importance as the southernmost station for the species; the plant was originally thought to be disjunct from West Virginia. The Virginia population is adjacent to land that is now farmed, and would be a very likely site for recreational development in the near future. The Virginia locality is important as a research site for this northern species.

Protective Measures Proposed: Land ownership should be determined, and appropriate owners should be notified of the significance of the site. Blue Ridge Parkway officials should be informed, and plans to keep workcrews from damaging the area should be formulated. If there is agreement from all concerned, the status could be changed; possibly even to *Special Concern*.

Remarks: Because the plant is small and inconspicuous, danger from collectors is minimized. However, because of its moisture requirements, changes in drainage of the surrounding areas could adversely affect the population.

References: Hardin *et al.* (1977); Fernald (1950); Strausbaugh and Core (1971).

Author: Douglas W. Ogle.

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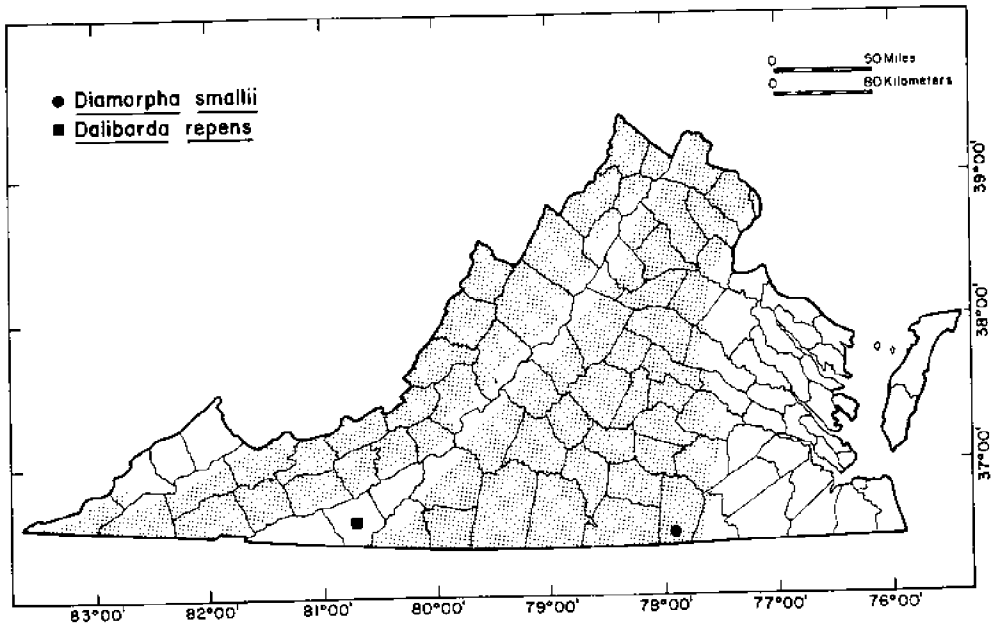


Figure 8. Distribution of *Diamorpha smallii* and *Dalibarda repens* in Virginia

THREATENED (33)

1. SHINING-CLIFF CLUBMOSS HYBRID

Lycopodium lucidulum X *porophilum*

Division: Lycopodophyta
 Class: Lycopsidea

Order: Lycopodiales
 Family: Lycopodiaceae

Description: Abortive-spored and intermediate between parental species. Medium-sized (20 centimeters or more high), evergreen clubmoss with dichotomous shoots forming a tuft, eventually becoming decumbent. Leaves (5-8 millimeters long), ovate-lanceolate with some teeth and crowded into spiral along length of shoot. Kidney-shaped sporangia borne in axils of fertile leaves, which alternate with sterile leaves, showing definite differentiation in size. Leaves spreading to reflexed, shoot approximately 10 millimeters in diameter. Spores abortive, misshapened. Shoots interrupted by zones of gemmiphores with three-lobed gemmae with broad lobes and slightly acute tips.

Present Range: Occurring with almost all colonies of *Lycopodium porophilum*, often in numbers equal to it. Parental range central eastern United States, northwest to Minnesota, northeast to Pennsylvania, south to Alabama, and west to Missouri. Colonies widely disjunct throughout entire range due to scattered nature of specialized habitat.

Distribution in Virginia: Cumberland Mountain, Lee County. *Lycopodium porophilum* was not collected at this site but may be present (Figure 9).

Habitat and Mode of Life: Same as *Lycopodium porophilum* (which see) but may sometimes be terrestrial under cliffs.

Reproduction: Abortive-spored, and therefore presumably sterile. However, it is able to form new individuals by gemmae. The hybridization event need only occur once, and the hybrid can reproduce well enough even to outnumber or replace the parental species.

Cultivation: Rarely survives in cultivation.

Status: *Threatened*.

Protective Measures Proposed: Maintenance of the habitat will protect the plant as long as collecting is kept to a minimum.

Remarks: see *Lycopodium porophilum*.

Author: Joseph M. Beitel.

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2. CLIFF CLUBMOSS

Lycopodium porophilum Lloyd and Underwood

Division: Lycopodophyta
 Class: Lycopsidea

Order: Lycopodiales
 Family: Lycopodiaceae

Description: Medium-sized (to 20 centimeters high) evergreen clubmoss with dichotomous shoots forming a tuft, shoots on older individuals becoming somewhat decumbent. Leaves (5-8 millimeters long) linear-lanceolate, with a few teeth, crowded in a spiral along entire stem. Kidney-shaped sporangia in axils of leaves. Sterile leaves alternating with fertile leaves, showing definite differentiation in size. Leaves spreading to reflexed, stem approximately 10 millimeters in diameter. Spores normal, larger than 30 microns. Shoots interrupted by zones of gemmiphores with three-lobed gemmae with narrow, acute tips.

Present Range: Central eastern United States: northwest to Minnesota, northeast to Pennsylvania, south to Alabama and west to Missouri. Colonies widely disjunct throughout the entire range due to the scattered nature of the specialized habitat.

Distribution in Virginia: Bald Knob near Mountain Lake Biological Station (Giles County); a sterile hybrid with *Lycopodium lucidulum* has been collected in Lee County which may indicate the presence of *Lycopodium porophilum* at this site. Found in nearby Monroe County, West Virginia, and Whitley County, Kentucky (Figure 9).

Habitat and Mode of Life: Restricted to moist, acidic sandstone cliffs and ledges, usually in the shade of some evergreen such as white pine or eastern hemlock. May be locally common due to reproduction by gemmae.

Reproduction: Mainly by gemmae in the appropriate habitat, with sexual reproduction rare. Gametophyte unknown, though presumed to be epipetric, subterranean, and mycorrhizal.

Cultivation: Rarely survives in cultivation.

Status: *Threatened*. Rare on exposed cliffs at Bald Knob. Should be looked for at the Lee County station for *Lycopodium lucidulum* X *porophilum*.

Protective Measures Proposed: Maintenance of the habitat will save the plant if collecting is kept to a minimum.

Remarks: This endemic North American taxon has been badly confused with *Lycopodium selago* and *Lycopodium lucidulum*, having been made a variety of each at one time or another. Sterile hybrids with *Lycopodium lucidulum* are intermediate in morphology and have usually been undetected in spite of abortive spores. This hybrid, which is found only with the rarer parent, may outnumber it due to its extensive reproduction by gemmae.

Author: Joseph M. Beitel.

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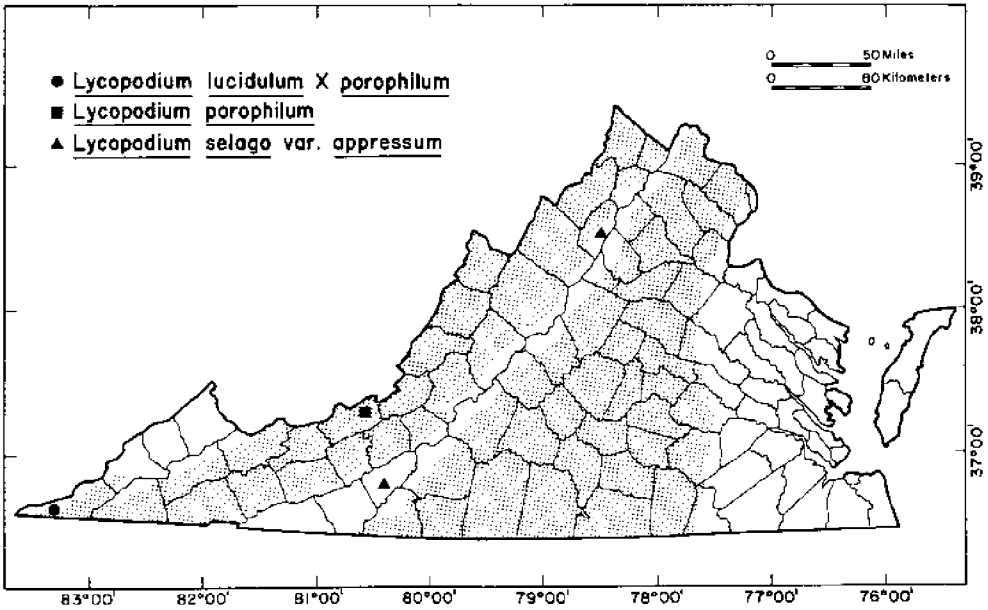


Figure 9. Distribution of *Lycopodium lucidulum* X *porophilum*, *Lycopodium porophilum* and *Lycopodium selago* var. *appressum* in Virginia

3. FIR CLUBMOSS

Lycopodium selago var. *appressum* Desv.

Division: Lycopodophyta
 Class: Lycopsidea

Order: Lycopodiales
 Family: Lycopodiaceae

Description: Small (to 15 centimeters high) evergreen clubmoss with simple or dichotomous erect shoots forming a dense tuft. Leaves (3-5 millimeters long) lanceolate, entire, broadest at base and crowded into a spiral along entire stem. Kidney-shaped sporangia in axils of leaves. Except for juvenile leaves, leaves appressed, forming narrow shoots approximately 5 millimeters in diameter. Spores more than 30 microns in diameter, uniform. Fertile leaves interrupted by zones of gemmiphores with small (3 millimeters) three-lobed gemmae with acute tips.

Present Range: Arctic and boreal eastern North America, with widely scattered colonies in high elevation, rocky areas of New England, south to Georgia.

Distribution in Virginia: Definitely known from the summit of Buffalo Mountain, Floyd County. A possible specimen from Little Stony Man (Page County) is without spores so positive identification is difficult (Figure 9).

Habitat and Mode of Life: Acidic bogs and open, rocky habitats on acidic, igneous rocks, usually supplied with seepage water. Locally common in a small area on Buffalo Mountain due to extensive reproduction by means of gemmae.

Reproduction: Mainly by gemmae, with sexual reproduction rare. The gametophyte is subterranean and is supplied with nutrition by mycorrhizal fungi.

Cultivation: Rarely successful.

Status: *Threatened*. Local in steep, rocky sites near the summit of Buffalo Mountain, where it exists in about equal numbers with its sterile hybrid, *Lycopodium selago* var. *appressum lucidulum* (see remarks). Much reproduction by gemmae.

Protective Measures Proposed: As long as the rocky, high elevation habitat is protected, the plants should continue to reproduce. This habitat, however, should be protected from too much disturbance, and the plant itself with its tufted habit is susceptible to depletion by over-collecting.

Remarks: The *Lycopodium selago* complex has been confusing due to environmental effects on members and the high frequency of hybridization. Sterile hybrids with *Lycopodium lucidulum* can be easily detected by abortive spores. They have been overlooked or considered forms of *Lycopodium selago*. In addition, *Lycopodium selago* is a species complex and this "variety" is probably a species distinct from *Lycopodium selago* of Linnaeus, which is basically a lowland species. The disjunct colonies in New England and the southern Appalachians probably represent relict populations of a much wider distribution during glaciation when suitable habitat was continuous down the entire Appalachian chain. All the material examined from the Blue Ridge in Virginia ascribed to this species is its hybrid with *Lycopodium lucidulum*, a common member of the temperate forest. The hybrid survives the conditions of the now warmer, rocky cliffs which are not covered by forest. The more robust hybrid is preferentially collected over the depauperate-looking parental species where it grows in the Blue Ridge.

Author: Joseph M. Beitel.

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4. MASSACHUSETTS FERN

Thelypteris simulata (Davenport)
Nieuwland

Division: Pteridophyta
Class: Filicopsida

Order: Polypodiales
Family: Aspleniaceae

Description: A medium-sized, deciduous fern with pinnate-pinnatifid fronds loosely clustered at tips of slender, branched rhizomes. Fertile leaves slightly taller than sterile; indusia reniform. Distinguished from *Thelypteris palustris* (Marsh fern) by frond slightly tapered at base, basal pinnae markedly tapering at both ends, and presence of unbranched veins extending from midvein of pinnule to margin. Differs from *Thelypteris noveboracensis* (New York fern) in its longer petiole and fewer reduced pinnae.

Present Range: Northeastern North America; coastal plain from Nova Scotia to Virginia, inland in mountains to Vermont, New Hampshire, New York, Pennsylvania, and West Virginia, disjunct populations in the Driftless Area of Wisconsin.

Distribution in Virginia: Known from the Coastal Plain in Accomack, New Kent and Northampton counties (Figure 10).

Habitat and Mode of Life: Acidic swamps and bogs; usually associated with spring water.

Reproduction: Sexual reproduction by spores and superficial gametophytes. Vegetation reproduction by creeping rhizomes.

Cultivation: Not known to be cultivated.

Status: *Threatened*. Populations in Virginia are peripheral populations of a more northern range. Status of populations in Virginia unknown to authors. Because of its restricted range in specialized habitats, it should be considered *Threatened* until proven otherwise.

Protective Measures Proposed: Preservation of acidic swamp and bog habitat will preserve populations if they are still in existence.

Remarks: Species can be overlooked because of confusion with other *Thelypteris* species. Should be sought in extremely acidic swampy habitats. Not likely to be found in marly swamps or dry upland forest.

Reference: Tryon, A. and R. Tryon (1973).

Authors: Joseph M. Beitel and Warren H. Wagner.

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5. FRASER'S FIR or SHE BALSAM

Abies fraseri (Pursh) Poir.

Division: Pinophyta
Class: Pinopsida

Order: Pinales
Family: Pinaceae

Description: Small to medium-sized tree to 70 feet high. Leaves flat, linear, 1-2 centimeters long, shiny green above, glaucous below. Scales deciduous.

Present Range: Virginia, North Carolina, Tennessee.

Distribution in Virginia: Summit of Mount Rogers. The Grayson-Smyth County line goes across the summit and the plant is recorded in both counties for no reason other than placement of line. There is only one population (Figure 10).

Habitat and Mode of Life: A high altitude (above 5,000 feet) Southern Appalachian endemic. Virginia is the northernmost station for the species.

Status: *Threatened*. Listed as *Special Concern* in the Tennessee endangered list. Mount Rogers is the northern station and is an isolated colony, disjunct from the major portion of the other populations of this plant. In other areas, aphids have damaged the trees, though the Virginia population is so far free from the pest. Development of the Mount Rogers National Recreation Area (unless appropriate planning is done) and increased use of crest zone for recreation could severely hamper the reproductive capacity of this plant.

Protective Measures Proposed: The United States Forest Service should be notified of the significance of this population, and plans to preserve it should be formulated in the management of the Mount Rogers National Recreation Area.

References: Committee for Tennessee Rare Plants (1978); Fernald (1950); Radford *et al.* (1968).

Author: Douglas W. Ogle

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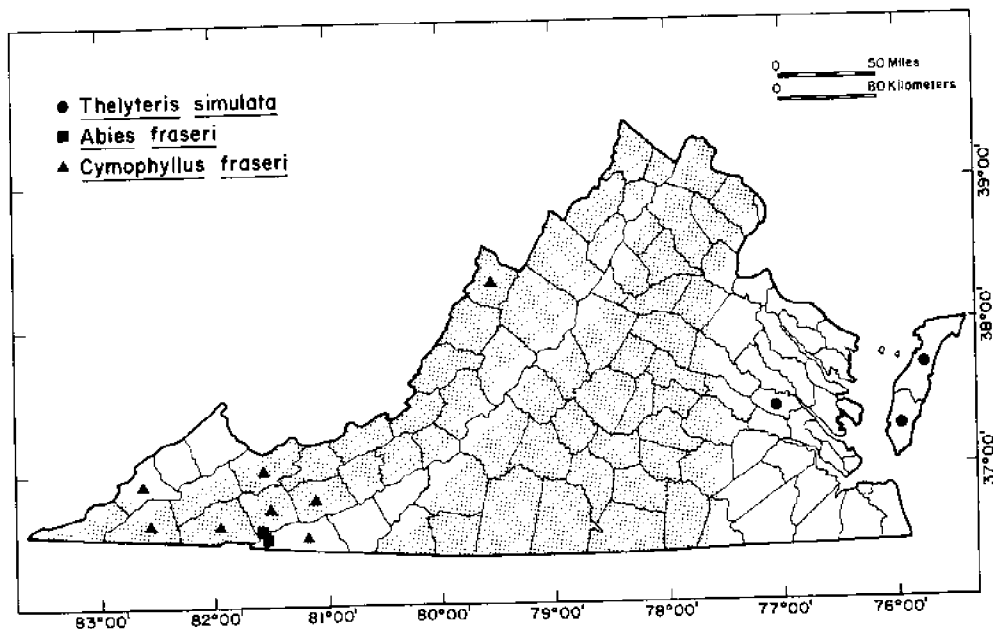


Figure 10. Distribution of *Thelypteris simulata*, *Abies fraseri* and *Cymophyllus fraseri* in Virginia

6. FRASER'S SEDGE

Cymophyllus fraseri (Andrz.) Mackenzie

Division: Magnoliophyta

Order: Cyperales

Class: Monocotyledoneae

Family: Cyperaceae

Description: Perennial herb from a short, thick rhizome. Leaves are evergreen, basal, thick, and many ribbed; 1-7 decimeters long and 2 to 4.5 centimeters wide. Flowers on terminal spike, staminate very obvious and above the pistillate. Twenty or more white inflated pistillate flowers with a white perigynium enclosing the ovary. The only living member of this genus, *Cymophyllus* is very distinctive, and difficult to mistake.

Present Range: Mountainous areas in the Carolinas, Virginia, Tennessee, West Virginia and Pennsylvania.

Distribution in Virginia: Scott, Washington, Grayson, Smyth, Wythe, Tazewell, Highland and Wise counties (Figure 10).

Habitat and Mode of Life: Rich woods in Virginia, often associated with rocky outcrops.

Reproduction: Colonies are often so small and isolated that reproduction could be affected.

Number in Captivity: Because this plant is unusual, evergreen, and often showy, more elite wildflower enthusiasts transplant it.

Status: *Threatened*. Because of the unique taxonomic status of this genus, considerable concern over its survival is merited. In Virginia, as well as surrounding states, colonies are most often small, and fairly isolated. Destruction of suitable habitat poses a constant threat to its survival.

Protective Measures Proposed: Populations on both public land and areas near roads should be located and appropriate agencies should be notified.

References: Clarkson (1961); Hardin *et al.* (1977); Fernald (1950); Harvill *et al.* (1977); Strausbaugh and Core (1970).

Author: Douglas W. Ogle.

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7. CUT GRASS

Leersia hexandra Sw.

Division: Magnoliophyta

Order: Cyperales

Class: Monocotyledoneae

Family: Poaceae

Description: A slender, rhizomatous perennial with a long-decumbent culm, 3-10 decimeters high. Stamen number (6), spikelet shape (elliptic), and panicle disposition (narrow with ascending branches) are the major distinguishing characteristics. Leaf blades stiff and retrorsely-scabrous to glabrous; spikelets 3.5 to 4.7 millimeters long, 1.5 to 2.0 millimeters wide.

Present Range: Overall the species is distributed from southern Virginia to Florida and along the Gulf Coast to eastern Texas. It also is widely distributed in the tropics of both hemispheres.

Distribution in Virginia: Known only from Sussex County in the Coastal Plain (Figure 11).

Habitat and Mode of Life: Marshes and other wet places.

Reproduction: Unknown, but probably reproduces vegetatively by its extensive leafy stolons.

Status: *Threatened*. Its habitats are threatened by future development.

References: Hitchcock and Chase (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); and Mayes (in press).

Author: Richard A. Mayes.

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8. PANIC GRASS

Panicum hians Ell.

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Poaceae

Description: A slender, erect to sprawling perennial with short rhizomes; culms compressed, 1-6 decimeters high. The minute ligules, short-pedicelated glabrous spikelets, and indurate sterile palea inflated at maturity are the major distinguishing characteristics. Leaf blades sparsely pilose above, glabrous beneath, and scaberulous marginally; spikelets 1.5 to 2.3 millimeters long.

Present Range: Overall the species is reported from the majority of the southeastern states and from Missouri, Texas, Oklahoma, and New Mexico.

Distribution in Virginia: Known only from the Coastal Plain counties of Greensville, Southampton, and Sussex (Figure 11).

Habitat and Mode of Life: An aquatic species found in marshes and ditches, along streams and ponds, and on seepage slopes.

Reproduction: Unknown.

Status: *Threatened*. Populations are local and scattered, and many habitats (marshes, ditches, and seepage slopes) are threatened by development in the future.

References: Fernald (1950); Hitchcock and Chase (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); and Mayes (in press).

Author: Richard A. Mayes.

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9. ONE-FLOWERED RUSH

Juncus trifidus var. *monanthos*
(Nutt.) Bluff & Fingerhuth

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Juncales
Family: Juncaceae

Description: Stems loosely tufted from creeping rhizomes, to 6 decimeters high; leaves basal, numerous, often equalling stems in length; flowers 1-3 per inflorescence; sepals shorter than obovoid, beaked, dark brown capsule; seeds few, angled, 1.5 to 2.0 millimeters long; flowering and fruiting June through August (mainly after Fernald, 1950).

Illustrations: Gleason (1952).

Present Range: Eastern New York to New Hampshire and south to the mountains of North Carolina; also in Europe.

Distribution in Virginia: Known only from Stony Man Mountain, Page County (Fig. 11).

Habitat and Mode of Life: Exposed crevices and mossy ledges of greenstone cliffs.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status: *Threatened*. Also *Threatened* in North Carolina (Hardin *et al.*, 1977).

Protective Measures Proposed: The habitat in which this species grows, which is in Shenandoah National Park, must be protected from development.

Remarks: This high elevation mountain species nearly reaches the southern limit of its range in Virginia. It is known from only one locality in North Carolina (Hardin *et al.*, 1977).

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Radford *et al.* (1968); Hardin *et al.* (1977).

Author: Duncan M. Porter.

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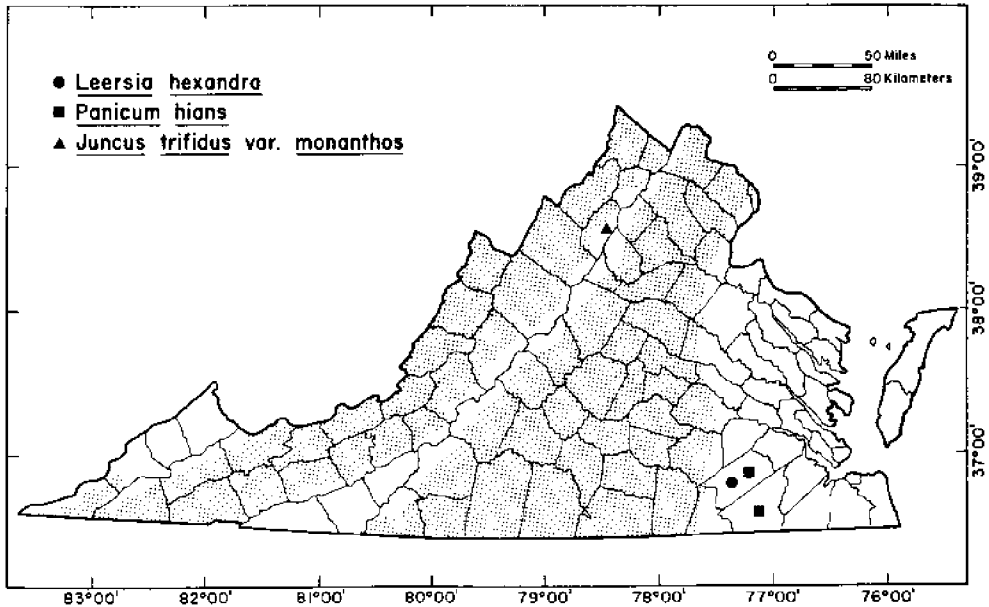


Figure 11. Distribution of *Leersia hexandra*, *Panicum hians*, and *Juncus trifidus* var. *monanthos* in Virginia

10. SPOTTED OR NODDING MANDARIN

Disporum maculatum (Buckl.) Britt.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Liliales
 Family: Liliaceae

Description: Low herbs (2-6 decimeters high) from creeping root stocks. Stems pubescent, at least when young; leaves thin, alternate, sessile or clasping, pubescent beneath. Flowers perfect, solitary, or few in an umbellate cluster; yellowish-white, spotted with purple. Perianth six narrow parted segments 1.5 to 2.5 centimeters long; six stamens, longer than the perianth. Fruit yellow, pubescent, and three-lobed. Its closest relative is *Disporum lanuginosum* (Michx.) Nicholson, distinguished by stamens being one-half to two-thirds as long as the perianth, petals unspotted, and fruits red and glabrous.

Present Range: Eastern Ohio, eastern Kentucky, southern West Virginia, southwestern Virginia, eastern Tennessee, western North Carolina, northern Georgia, and southeastern Michigan.

Distribution in Virginia: Washington, Russell, and Smyth counties (Figure 12).

Habitat and Mode of Life: Usually small colonies in rich deciduous woods.

Status: *Threatened*. Found in only two counties of North Carolina; *Disporum maculatum* was listed there as *Threatened*. A list of rare plants in Tennessee produced by A. J. Sharp in May 1974 included the plant, but a more recent list (September, 1976) by Wofford and Evans did not. In Kentucky, the plant is becoming "more and more rare" as its habitat is destroyed. The colonies I have examined in Virginia are small, and as the rich deciduous woods are removed, this species may be expected to rapidly decline in numbers.

Protective Measures Proposed: Federal and state lands should have listed localities, and developmental plans should not interfere with the populations. Private landowners should be notified and informed of the importance of the species.

References: Hardin *et al.* (1977); Gleason (1952); Harvill *et al.* (1977); Radford *et al.* (1968); Strausbaugh and Core (1970); Wharton (1971).

Author: Douglas W. Ogle.

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11. SWAMP PINK

Hellonias bullata L.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Liliales
 Family: Liliaceae

Description: Smooth perennial from tuberous rhizomes, hollow scape elongating in fruit to 1 meter tall. Leaves basal, evergreen, oblong or oblanceolate. Flowers fragrant, perfect, in a dense ebracteate raceme, sepals (6); lilac or pink, shorter than filiform filaments; anthers blue; capsule loculicidal, each valve divergently 2-lobed, ovules numerous on axile placentae.

Present Range: On the Coastal Plain from Staten Island, New York and New Jersey to eastern Virginia; in the mountains from Pennsylvania to Georgia.

Distribution in Virginia: Augusta, Nelson, and Henrico counties (Figure 12).

Habitat and Mode of Life: Very local in swamps and bogs.

Status: *Threatened*. The swamp and bog habitat is a fragile one and may be subjected to drainage for development.

Protective Measures Proposed: Maintain the habitat. The swamps and bogs where *Hellonias* occurs should be made known so that any developmental plans for the land will not interfere with the habitat. Local land owners should be informed.

References: Hardin *et al.* (1977); Fernald (1950); Gleason and Cronquist (1963); Harvill *et al.* (1977); Harvill (1970a); Radford *et al.* (1968).

Author: Miles F. Johnson.

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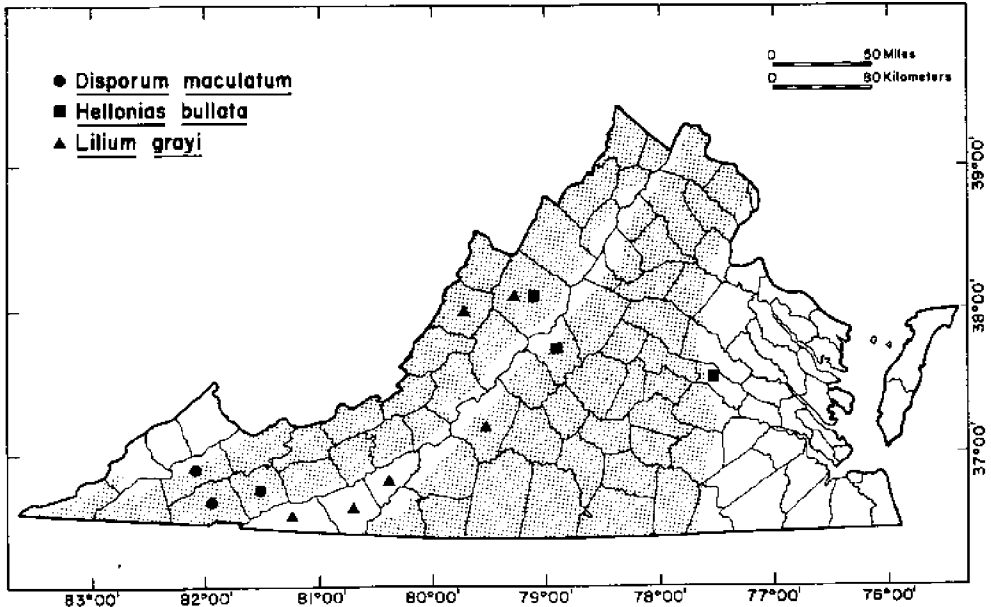


Figure 12. Distribution of *Disporum maculatum*, *Hellonias bullata*, and *Lilium grayi* in Virginia

12. GRAY'S LILY

Lilium grayi S. Wats.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Liliales
 Family: Liliaceae

Description: Stem to 2 meters high, with several whorls of 3-11 lanceolate to lance-ovate or oblong leaves 4-13 centimeters long, margins roughened. Flowers 1-8, nearly horizontal to slightly nodding, bell-shaped, 4-6 centimeters long; perianth deep reddish-orange, dark-spotted inside nearly to apex, with gold in throat; sepals and petals clawless, oblong-spatulate with only slightly out-curved short-pointed tips.

The red form of the Canada lily (*Lilium canadense* f. *rubrum* Britt.) is sometimes mistaken for Gray's lily. The former is distinguished by having five leaves 6-18 centimeters long, flower nodding, petals and sepals curving outward from near or below the middle and generally spotted less than two-thirds of their length.

Illustration: Gleason (1952).

Present Range: Mountains of North Carolina and adjacent Virginia and Tennessee.

Distribution in Virginia: Bath, Augusta, Grayson, Carroll, Floyd, and Bedford counties. The first two are old records, 1907 and 1908 respectively, but all of the others have been documented at least as recently as 1958, and some very recently (Figure 12).

Habitat and Mode of Life: Mountain balds, forest openings, and meadows.

Reproduction: Flowering mid-June to July.

Remarks: This species is also known as Roan lily and orange bell lily.

Status: *Threatened*. *Lilium grayi* is a Southern Appalachian endemic of very local occurrence that is known to be exploited both for commercial and private horticultural use.

References: Hardin *et al.* (1977); Crandall-Bliss (pers. comm., 1978); Fernald (1950); Gleason (1952); Harvill *et al.* (1977); Johnson (1969); Massey (1961); Radford *et al.* (1968).

Author: Donna M. E. Ware

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13. BOG ROSE

Arethusa bulbosa L.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Orchidales
 Family: Orchidaceae

Description: Perennial terrestrial herbs from a bulbous corm 5-15 millimeters in diameter with a few fibrous roots, glabrous, scapose, to 40 centimeters high; leaves 1, basal, lanceolate, 8-20 centimeters long, 3-12 millimeters wide, developing after flower fades, with 2-3 tubular sheaths below around stem base; flowers 1, showy terminating stem, rose (magenta to white); floral bracts scale-like, triangular, 3 millimeters long, 2 millimeters wide; ovary subsessile, erect, 15 millimeters long, 4 millimeters in diameter; sepals oblanceolate, oblique, 2-4 centimeters long, 6-9 millimeters wide, laterals falcate; petals linear-oblong, curved, 2-3 centimeters long, 5-8 millimeters wide; lip obovate, indistinctly 3-lobed, lateral lobes short and broadly triangular, mid-lobe curved downward, expanded, margins crenulate, marked or

veined with deep purple, 2-3 centimeters long, 1-2 centimeters wide, disc with yellow crests basally and becoming fleshy and fringed apically; column elongated, flattened with lateral wings, pink, 2.0 to 3.5 centimeters long, 7-10 millimeters wide; anther on front of column below apex, with two pairs of soft green pollinia; capsule ellipsoid, erect, 2.5 centimeters long, 1.5 centimeters in diameter. (after Luer, 1975).

Photographs: Luer (1975).

Illustrations: Gleason (1952); Radford *et al.* (1968); Luer (1975).

Present Range: Southern Ontario and Quebec to Newfoundland, eastern Minnesota south and east to northeastern Illinois, northern Indiana and Ohio, Pennsylvania, and New Jersey northward; disjunct in Virginia and North Carolina.

Distribution in Virginia: Mountain counties of Augusta and Patrick and City of Virginia Beach in the Coastal Plain. The latter collection needs to be verified. Not reported from Virginia by Luer (1975) (Figure 13).

Habitat and Mode of Life: Sphagnous bogs and wet meadows.

Reproduction: Presumably sexual.

Status: *Threatened*. Little is known about the distribution of this rare orchid in Virginia. Further study may indicate that it is best regarded as *Endangered*, as it is in North Carolina (Hardin *et al.*, 1977).

Protective Measures Proposed: The habitats in which the plants occur must be protected from development, as must the plants from the collectors of rarities.

Remarks: According to Fernald (1950), *Arethusa bulbosa* is "rapidly becoming *extinct* (the bulbs only loosely attached in the moss)" south of its Canadian distribution. Luer (1975) indicates that populations of this species vary greatly in size from year to year, perhaps explaining the basis of Fernald's comment.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Radford *et al.* (1968); Luer (1975); Hardin *et al.* (1977).

Author: Duncan M. Porter

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14. EARLY CORAL ROOT

Corallorhiza trifida Chatelain

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Orchidales
Family: Orchidaceae

Description: Leafless saprophytic herbs from a fragile, short, branching rhizome, stems erect, yellow to green, partly clothed by a few tubular sheaths, to 30 centimeters high; racemes scapose, loosely-flowered, flowers to 20; floral bracts minute; ovary short-pedicellate, 8 millimeters long; sepals yellowish-green, upper oblanceolate, 6 millimeters long, 1.5 millimeters wide, laterals linear-oblanceolate, falcate, 6 millimeters long, 1 millimeter wide; petals similar to sepals, but shorter, lip white (sometimes purple-striped), obovate, 3-lobed, 5 millimeters long, 3 millimeters wide; column curved, 4 millimeters long; another terminal, pollinia 4, yellow; capsule pendant, ellipsoid, 10 millimeters long, 5 millimeters in diameter; flowering from May to August. (after Luer, 1975)

Photographs: Luer (1975).

Illustrations: Gleason (1952), Luer (1975).

Present Range: A circumboreal species. In the United States found along the Rocky Mountains to New Mexico in the West, and in the East from northern Minnesota through Wisconsin, in northern Indiana, and in Pennsylvania and New Jersey northward, with disjunct localities in Missouri, Illinois, West Virginia, and Virginia.

Distribution in Virginia: Known only from a single locality in the Mountain county of Albemarle. Not reported from Virginia or West Virginia by Luer (1975) (Figure 13).

Habitat and Mode of Life: Under hemlocks and mixed hardwoods.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status: *Threatened*. The only known locality for this species in Virginia, which is within the boundaries of Shenandoah National Park, is near springs which are an important water source for Park facilities. "Continued demands on Park and additional facilities now under construction could endanger the species." (T. F. Wieboldt, pers. comm.)

Protective Measures Proposed: The habitat in question must be protected from further development.

Remarks: The Early Coral Root is extremely rare in Virginia and West Virginia, but further north in its main range of distribution, it is the "most commonly encountered saprophytic orchid" (Luer, 1975).

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Luer (1975); Fortney *et al.* (1978).

Author: Duncan M. Porter.

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15. LEWIS' HEART-LEAF

Hexastylis lewisii (Fern.)
Blomquist & Oosting
(Syn. *Asarium lewisii* Fern.)

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Aristolochiales
Family: Aristolochiaceae

Description: Acaulescent, rhizomatous herbs; rhizomes slender, horizontal, greatly elongated and branching; leaves solitary and scattered or single at apices of slender stolons, cordate, 2.5 to 6.0 centimeters long and wide; flowers solitary, found under leaves or litter, gray-brown outside, purple within; calyx-tube tubular and bell-shaped, 14-20 millimeters long, 16-22 millimeters in diameter, lobes five, 8-15 millimeters long, spreading, throat pubescent; flowering in April and May (mainly after Fernald, 1950).

Illustrations: Radford *et al.* (1968), Hardin *et al.* (1977).

Present Range: Outer Piedmont and inner Coastal Plain of North Carolina and adjacent Virginia.

Distribution in Virginia: Amelia and Brunswick counties in the Piedmont, and Greensville County in the Coastal Plain (Figure 13).

Habitat and Mode of Life: Wooded rocky streambanks and hillsides.

Reproduction: Presumably sexual and asexual (by stolons and rhizomes).

Status: *Threatened*. Due to loss of habitat. Also considered to be *Threatened* in North Carolina (Hardin *et al.*, 1977) where more common than in Virginia, and by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: Habitats in which this species occurs must be protected from development.

Remarks: Lewis Heart-Leaf is being eliminated by development in North Carolina (Hardin *et al.*, 1977) and it shares the same fate in Virginia. In fact, it may already have been extirpated from the Commonwealth, as no collections in Virginia appear to have been made since 1943.

References: Fernald (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); Ripley (1975); Hardin *et al.* (1977).

Author: Duncan M. Porter.

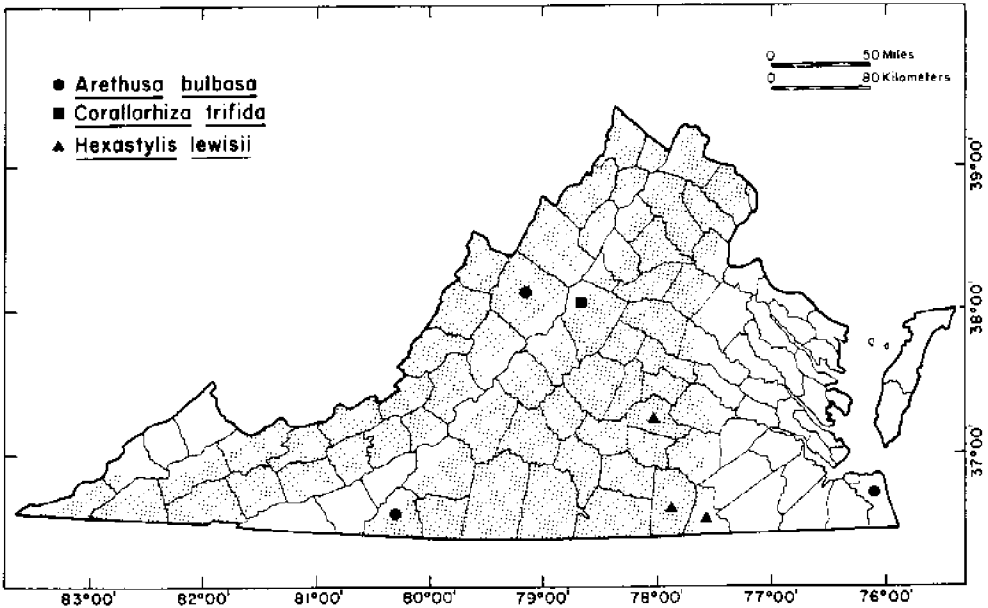


Figure 13. Distribution of *Arethusa bulbosa*, *Corallorhiza trifida*, and *Hexastylis lewisii* in Virginia

16. INDIAN PLANTAIN

Cacalia suaveolens L.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Asterales
 Family: Asteraceae

Description: Perennial herb to 1.6 meters high, with distinctive hastate, triangular leaves. Involucre 25- to 30-flowered, as opposed to about 5-flowered on the common *Cacalia atriplicifolia* L.

Present Range: Widely scattered from Connecticut to Iowa, south to Florida, Tennessee and Missouri. Because of the rarity throughout its range, this species is cited on the list for Tennessee as *Threatened*. In North Carolina, the plant is considered an *Endangered* peripheral species.

Distribution in Virginia: There are several old and two new records for Fairfax County and the Washington, D.C. area, and recent records for Pulaski and Carroll counties (Figure 14).

Habitat and Mode of Life: Records for Virginia are generally from alluvial soil, stream banks or marsh borders. In North Carolina the plant is found in bogs.

Status: *Threatened*. The localities in northern Virginia are near metropolitan areas that could possibly be developed. In southwest Virginia, localities might be destroyed by road work.

Protective Measures Proposed: The Virginia Department of Highways should be informed of localities so herbicide spraying and cutting will not interfere with the populations.

Remarks: In all likelihood, collectors and development are the only threats to the continued existence of the plant.

References: Committee for Tennessee Rare Plants (1978); Hardin *et al.* (1977); Fernald (1950); Radford *et al.* (1968).

Author: Douglas W. Ogle.

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17. RATTLESNAKE ROOT

Prenanthes roanensis (Chickering)
Chickering

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Asterales
 Family: Asteraceae

Description: Leaves ovate to deeply palmately-lobed; involucral phyllaries green grading to black at apex, dark-pilose at least on midrib.

Present Range: Moderate to high elevations in mountains of Tennessee, North Carolina and southwestern Virginia.

Distribution in Virginia: Mount Rogers - Grayson and Smyth counties (Figure 14).

Habitat and Mode of Life: Along trails, borders of woods, and in forests.

Status: *Threatened*. Possibly should be considered endemic.

References: Hardin *et al.* (1977); Milstead (1964).

Author: Miles F. Johnson.

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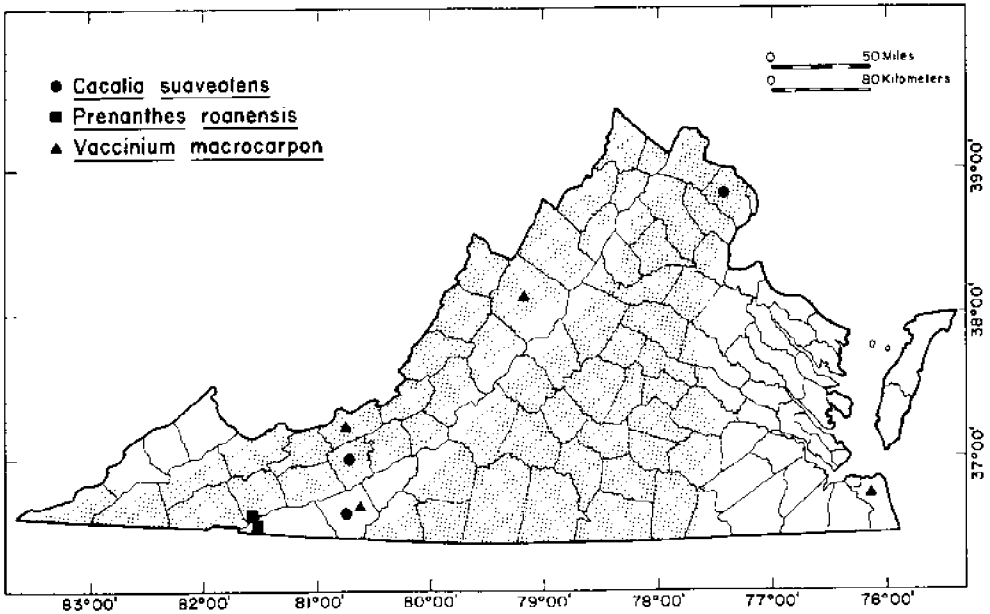


Figure 14. Distribution of *Cacalia suaveolens*, *Prenanthes roanensis*, and *Vaccinium macrocarpon* in Virginia

18. LARGE OR AMERICAN CRANBERRY

Vaccinium macrocarpon Ait.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Ericales
Family: Ericaceae

Description: Trailing, glabrous shrub with erect branches to 36 centimeters high, often rooting at nodes. Leaves evergreen, often reddish-brown in winter, elliptic with rounded tips, slightly whitened beneath, margins revolute, 5-18 millimeters long, 1-8 millimeters wide. Flowers nodding and solitary, with pink recurved petals, 6-10 millimeters long, blooming from May to July. Fruit bright red and persistent.

Present Range: Southeastern Canada, west to Michigan and Arkansas, south to North Carolina.

Distribution in Virginia: Augusta, Giles and Carroll counties, and possibly the City of Virginia Beach (Figure 14).

Habitat and Mode of Life: Sphagnum bogs.

Reproduction: Limited by available habitat and fastidious climatic requirements in Virginia.

Number in Captivity: Cultivated in many northern states.

Status. *Threatened*. Many bogs have been drained, and although in West Virginia this relict species is "considered typical of all sphagnum bogs," in Virginia examination of many suitable habitats has failed to produce numerous records. At least two sites (Carroll and Augusta) have been used commercially, but the prolific production of numerous, large fruits in a very small area is the primary reason for harvest. Considered *Endangered* in West Virginia and North Carolina, *Threatened* in Tennessee, and very *Rare* in Illinois.

Protective Measures Proposed: Management plans for sites on public lands should be formulated, and private landowners should be informed of the importance of this plant. Due to the specific nature of the habitat, technical assistance should be made available to individuals wishing to maintain the conditions necessary for survival of the cranberry.

References: Committee for Tennessee Rare Plants (1978); Hardin *et al.* (1977); Fernald (1950); Kartesz and Kartesz (1977); Radford *et al.* (1968).

Author: Douglas W. Ogle.

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19. GUYANDOTTE BEAUTY

Synandra hispidula (Michx.) Baill.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Lamiales
Family: Lamiaceae

Description: Herbaceous biennial with erect or ascending stem to 8 decimeters high. Leaves opposite, broadly ovate, cordate and toothed, 5-10 centimeters long, lower ones with long petioles. Flowers solitary in axils of reduced leaves of terminal spike, yellowish-white; corolla 2.5 to 3.5 centimeters, showy, two-lipped, upper lip entire, lower lip three-lobed.

Present Range: North Carolina, eastern Tennessee, western Virginia, southern West Virginia, southern Ohio, northern Kentucky and Illinois.

Distribution in Virginia: Three localities in Smyth-Tazewell, Washington and Wise counties (Figure 15).

Habitat and Mode of Life: Rich damp woods and stream banks.

Reproduction: The colonies are isolated enough to hamper distribution.

Status: *Threatened*. Habitat destruction has limited the distribution of this plant to small separated undisturbed areas. Considered to be *Threatened* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: Most known populations in Virginia are on private land. Finding new populations on public land would be a high priority.

References: Hardin *et al.* (1977); Fernald (1950); Ripley (1975); Strausbaugh and Core (1958).

Author: Douglas W. Ogle.

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20. WOOD POPPY *Stylophorum diphyllum* (Michx.) Nutt.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Papaverales
Family: Papaveraceae

Description: Low perennial herbs with basal, pinnately-parted leaves that are cauline and pale beneath. Height to 4.5 decimeters. Leaves with slender petioles, 1-2 pinnatifid, with divisions obovate, obtuse, lobed, or irregularly crenate, two to four per stem, upper leaves opposite. Flowers terminal, two to four, yellow, with petals to 2.5 centimeters long. Stigmas three to four, buds covered by two hairy sepals. Ovoid capsule to 2.5 centimeters long. Blooming in April or May in Virginia. Genus native to eastern North America, the Himalayas, Japan, and Manchuria.

Present Range: Western Pennsylvania to Wisconsin, Ohio, Kentucky, Tennessee, and southwest Virginia.

Distribution in Virginia: Lee, Washington and Smyth counties (Figure 15).

Habitat and Mode of Life: Moist, rich woods. Localities in Washington and Smyth counties are near water.

Status. *Threatened.* Populations in Washington and Smyth counties are near expanding population and development areas. A major park development is planned adjacent to the Smyth locality. Plans have been formulated to preserve the site.

Protective Measures Proposed: See Status.

Remarks: An introduced European plant, *Chelidonium majus* L. resembles the wood poppy, but differs in having narrower petals and a glabrous, linear capsule.

References: Britton and Brown (1913); Fernald (1950); Strausbaugh and Core (1971); Wharton (1971).

Author: Douglas W. Ogle.

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21. UMBRELLA LEAF *Diphylleia cymosa* Michx.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Ranunculales
Family: Berberidaceae

Description: Perennial herbs, to 1 meter tall, with peltate, two-segment, umbrella-like leaves. Inflorescence terminal, with white flowers arranged in a cyme, producing dark blue berries on red pedicels in late summer. Very distinctive during its growing season, *Diphylleia* is difficult to confuse with any other species in our area.

Present Range: Virginia, Tennessee, North Carolina.

Distribution in Virginia: Grayson, Smyth, and Washington counties, reaching the northern extent of its range (Figure 15).

Habitat and Mode of Life: Streamsides, wet seeps, and springs in rich woods.

Status: *Threatened.* A southern Appalachian endemic, *Diphylleia* is distributed only in the Mount Rogers-Whitetop region. This area is subject to recreational development, and with increasing numbers of roads, campgrounds, and visitors, the population could be severely limited.

Protective Measures Proposed: The U.S. Forest Service and the Virginia Department of Highways should be informed of localities, so populations of this plant within the National Recreation Area can be protected.

References: Fernald (1950); Massey (1961).

Remarks: A literature citation is given in Massey (1961) for Montgomery County, but attempts to locate specimens or a locality have been unproductive.

Author: Douglas W. Ogle.

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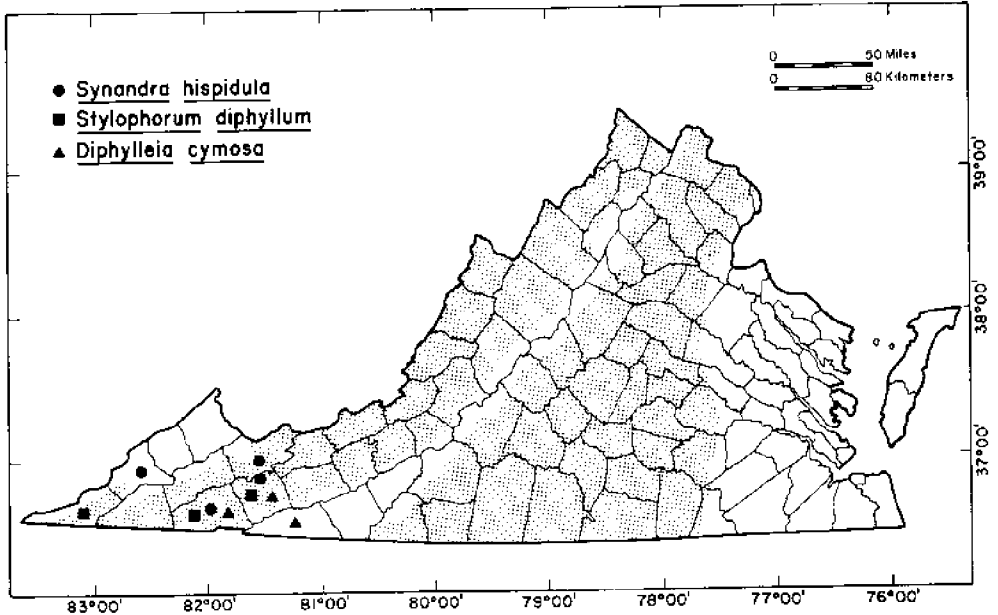


Figure 15. Distribution of *Synandra hispidula*, *Stylophorum diphyllum*, and *Diphylla cymosa* in Virginia

22. KEARNEY'S BUGBANE

Cimicifuga rubifolia Kearney

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Ranunculales
 Family: Ranunculaceae

Description: A tall (sometimes over 7 feet high) bugbane, having leaves composed of 3-9 large leaflets; three bracts at bases of pedicels; fruit an oblong follicle to 14 millimeters long.

Present Range: Southwestern Virginia, Tennessee (13 counties), southern Illinois (3 counties) and western Kentucky.

Distribution in Virginia: Only on the Clinch and Holston drainages in Scott County (Figure 16).

Habitat and Mode of Life: North-facing limestone talus slopes.

Number in Captivity: I have two or three plants in wildflower garden.

Status. *Threatened*. However, rather plentiful locally.

References: Ramsey (1964, 1965).

Author: Gwynn W. Ramsey.

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23. GOLDEN-SEAL

Hydrastis canadensis L.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Ranunculales
 Family: Ranunculaceae

Description: Herbaceous perennial from a yellowish rhizome, 1.5 to 5.0 decimeters tall; leaves long-petiolate, cordate.

Present Range: North Carolina, Virginia, Tennessee, Kentucky and West Virginia.

Distribution in Virginia: Three counties west of the Blue Ridge (Smyth, Pulaski, Montgomery), one county east of the Blue Ridge (Campbell) (Figure 16).

Habitat and Mode of Life: Deciduous woods near creeks.

Number in Captivity: One growing in a wildflower garden.

Status: *Threatened*. Exploited for medicinal purposes.

Remarks. The station in Campbell County has been clearcut and I doubt that this species will be seen there again.

References: Hardin *et al.* (1977).

Author: Gwynn W. Ramsey.

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24. CANADIAN TICK-TREFOIL

Desmodium canadense (L.) DC.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Rosales
 Family: Fabaceae

Description: Perennial erect herb, to 15 decimeters high, with 3-foliolate leaves, peduncles both terminal and axillary, stipules linear or lanceolate. Loments with generally more than four sections, bracts large, petioles less than 2.5 centimeters long. Showy flowers for a *Desmodium*, changing from pink to blue, blooming from late July to September.

Present Range: Nova Scotia to southern Saskatchewan to New England, Maryland, Virginia, West Virginia, Indiana, Illinois, Missouri and Oklahoma. Not common in West Virginia; reported from only six counties.

Distribution in Virginia: Reaches its southeasternmost extension of range in Virginia; not found in North Carolina. Recorded from the Washington, D.C. area, Fairfax, Rockbridge and Carroll counties. The latter is the southernmost locality (Figure 16).

Habitat and Mode of Life: Usually cool, wet meadows, though there is a Virginia record for a dry roadside.

Reproduction: The one colony I have observed for three years seems to vary greatly in numbers of plants from year to year.

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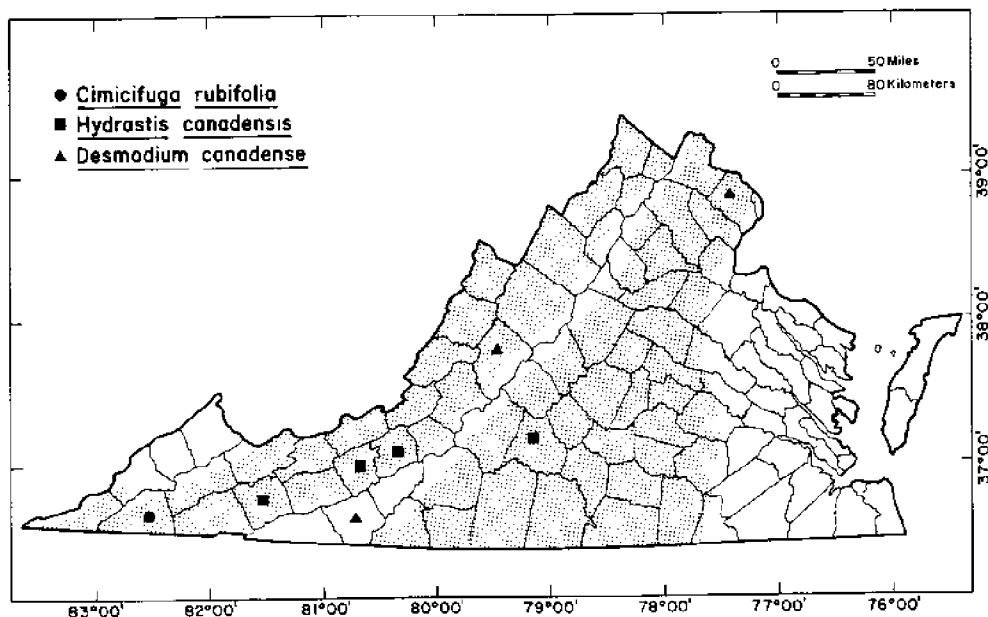


Figure 16. Distribution of *Cimicifuga rubifolia*, *Hydrastis canadensis*, and *Desmodium canadense* in Virginia

Status: *Threatened*. A northern plant reaching its southern limit in our area, its habitat preference for wet meadows could cause the populations to be eliminated by drainage projects or road work. Many records are near urban centers or roadsides.

Protective Measures Proposed: The Virginia Department of Highways should be informed of localities so that roadwork or the planting of alien species would not hamper the populations.

References: Fernald (1950); Strausbaugh and Core (1971).

Author: Douglas W. Ogle.

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25. THREE-TOOTHED CINQUEFOIL

Potentilla tridentata Ait.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Rosaceae

Description: Low perennial with extensive, creeping, somewhat woody stems, 3-22 centimeters tall. Leaves evergreen, often reddish-brown in winter, 3-foliate, thick, glabrous above, strigillose below, with long petioles except on flowering stems. Flowers white, borne in a compound cyme, petals 5-8 millimeters long and rounded, blooming from June through August. Achenes dark brown and pubescent.

Present Range: Eastern Canada down the mountains to Georgia, west to northeast Iowa.

Distribution in Virginia: Page, Madison, Nelson, Floyd, Grayson, Smyth, and Washington counties (Figure 17).

Habitat and Mode of Life: Exposed areas on high mountains in Virginia, usually near rock outcrops.

Reproduction: Restricted by appropriate habitat.

Status: *Threatened*. Though appearing to be widespread in county records, this relict species occurs only on approximately five mountain tops in the state. The largest population is on Whitetop Mountain where extensive recreational development is planned. The Page-Madison county populations are mostly within Shenandoah National Park and are the second largest concentration. If plans are not formulated to protect these available habitats, the plant could become endangered. Listed as *Threatened* in North Carolina and Pennsylvania, *Endangered* in New Jersey, Vermont, and Georgia, *Rare* in Iowa, and *Extirpated* in Illinois. In West Virginia it occurs in only three counties.

Protective Measures Proposed: Mount Rogers National Recreation Area and Shenandoah National Park officials should be notified of the importance and localities of this plant within their boundaries, and protective measures should be formulated. A status change should follow the implementation of such plans.

References: Hardin *et al.* (1977); Fernald (1950); Fortney *et al.* (1978); Kartesz and Kartesz (1977); Stevens (pers. comm., 1978).

Author: Douglas W. Ogle.

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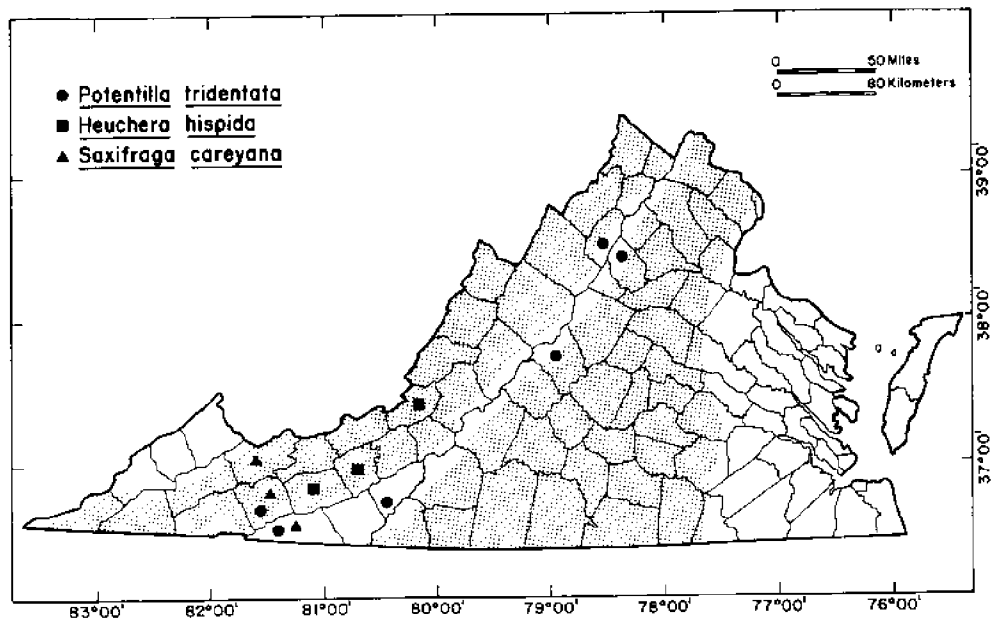


Figure 17. Distribution of *Potentilla tridentata*, *Heuchera hispida*, and *Saxifraga careyana* in Virginia

26. ROUGH ALUMROOT

Heuchera hispida Pursh.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Saxifragaceae

Description: Erect, perennial herbs; leaves mostly basal, blades reniform to round-cordate, 7- to 9-lobed, 5.5 to 12.5 centimeters long, 5.5 to 11.5 centimeters wide, petioles minutely glandular-puberulent to nearly glabrous; inflorescence a panicle; flowers greenish to dark reddish-purple, 5-7 millimeters long; glandular-puberulent; calyx irregular; capsules ellipsoidal, 6.5 to 8.0 millimeters long; flowering in May and June. (after Strausbaugh and Core, 1971).

Illustrations: Gleason (1952), Strausbaugh and Core (1971).

Present Range: Eastern West Virginia and southwestern Virginia.

Distribution in Virginia: Mountain counties of Craig, Pulaski, and Wythe (Fig.17).

Habitat and Mode of Life: Calcareous ledges.

Reproduction: Presumably sexual.

Status. *Threatened*. Known from only three localities in Virginia, and likewise only three in West Virginia. Considered as *Threatened* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: The habitats in which the species is found should be protected from development.

Remarks: A very rare Southern Appalachian endemic.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1936); Strausbaugh and Core (1971); Ripley (1975); Fortney *et al.* (1978).

Author: Duncan M. Porter

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27. CAREY or GOLDEN-EYE SAXIFRAGE

Saxifraga careyana Gray

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Saxifragaceae

Description: Perennial herb with basal rosette arising from rootstock. Leaves with long winged petioles, elliptic to rounded blades approximately 14 x 4 centimeters, 6- to 11-dentate on each margin. Inflorescence cymose-paniculate; flowers small, white, with two yellow spots, blooming late May-June, with distinctly filiform (slender-subulate) filaments. Follicles 2.5 to 3.0 millimeters long; seeds striate, crested. Filament and follicle characteristics are the distinguishing factors used to separate this species from *Saxifraga caroliniana* Gray which has slightly clavate filaments and follicles 4-5 millimeters long. At the present time, the taxonomic status of these species is questioned by many individuals.

Present Range: Virginia, North Carolina, Tennessee, and Georgia.

Distribution in Virginia: Tazewell, Grayson, Smyth, and Washington counties. Reported from Giles County at VPI&SU Symposium. A specimen from Craig County, collected in 1936, needs to be verified (Figure 17).

Habitat and Mode of Life: Moist rocks and streamside cliffs.

Status. *Threatened.* A Southern Appalachian endemic rarely found in large numbers, and always in restricted habitats, this plant could become endangered because of changes in land use patterns. Listed as *Threatened* in North Carolina, *Endangered* in Georgia, reaching its northern limit in Virginia.

Protective Measures Proposed. Inform appropriate federal and state officials of sites on public lands so use and development will not hamper the area necessary for survival.

References: Hardin *et al.* (1977); Fernald (1950); Hoffman, R. L. (pers. comm., 1978); Kartesz and Kartesz (1977); Radford *et al.* (1968).

Author: Douglas W. Ogle.

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28. CAROLINA SAXIFRAGE

Saxifraga caroliniana Gray

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Saxifragaceae

Description: Perennial herb with basal rosette arising from rootstock. Leaves with long winged petioles, elliptic to rounded blades approximately 14 x 4 centimeters, 6- to 11-dentate on each margin. Inflorescence cymose-paniculate; flowers small, white, usually with two yellow spots, blooming late May-June,

with filaments slightly clavate. Follicles 4-5 millimeters long; seeds striate, crested. Filament and follicle characteristics are the distinguishing factors used to separate this species from *Saxifraga careyana* Gray, which has distinctly filiform (slender-subulate) filaments and follicles 2.5 to 3.0 millimeters long. At the present time, the taxonomic status of these species is questioned by many individuals.

Present Range: Virginia, North Carolina, West Virginia, and Kentucky; reported from Tennessee.

Distribution in Virginia: Tazewell, Grayson, Smyth, and Washington counties (Figure 18).

Habitat and Mode of Life: Moist rocks and streamside cliffs.

Status. *Threatened.* A Southern Appalachian endemic rarely found in large numbers, and always in restricted habitats, this plant could become endangered because of changes in land use patterns. Listed as *Endangered* in North Carolina and *Threatened* in Kentucky; it is found in only one county in West Virginia.

Protective Measures Proposed: Inform appropriate federal and state officials of sites on public lands, so use and development will not hamper the area necessary for survival.

References: Hardin *et al.* (1977); Fernald (1950); Fortney *et al.* (1978); Kartesz and Kartesz (1977); Radford *et al.* (1968).

Author: Douglas W. Ogle.

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29. PIRATEBUSH

Buckleya distichophylla Torr.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Santalales
Family: Santalaceae

Description: Dioecious shrubs or small trees to 6 meters high; leaves simple, distichous, lanceolate, 3-7 centimeters long; flowers greenish, small, staminate in umbels, pistillate solitary; sepals four, petals absent; stamens four; pistil one, remaining almost to maturity; flowering in May.

Illustrations: Gleason (1952); Radford *et al.* (1968), Hardin *et al.* (1977).

Present Range: Tennessee (six counties), North Carolina (five counties), and Virginia (four counties), but only occurring in about 10 localities (Musselman, 1974).

Distribution in Virginia: Mountain counties of Bland, Craig, Montgomery and Roanoke. Known from only three localities, however, as one population is on the Craig-Roanoke County line (Figure 18).

Habitat and Mode of Life: Streambanks and steep shaly slopes; often associated with hemlock (*Tsuga canadensis* (L.) Carr.).

Reproduction: Sexual and asexual (by rhizomes).

Status. *Threatened.* Although some plants are within the boundary of Jefferson National Forest, they are still vulnerable to logging or road-building operations. Considered to be *Endangered* in North Carolina (Hardin *et al.*, 1977) and *Threatened* in Tennessee (Committee for Tennessee Rare Plants, 1978) and by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: Habitats should be protected against development. The species also should be protected against collectors (Musselman, 1974). The localities where it occurs are well known, and the plant has been collected often for herbarium specimens.

Remarks: This is a rare Southern Appalachian endemic found in a restricted habitat. It is a root parasite which often is found on hemlocks, although it also will parasitize a number of other species (Musselman, 1974).

Reference: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Radford *et al.* (1968); Musselman (1974); Ripley (1975); Hardin *et al.* (1977); Committee for Tennessee Rare Plants (1978).

Author: Duncan M. Porter.

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30. TRUMPETS

Sarracenia flava L.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Sarraceniales
Family: Sarraceniaceae

Description: Rhizomatous perennial herbs; leaves hollow, usually partially water-filled, trumpet-shaped, 3-10 decimeters high, with a suberect, rounded, 4-7 (-14) centimeter wide apical hood which projects over opening to leaf-hollow; scape about as high as leaves; flowers solitary, nodding, 5-parted, with a strong musty odor; petals bright yellow, 5.5 to 8 centimeters long; style disc 3-7 centimeters in diameter; capsules 10-15 millimeters in diameter; flowering in May and June. (in part after Radford *et al.*, 1968).

Illustrations: Gleason (1952), Radford *et al.* (1968), McCollum and Ettman (1977).

Present Range: A Coastal Plain endemic occurring from Virginia to Florida and Alabama.

Distribution in Virginia: Dinwiddie and Prince George counties, and the City of Suffolk (Figure 18).

Habitat and Mode of Life: Bogs and wet pinelands.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status: *Threatened*. "The plant is mentioned a number of times in the Fernald papers on S.E. Virginia in which he expresses concern for the loss of habitat due to ditching and draining. The City of Petersburg has sprawled over some of his stations. In view of the decline of this species during the 12 years Fernald was active in our area and the continued loss of habitat, the relatively few extant stations and the appeal of insectivorous plants among collectors, we might better consider the taxon threatened..." (T. F. Wieboldt, pers. comm.). Also considered *Threatened* in Georgia (McCollum and Ettman, 1977).

Protective Measures Proposed: Areas where the few populations remain must be protected from development, pollution, and over-zealous collectors.

Remarks: "Occasional, once common but now rapidly disappearing" (Duncan and Foote, 1975). "Several spectacular stands of these plants still exist at a few localities in the Carolinas" (Radford *et al.*, 1968). If the present trend continues, this species will soon become *Endangered* or *Extirpated* in Virginia.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963);
Radford *et al.* (1968); Duncan and Foote (1975); McCollum and Ettman (1977).

Author: Duncan M. Porter.

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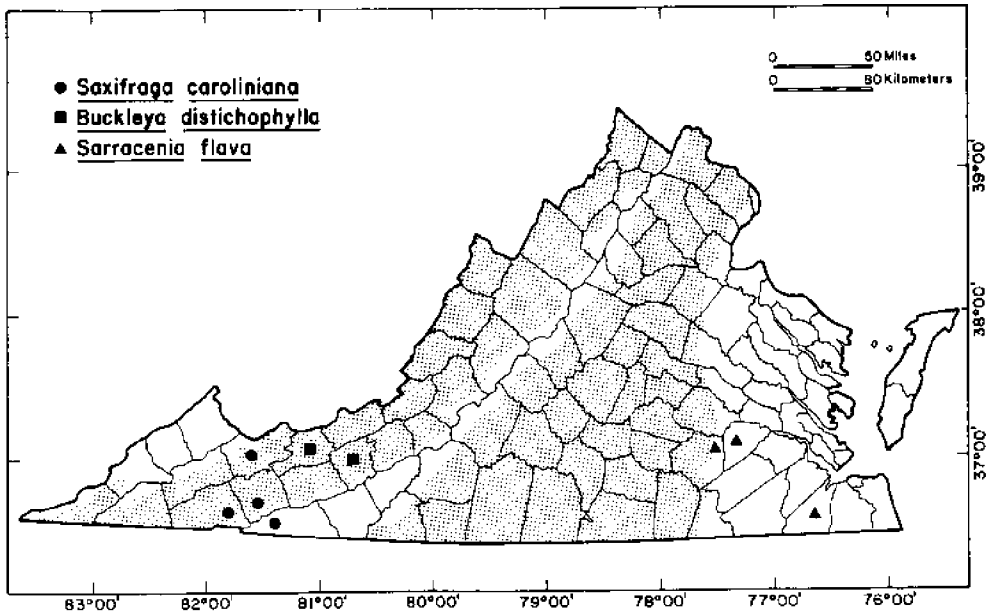


Figure 18. Distribution of *Saxifraga caroliniana*, *Buckleya distichophylla*, and *Sarracenia flava* in Virginia

31. WATER WILLOW

Justicia mortuifluminis Fern.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Acanthaceae

Description: Colonial perennial herbs, with deep-seated stolons and rhizomes 3-7 millimeters in diameter; stems 2-6 decimeters high; leaves opposite, oblong-lanceolate to narrowly elliptic-oblong, mostly 5-9 centimeters long and 1.5 to 3.5 centimeters wide; peduncles 3.5 to 10 centimeters long, spreading-ascending; spikes compact, subcapitate, 1.5 to 3.0 centimeters long, flowers densely overlapping; corolla pale violet or lilac, lower lip flat and projected forward, lobes not constricted basally; seeds quadrate-orbicular, deep brown, not thickened marginally; flowering in June and July. (after Fernald, 1950).

Photographs: Fernald (1941), as *Justicia umbratilis* Fern.

Present Range: Southeastern Virginia.

Distribution in Virginia: Coastal Plain; counties of Prince George, Southampton, Surry, Sussex and City of Suffolk (Figure 19).

Habitat and Mode of Life: Wooded bottomlands and shady margins of slow-flowing streams.

Reproduction: Presumably sexual and asexual (by stolons and rhizomes).

Status. *Threatened*. Due to loss of habitat. Also considered *Threatened* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: Protection of the habitats in which the species occurs from development and pollution is essential to its survival.

Remarks: A Virginia endemic.

References: Fernald (1941, 1950); Ripley (1975).

Author: Duncan M. Porter.

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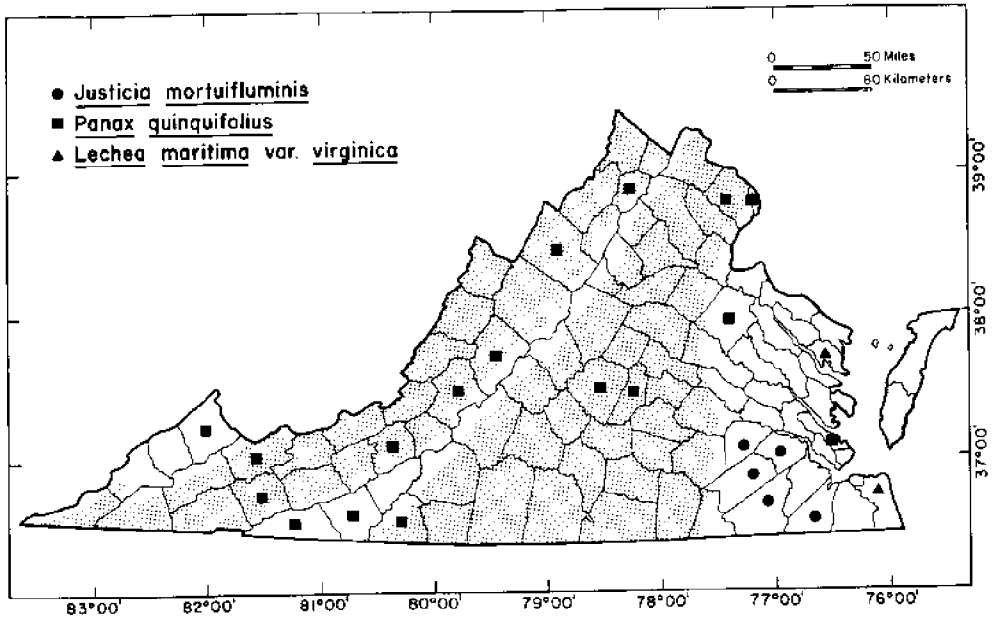


Figure 19. Distribution of *Justicia mortuifluminis*, *Panax quinquefolius*, and *Lechea maritima* var. *virginica* in Virginia

32. GINSENG, SANG

Panax quinquefolius L.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Umbellales
 Family: Araliaceae

Description: Perennial herbs from a large, spindle-shaped, often forked tuberous root; stems simple, 2-6 decimeters high; leaves 3 (-4), in an apical whorl, palmately compound; leaflets (3-) 5, elliptic to obovate, to 15 centimeters long and 8 centimeters wide, serrate, petiolulate; umbels solitary, terminal, peduncles 2-25 centimeters long, pedicels to 12 millimeters long; flowers white to greenish-white; drupes red, 2-3 seeded, about 1 centimeter in diameter, clustered; flowering in May and June, fruiting in the Fall. (in part after Radford *et al.*, 1968).

Illustrations: Gleason (1952), Radford *et al.* (1968), Hardin *et al.* (1977).

Present Range: From Manitoba to Quebec, south to Oklahoma, Louisiana, Alabama, and Florida.

Distribution in Virginia: Occurring in the mountains (Botetourt, Buchanan, Carroll, Grayson, Montgomery, Patrick, Rockbridge, Rockingham, Smyth, Tazewell and Warren counties), Piedmont (Arlington, Buckingham, Cumberland, and Fairfax counties), and Coastal Plain (Caroline and York counties) (Figure 19).

Habitat and Mode of Life: Rich, deciduous woods.

Reproduction: Presumably sexual.

Cultivation: Ginseng is cultivated on a small scale in Virginia as a crop plant. This cultivation could be greatly expanded.

Status. *Threatened.* Ginseng has been exported from the New World to the Far East since the eighteenth century (Graham, 1966). Populations have been greatly depleted by collectors, who gather the roots before fruits are formed in the fall. In spite of the seemingly wide distribution in Virginia, the plant is much rarer than it once was. Further heavy exploitation will lead to its becoming *Endangered* or *Extirpated*. Also *Threatened* in Tennessee (Committee for Tennessee Rare Plants, 1978) and North Carolina (Hardin *et al.*, 1977); *Endangered* in Alabama (Thomas, 1976); and *Status Undetermined* in West Virginia (Fortney *et al.*, 1978).

Protective Measures Proposed: The collection of wild plants must be regulated and curtailed. Cultivation must be encouraged, as it is quite easy.

Remarks: The literature is filled with comments on the exploitation of this species and its subsequent rareness. Collecting has increased markedly in recent years, and the scattered populations generally consist of a few individuals. A good bibliography for two species will be found in Graham (1966).

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Graham (1966); Radford *et al.* (1968); Thomas (1976); Hardin *et al.* (1977); Committee for Tennessee Rare Plants (1978); Fortney *et al.* (1978).

Author: Duncan M. Porter.

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33. VIRGINIA PINWEED

Lechea maritima var. *virginica* Hodgdon

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Violales
 Family: Cistaceae

Description: Suffruticose perennials, caudex with stout, nearly erect branches; basal shoots to 1 decimeter high, densely pubescent; leaves lanceolate to elliptic, thick, dull green, three to five times as long as wide, pilose beneath; panicles thick-subcylindric to broadly subpyramidal, branching mostly from near bases of fruiting stems, often one-sided and persistent; calyx mostly pyriform to obconic or subglobose, outer sepals much shorter than inner; seeds two, convex abaxially, flattened to slightly concave adaxially; fruiting from September to November (after Fernald, 1950).

Present Range: Eastern Maryland and eastern Virginia.

Distribution in Virginia: Outer Coastal Plain; known from Lancaster County and the City of Virginia Beach (Figure 19).

Habitat and Mode of Life: Coastal sand dunes.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status. *Threatened*. Due to habitat modification or destruction. Considered to be *Endangered* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: Specialized habitat in which this vulnerable taxon grows must be protected from development.

Remarks: An outer Coastal Plain endemic, it should occur also on the Eastern Shore, although it has not been reported from there. Fairly common, but jeopardized, in Virginia Beach. Its populations perhaps could be increased markedly by using it to stabilize sand dunes. It is perhaps not distinct from typical *Lechea maritima* Leggett var. *maritima*. Nevertheless, in Virginia it is *Threatened*, no matter what name is applied to it.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Ripley (1975).

Author: Duncan M. Porter.

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SPECIAL CONCERN (103)

Division: Lycopodophyta
Class: Lycopsidea

Order: Lycopodiales
Family: Lycopodiaceae

1. *Lycopodium carolinianum* L. (Slender Clubmoss) - Coastal Plain (Greensville and Sussex counties).
2. *Lycopodium* X *habereri* House (Haberer's Running Pine) - Mountains (Giles County).
3. *Lycopodium lucidulum* Michx. X *Lycopodium selago* var. *appressum* (Shining-Fir Clubmoss Hybrid) - Mountains (Floyd and Page counties).

Division: Pteridophyta
Class: Filicopsida

Order: Aspidiales
Family: Aspidiaceae

4. *Dryopteris* X *separabilis* Small (Woodfern) - Coastal Plain (City of Chesapeake).

Division: Pteridophyta
Class: Filicopsida

Order: Ophioglossales
Family: Ophioglossaceae

5. *Botrychium simplex* E. Hitchc. (Little Grapefern) - Mountains (Giles and Grayson counties).

Division: Pinophyta
Class: Pinopsida

Order: Pinales
Family: Cupressaceae

6. *Chamaecyparis thyoides* (L.) BSP. (Atlantic White Cedar) - Coastal Plain (Accomack and Southampton counties and cities of Chesapeake and Suffolk).

Division: Pinophyta
Class: Pinopsida

Order: Pinales
Family: Pinaceae

7. *Abies balsamea* var. *phanerolepis* Fern. (Balsam Fir) - Mountains (Madison and Page counties).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Bromeliales
Family: Bromeliaceae

8. *Tillandsia usneoides* L. (Spanish Moss) - Coastal Plain (Isle of Wight, Northampton and York counties and cities of Chesapeake, Hampton, Suffolk and Virginia Beach).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Commelinales
Family: Commelinaceae

9. *Tradescantia rosea* var. *graminea* (Small) Anderson & Woodson (Spiderwort) - Coastal Plain (Southampton County and City of Suffolk).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Cyperaceae

10. *Eleocharis baldwinii* (Torr.) Chapman (Baldwin's Spike Rush) - Piedmont (Brunswick County) and Coastal Plain (Isle of Wight County and cities of Chesapeake, Suffolk, and Virginia Beach).
11. *Eleocharis equisetoides* (Ell.) Torr. (Spike Rush) - Piedmont (Prince Edward County) and Coastal Plain (Accomack County).
12. *Rhynchospora alba* (L.) Vahl (Beak Rush) - Coastal Plain (Accomack County and City of Virginia Beach).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Poaceae

13. *Agropyron trachycaulum* (Link) Malte (Wheat Grass) - Mountains (Highland and Rockingham counties).
14. *Agrostis borealis* Hartm. (Bent Grass) - Mountains (Grayson County).
15. *Amphicarpum purshii* Kunth (Amphicarpum) - Coastal Plain (Northampton County).
16. *Aristida tuberculosa* Nutt. (Seabeach Needlegrass) - Coastal Plain (Accomack and Northampton counties).
17. *Bromus ciliatus* L. (Ciliate Brome Grass) - Mountains (Clarke, Floyd and Warren counties).
18. *Cinna latifolia* (Trev.) Griseb. (Wood Reed) - Mountains (Grayson, Highland and Smyth counties).
19. *Ctenium aromaticum* (Walt.) Wood (Toothache Grass) - Coastal Plain (Greensville, Prince George and Sussex counties and City of Suffolk).
20. *Deschampsia caespitosa* var. *glauca* (Hartm.) Lindm. (Tufted Hairgrass) - Mountains (Giles and Page counties).
21. *Diarrhena americana* Beauv. (Diarrhena) - Mountains (Carroll, Patrick and Russell counties).
22. *Erianthus brevibarbis* Michx. (Beard Grass) - Piedmont (Spotsylvania County) and Coastal Plain (Sussex County).
23. *Glyceria grandis* Wats. (Reed Meadow-grass) - Mountains (Highland County) and Coastal Plain (Arlington and James City counties).
24. *Manisuris rugosa* (Nutt.) Kuntze (Joint Grass) - Coastal Plain (Sussex County).
25. *Melica nitens* Scribn. (Melic Grass) - Mountains (Frederick and Shenandoah counties).
26. *Muhlenbergia brachyphylla* Bush (Muhly) - Piedmont (Brunswick and Dinwiddie counties) and Coastal Plain (Sussex County).

27. *Muhlenbergia expansa* (DC) Trin. (Hairgrass) - Coastal Plain (Greensville County).
28. *Muhlenbergia glabriflora* Scribn. (Muhly) - Piedmont (Brunswick County).
29. *Muhlenbergia glomerata* (Willd.) Trin. (Muhly) - Mountains (Fauquier and Page counties).
30. *Panicum fusiforme* Hitchc. (Panic Grass) - Piedmont (Dinwiddie County).
31. *Panicum strigosum* Muhl. (Panic Grass) - Piedmont (Dinwiddie County) and Coastal Plain (Prince George County and City of Chesapeake).
32. *Panicum wrightianum* Scribn. (Panic Grass) - Coastal Plain (Isle of Wight, Southampton and Sussex counties and City of Chesapeake).
33. *Paspalum praecox* Walt. (Early Paspalum) - Coastal Plain (Greensville and Sussex counties and City of Suffolk).
34. *Poa saltuenis* Fern and Wieg. (Blue Grass) - Mountains (Augusta and Rockingham counties).
35. *Poa wolfii* Scribn. (Blue Grass) - Mountains (Clarke County).
36. *Schizachne purpurascens* (Torr.) Swallen (Schizachne) - Mountains (Highland County).
37. *Sphenopholis filiformis* (Chapm.) Scribn. (Wedge Grass) - Coastal Plain (Isle of Wight County and City of Suffolk).
38. *Sphenopholis pallens* (Biehl.) Scribn. (Pale Wedge Grass) - Piedmont (Brunswick and Fairfax counties) and Coastal Plain (Southampton County).
39. *Sporobolus junceus* (Michx.) Kunth (Dropseed) - Piedmont (Lunenburg and Mecklenburg counties).
40. *Tridens strictus* (Nutt.) Nash (Tridens) - Coastal Plain (York County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Juncales
Family: Juncaceae

41. *Juncus megacephalus* M. A. Curtis (Large-headed Rush) - Coastal Plain (City of Virginia Beach).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Liliales
Family: Liliaceae

42. *Allium oxyphilum* Wherry (Wild Onion) - Mountains (Bath, Highland, Patrick and Roanoke counties).
43. *Erythronium albidum* Nutt. (White Dog-tooth Violet) - Piedmont (Arlington, Fairfax and Loudoun counties).
44. *Lilium canadense* var. *rubrum* Britt. (Red Canada Lily) - Mountains (Amherst, Augusta, Giles, Montgomery, Rockingham and Washington counties).
45. *Smilacina stellata* (L.) Desf. (False Solomon's-seal) - Mountains (Frederick, Rockbridge and Rockingham counties) and Piedmont (Fairfax County).

46. *Trillium pusillum* var. *virginianum* Fern. (Dwarf Trillium) - Mountains (Rockingham County) and Coastal Plain (Accomack, Charles City, Chesterfield, Dinwiddie, Henrico, James City and Surry counties and cities of Chesapeake and Suffolk).
47. *Zigaderus densus* (Desr.) Fern. (Black Snakeroot) - Coastal Plain (Greensville County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Orchidales
Family: Orchidaceae

48. *Cleistes divaricata* (L.) Ames (Spreading Pogonia) - Mountains (Roanoke and Scott counties) and Coastal Plain (Chesterfield, Henrico, Isle of Wight, Prince George and Sussex counties and City of Suffolk).
49. *Cypripedium calceolus* var. *pubescens* (Willd.) Correll (Yellow Lady's-slipper) - Mountains (30 counties), Piedmont (13 counties), and Coastal Plain (6 counties).
50. *Goodyera repens* var. *ophioides* Fern. (Lesser Rattlesnake Plantain) - Mountains (Amherst, Augusta, Botetourt, Carroll, Craig, Giles, Montgomery, Roanoke, Rockingham, Washington and Wythe counties).
51. *Habenaria flava* (L.) R. Br. (Pale Green Orchid) - Mountains (Bedford, Botetourt, Giles and Tazewell counties), Piedmont (Amelia, Campbell, Pittsylvania and Powhatan counties) and Coastal Plain (Fairfax and Sussex counties).
52. *Habenaria peramoena* Gray (Purple Fringeless Orchid) - Mountains (Bath, Giles, Grayson, Patrick and Rockbridge counties), Piedmont (Albemarle, Fairfax, Fauquier, Pittsylvania and Spotsylvania counties) and Coastal Plain (Greensville County).
53. *Liparis loeselii* (L.) Rich. (Fen Orchid) - Mountains (Giles, Rockingham and Shenandoah counties), Piedmont (Campbell and Fairfax counties) and Coastal Plain (New Kent and York counties).
54. *Ponthieva racemosa* (Walt.) Mohr (Shadow-witch) - Coastal Plain (Gloucester, Isle of Wight, James City, Southampton, Surry and York counties).
55. *Spiranthes lucida* (Eaton) Ames (Shining Lady's-tresses) - Mountains (Shenandoah and Smyth counties) and Piedmont (Amelia and Fairfax counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Asterales
Family: Asteraceae

56. *Aster schreberi* Nees (Aster) - Mountains (Augusta, Floyd, Giles and Montgomery counties) and Piedmont (Fairfax, Fauquier and Loudoun counties).
57. *Echinacea laevigata* (Boynnton & Beadle) Blake (Purple Coneflower) - Mountains (Montgomery and Roanoke counties) and Piedmont (Campbell and Nottoway counties).
58. *Helenium virginicum* Blake (Sneezeweed) - Mountains (Augusta and Rockingham counties).
59. *Hieracium trailii* Greene (Devil's Paint Erush) - Mountains (Augusta, Bath and Highland counties).

69. *Gaylussacia brachycera* (Michx.) Gray (Box Huckleberry) - Mountains (Bland, Craig and Montgomery counties).
70. *Rhododendron cumberlandense* E. L. Braun (Cumberland Azalea) - Mountains (Dickenson, Lee, Russell, Scott and Wise counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Euphorbiales
Family: Euphorbiaceae

71. *Euphorbia purpurea* (Raf.) Fern. (Wolf's Milk) - Mountains (Botetourt and Rockbridge counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Fagales
Family: Fagaceae

72. *Castanea dentata* (Marsh.) Borkh. (American Chestnut) - Mountains (14 counties), Piedmont (5 counties), and Coastal Plain (2 counties).
73. *Quercus virginiana* Miller (Live Oak) - Coastal Plain (Elizabeth City, Mathews and Northampton counties and cities of Chesapeake, Hampton and Virginia Beach).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Lamiales
Family: Lamiaceae

74. *Scutellaria nervosa* Pursh (Skullcap) - Mountains (Alleghany, Giles and Montgomery counties) and Piedmont (Amelia and Loudoun counties and City of Alexandria).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Magnoliales
Family: Magnoliaceae

75. *Magnolia macrophylla* Michx. (Umbrella Tree) - Mountains (Lee County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Polemoniales
Family: Solanaceae

76. *Physalis viscosa* subsp. *maritima* (M. A. Curtis) Waterfall (Ground Cherry) - Coastal Plain (City of Virginia Beach).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Ranunculales
Family: Ranunculaceae

77. *Anemone berlandieri* Pritzell (Anemone) - Piedmont (Pittsylvania County).
78. *Anemone minima* DC. (Anemone) - Mountains (Alleghany, Carroll, Craig, Floyd, Franklin, Giles, Highland, Montgomery, Roanoke, Washington and Wythe counties) and Piedmont (Henry and Pittsylvania counties).
79. *Clematis addisonii* Britt. (Addison's Leather Flower) - Mountains (Botetourt, Montgomery, Roanoke and Rockbridge counties).
80. *Clematis albicoma* Wherry (White-haired Leather Flower) - Mountains (Alleghany, Augusta, Bath, Botetourt, Craig, Highland, Montgomery, Roanoke and Rockbridge counties).
81. *Clematis coactilis* (Fern.) Keener (Leather Flower) - Mountains (Botetourt, Craig, Montgomery, Pulaski and Roanoke counties).
82. *Clematis crispa* L. (Blue Jasmine) - Piedmont (Patrick County) and Coastal Plain (Isle of Wight and Southampton counties and cities of Chesapeake and Virginia Beach).
83. *Clematis glaucophylla* Small (Leather Flower) - Mountains (Floyd and Lee counties).
84. *Ranunculus ambigens* S. Wats. (Spearwort) - Mountains (Bath County), Piedmont (Fairfax, Louisa and Orange counties), and Coastal Plain (Isle of Wight and Southampton counties).
85. *Ranunculus carolinianus* DC. (Carolina Buttercup) - Mountains (Clarke and Shenandoah counties), Piedmont (Albemarle and Fauquier counties) and Coastal Plain (Gloucester and Prince George counties and City of Norfolk).
86. *Ranunculus flabellaris* Raf. (Yellow Water Crowfoot) - Piedmont (Amelia County) and Coastal Plain (Middlesex and Southampton counties).
87. *Ranunculus hederaceus* L. (Buttercup) - Coastal Plain (Fairfax, Prince George and Westmoreland counties and cities of Chesapeake, Hampton and Virginia Beach).
88. *Ranunculus laxicaulis* (Torr. & Gray) Darby (Spearwort) - Coastal Plain (Dinwiddie, Southampton and Surry counties).
89. *Thalictrum dasycarpum* Fisch. & Ave Lall. (Purple Meadowrue) - Piedmont (Powhatan County) and Coastal Plain (Charles City and Gloucester counties).
90. *Thalictrum macrostylum* Small & Heller (Meadowrue) - Mountains (Giles County) and Piedmont (Greene and Henrico counties and City of Lynchburg).
91. *Thalictrum steeleanum* Boivin (Meadowrue) - Mountains (Augusta, Madison, Rockbridge, Rockingham, Shenandoah and Wise counties) and Piedmont (Fairfax County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Fabaceae

92. *Trifolium virginicum* Small (Virginia Clover) - Mountains (Augusta, Bath, Frederick and Shenandoah counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Rosaceae

93. *Sanguisorba canadensis* L. (Canada Burnet) - Mountains (Grayson and Madison counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Rosales
Family: Saxifragaceae

94. *Astilbe biternata* (Vent.) Britt. (False Goatsbeard) - Mountains (Wise County).
95. *Ribes glandulosum* Grauer (Gooseberry) - Mountains (Grayson, Smyth and Washington counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Oleaceae

96. *Osmanthus americana* (L.) Gray (Wild Olive) - Coastal Plain (City of Virginia Beach).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Scrophulariaceae

97. *Collinsia verna* Nutt. (Blue-eyed Mary) - Mountains (Smyth and Washington counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Theales
Family: Hypericaceae

98. *Hypericum mitchellianum* Rydb. (St. John's Wort) - Mountains (Grayson County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Theales
Family: Theaceae

99. *Stewartia malacodendron* L. (Silky Camellia) - Mountains (Lee County) and Coastal Plain (Accomack County and cities of Chesapeake and Virginia Beach).
100. *Stewartia ovata* (Cav.) Weatherby (Mountain Camellia) - Piedmont (Patrick and Pittsylvania counties) and Coastal Plain (James City, Lancaster and York counties).

11. *Xyris difformis* var. *curtissii* (Malme) Kral (Yellow-eyed Grass) - Coastal Plain (Dinwiddie, Greensville, New Kent and Sussex counties).
12. *Xyris fimbriata* Ell. (Yellow-eyed Grass) - Coastal Plain (City of Chesapeake).
13. *Xyris iridifolia* Chapm. (Yellow-eyed Grass) - Coastal Plain (City of Chesapeake).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Cyperaceae

14. *Bulbostylis ciliatifolia* (Ell.) Fern. (*Bulbostylis*) - Coastal Plain (Isle of Wight, Southampton and Sussex counties and cities of Suffolk and Virginia Beach).
15. *Carex barrattii* Schwein. & Torr. (Sedge) - Mountains (Augusta County) and Coastal Plain (Greensville and Sussex counties).
16. *Carex biltmoreana* Mackenzie (Sedge) - locality unknown.
17. *Carex busbaumii* Wahl. (Sedge) - Mountains (Bath and Madison counties) and Coastal Plain (Sussex County).
18. *Carex careyana* Dewey (Sedge) - Mountains (Rockbridge County) and Piedmont (Arlington and Fairfax counties).
19. *Carex champanii* Steud. (Sedge) - Coastal Plain (Greensville County).
20. *Carex cristatella* Britt. (Sedge) - Mountains (Giles County) and Piedmont (Fairfax County).
21. *Carex erus-corvi* Kuntze (Sedge) - Piedmont (Amelia County) and Coastal Plain (Greensville and Southampton counties).
22. *Carex decomposita* Muhl. (Sedge) - Coastal Plain (Isle of Wight, James City, Southampton, Surrey and Sussex counties).
23. *Carex hirtifolia* Mackenzie (Sedge) - Mountains (Grayson County).
24. *Carex hitchockiana* Dewey (Sedge) - Mountains (Roanoke, Shenandoah and Smyth counties) and Piedmont (Fairfax County).
25. *Carex lacustris* Schwein. (Sedge) - Coastal Plain (Fairfax and Westmoreland counties).
26. *Carex lasiocarpa* Ehrhart (Sedge) - Mountains (Bath and Madison counties) and Coastal Plain (Sussex County).
27. *Carex leptonevria* Fern. (Sedge) - Mountains (Grayson, Highland, Smyth and Tazewell counties).
28. *Carex lupuliformis* Dewey (Sedge) - Coastal Plain (Greensville, Northampton, Southampton, Sussex and York counties).
29. *Carex pallescens* L. (Sedge) - Mountains (Grayson County).
30. *Carex pedunculata* Willd. (Sedge) - Mountains (Montgomery, Rockbridge and Rockingham counties).
31. *Carex polymorpha* Muhl. (Sedge) - Mountains (Bath and Rockingham counties).
32. *Carex reniformis* (Bailey) Small (Sedge) - Coastal Plain (Gloucester, Greensville, Southampton and Surrey counties and City of Virginia Beach).
33. *Carex rostrata* Stokes (Sedge) - Mountains (Bath County) and Coastal Plain (Accomack County).

34. *Carex schweinitzii* Dewey (Sedge) - Mountains (Washington County).
35. *Carex suberecta* (Olney) Britt. (Sedge) - Mountains (Augusta, Madison and Montgomery counties).
36. *Carex tetanica* Schkuhr (Sedge) - Coastal Plain (Greensville and Sussex counties).
37. *Carex trichocarpa* Schkuhr (Sedge) - Mountains (Washington County).
38. *Carex vesicaria* L. (Sedge) - Mountains (Bath County).
39. *Carex vestita* Willd. (Sedge) - Coastal Plain (Henrico and Prince George counties).
40. *Carex walteriana* Bailey (Sedge) - Coastal Plain (Southampton and Sussex counties and cities of Suffolk and Virginia Beach).
41. *Cladium jamaicense* Crantz (Saw Grass) - Coastal Plain (City of Virginia Beach).
42. *Cladium mariscoides* (Muhl.) Torr. (Twig Rush) - Coastal Plain (Accomack County and cities of Chesapeake and Virginia Beach).
43. *Cyperus acuminatus* Torr. & Hook. (Umbrella Sedge) - Mountains (Roanoke County).
44. *Cyperus dentatus* Torr. (Umbrella Sedge) - Mountains (Augusta County).
45. *Cyperus engelmannii* Steud. (Umbrella Sedge) - Coastal Plain (Stafford County).
46. *Cyperus granitophyllus* McVaugh (Umbrella Sedge) - Piedmont (Brunswick and Mecklenburg counties).
47. *Cyperus haspan* L. (Umbrella Sedge) - Coastal Plain (Charles City, James City and New Kent counties and cities of Chesapeake and Virginia Beach).
48. *Cyperus houghtonii* Torr. (Umbrella Sedge) - Mountains (Page County).
49. *Dichromena colorata* (L.) Hitchc. (Dicromena) - Coastal Plain (James City County and City of Virginia Beach).
50. *Eleocharis elliptica* Kunth (Spike Rush) - Mountains (Augusta County), Piedmont (Amelia, Dinwiddie, and Fairfax counties) and Coastal Plain (James City County).
51. *Eleocharis halophila* Fern. & Brack (Spike Rush) - Coastal Plain (City of Virginia Beach).
52. *Eleocharis macrostachya* Britt. (Spike Rush) - Mountains (Augusta, Montgomery, Page, and Rockingham counties).
53. *Eleocharis melanocarpa* Torr (Spike Rush) - Mountains (Bath and Highland counties) and Coastal Plain (Isle of Wight County and City of Suffolk).
54. *Eleocharis radicans* (Poir.) Kunth (Spike Rush) - Coastal Plain (City of Virginia Beach).
55. *Eleocharis robbinsii* Oakes (Spike Rush) - Mountains (Augusta County).
56. *Eleocharis rostellata* Torr. (Spike Rush) - Coastal Plain (New Kent and York counties and cities of Newport News, Suffolk and Virginia Beach).
57. *Eleocharis smallii* Britt. (Spike Rush) - Mountains (Augusta, Giles, Rockingham and Shenandoah counties) and Coastal Plain (King William County).
58. *Eleocharis trichostata* Torr. (Spike Rush) - Coastal Plain (Gloucester, Isle of Wight, Southampton and Sussex counties).
59. *Eleocharis vivipara* Link (Spike Rush) - Coastal Plain (Accomack and Southampton counties and City of Virginia Beach).
60. *Fimbristylis caroliniana* (Lam.) Fern. (Fimbristylis) - Coastal Plain (Accomack, Middlesex, New Kent and Northampton counties and City of Virginia Beach).

61. *Fimbristylis puberula* (Michx.) Vahl (Fimbristylis) - Piedmont (Brunswick County).
62. *Hemicarpha micrantha* (Vahl) Pax (Hemicarpha) - Coastal Plain (Southampton County).
63. *Psilocarya nitens* (Vahl) Wood (Bald Rush) - Coastal Plain (Sussex County).
64. *Psilocarya scirpoides* Torr. (Bald Rush) - Coastal Plain (Southampton County and cities of Chesapeake, Suffolk and Virginia Beach).
65. *Rhynchospora capillacea* Torr. (Beak Rush) - Mountains (Montgomery and Washington counties).
66. *Rhynchospora fascicularis* (Michx.) Vahl (Beak Rush) - Coastal Plain (Isle of Wight County and cities of Suffolk and Virginia Beach).
67. *Rhynchospora filifolia* Gray (Beak Rush) - Coastal Plain (Sussex County).
68. *Rhynchospora grayi* Kunth (Beak Rush) - Coastal Plain (City of Chesapeake).
69. *Rhynchospora harveyi* W. Boott (Beak Rush) - Coastal Plain (Dinwiddie, Greensville, Prince George and Sussex counties).
70. *Rhynchospora miliacea* (Lam.) Gray (Beak Rush) - Coastal Plain (City of Chesapeake).
71. *Rhynchospora pallida* M. A. Curtis (Beak Rush) - Coastal Plain (Greensville County and City of Suffolk).
72. *Rhynchospora perplexa* Small (Beak Rush) - Coastal Plain (Dinwiddie, Greensville, Southampton, Surrey and Sussex counties).
73. *Scirpus acutus* Muhl. (Hardstem Bulrush) - Coastal Plain (Arlington, Fairfax and Prince William counties).
74. *Scirpus etuberculatus* (Steud.) Kuntze (Bulrush) - Coastal Plain (City of Virginia Beach).
75. *Scirpus fluviatilis* (Torr.) Gray (River Bulrush) - Coastal Plain (Fairfax County).
76. *Scirpus lineatus* Michx. (Bulrush) - Piedmont (Fairfax, Loudoun and Orange counties) and Coastal Plain (Gloucester, James City and Surrey counties).
77. *Scirpus maritimus* L. (Saltmarsh Bulrush) - Coastal Plain (Charles City, James City, New Kent, Stafford and Surrey counties).
78. *Scirpus olneyi* Gray (Bulrush) - Coastal Plain (James City, New Kent, Richmond and Stafford counties and City of Virginia Beach).
79. *Scirpus subterminalis* Torr. (Swaying Rush) - Mountains (Augusta County) and Coastal Plain (City of Virginia Beach).
80. *Scirpus torreyi* Olney (Bulrush) - Mountains (Augusta and Rockingham counties).
81. *Scleria minor* (Britt.) Stone - Coastal Plain (Greensville, Henrico and Prince George counties).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Poaceae

82. *Sporobolus asper* (Michx.) Kunth (Dropseed) - Mountains (Shenandoah County) and Coastal Plain (New Kent County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Eriocaulales
Family: Eriocaulaceae

83. *Eriocaulon compressum* Lam. (Pipewort) - Coastal Plain (Arlington County).
84. *Eriocaulon decangulare* L. (Pipewort) - Coastal Plain (James City, Prince George and Sussex counties and City of Chesapeake).
85. *Eriocaulon septangulare* With. (White Buttons) - Mountains (Augusta County) and Coastal Plain (Accomack County and City of Virginia Beach).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Hydrocharitales
Family: Hydrocharitaceae

86. *Limnobium spongia* (Bosc.) Steud. (Frog's Bit) - Coastal Plain (Fairfax and Northampton counties and cities of Chesapeake and Virginia Beach).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Juncales
Family: Juncaceae

87. *Juncus abortivus* Chapm. (Rush) - Coastal Plain (Isle of Wight County and City of Suffolk).
88. *Juncus balticus* Willd. (Rush) - Coastal Plain (Northampton County and City of Virginia Beach).
89. *Juncus brachycephalus* (Engelm.) Buch. (Rush) - Mountains (Augusta County).
90. *Juncus crassifolium* Buch. (Rush) - Coastal Plain (Greensville, Isle of Wight and Southampton counties and City of Chesapeake).
91. *Juncus validus* Cov. (Rush) - Coastal Plain (Isle of Wight County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Liliales
Family: Agavaceae

92. *Agave virginica* L. (False Aloe) - Mountains (Lee County) and Piedmont (Arlington County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Liliales
Family: Haemodoraceae

93. *Lachnanthes caroliniana* (Lam.) Dandy (Redroot) - Mountains (Augusta County) and Coastal Plain (cities of Chesapeake and Suffolk).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Orchidales
Family: Orchidaceae

108. *Calopogon pallidus* Chapm. (Pale Grass-pink) - Coastal Plain (Isle of Wight County and City of Suffolk).
109. *Habenaria fimbriata* (Ait.) R. Br. (Large Purple Fringed Orchid) - Mountains (Augusta, Giles, Grayson, Patrick, Rappahannock and Rockingham counties).
110. *Listera australis* Lindl. (Southern Twayblade) - locality unknown.
111. *Listera cordata* (L.) R. Br. (Heart-leaved Twayblade) - locality unknown.
112. *Spiranthes longilabris* Lindl. (Giant Spiral Orchid) - locality unknown.
113. *Triphora trianthophora* (Sw.) Rydb. (Three Birds Orchid) - Mountains (Bottetourt, Grayson, Rockingham and Washington counties) and Coastal Plain (Surrey County).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Typhales
Family: Sparganiaceae

114. *Sparganium androcladum* (Engelm.) Morong (Bur Reed) - Piedmont (Fairfax and Fauquier counties) and Coastal Plain (City of Virginia Beach).
115. *Sparganium chlorocarpum* Rydb. (Bur Reed) - Mountains (Bath, Clarke, Giles, Highland and Washington counties).

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Typhales
Family: Typhaceae

116. *Typha dominguensis* Pers. (Cat Tail) - Coastal Plain (Prince William, Stafford, Sussex and Westmoreland counties and City of Virginia Beach).
117. *Typha X glauca* Godron (Cat Tail) - Coastal Plain (Fairfax County and City of Virginia Beach).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Aristolochiales
Family: Aristolochiaceae

118. *Hexastylis minor* (Ashe) Blomquist (Heartleaf) - Piedmont (Appomattox County).
119. *Hexastylis naniflora* Blomquist (Dwarf-flowered Heartleaf) - locality unknown.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Asterales
Family: Asteraceae

120. *Cirsium carolinianum* (Walt.) Fern. & Schubert (Carolina Thistle) - Piedmont (Halifax County).
 121. *Elephantopus elatus* Bertol. (Elephant's Foot) - Coastal Plain (New Kent County).
 122. *Gnaphalium viscosum* HBK. (Everlasting) - Mountains (Highland County).
 123. *Heterotheca gossypina* (Michx.) Shinn. (Heterotheca) - Coastal Plain (Southampton County and City of Virginia Beach).
 124. *Tetragonotheca helianthoides* L. (Tetragonotheca) - Piedmont (Pittsylvania County) and Coastal Plain (Gloucester and Southampton counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Caryophyllales
Family: Caryophyllaceae

125. *Arenaria caroliniana* Walt. (Sandwort) - locality unknown.
 126. *Arenaria patula* Michx. (Sandwort) - Mountains (Lee County).
 127. *Paronychia riparia* Chapm. (Whitlow-wort) - Coastal Plain (Southampton County).
 128. *Paronychia virginica* Spreng. (Whitlow-wort) - Piedmont (Fairfax County).
 129. *Stipulicida setacea* Michx. (Stipulicida) - Coastal Plain (Isle of Wight County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Celastrales
Family: Aquifoliaceae

130. *Ilex amelanchier* M. A. Curtis (Holly) - locality unknown.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Chenopodiales
Family: Amaranthaceae

131. *Amaranthus pumilus* Raf. (Seabeach Amaranth) - Coastal Plain (Northampton County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Chenopodiales
Family: Cactaceae

132. *Opuntia humifusa* Raf. (Prickly Pear) - Mountains (Allegheny, Giles and Shenandoah counties) and Piedmont (Amelia, Culpeper and Fairfax counties).

153. *Polygonella polygama* (Vent.) Engelm. & Gray (October Flower) - Coastal Plain (Isle of Wight County).

Division:	Magnoliophyta	Order:	Primulales
Class:	Dicotyledoneae	Family:	Primulaceae

154. *Centunculus minimus* L. (Chaffweed) - Coastal Plain (Fairfax County).
 155. *Lysimachia radicans* Hook. (Loosestrife) - Mountains (Augusta County) and Coastal Plain (New Kent and Southampton counties).

Division:	Magnoliophyta	Order:	Ranunculales
Class:	Dicotyledoneae	Family:	Ranunculaceae

156. *Enemion bitermatum* Raf. (False Rue Anemone) - Piedmont (Halifax County).
 157. *Ranunculus longirostris* Godr. (White Water-crowfoot) - Mountains (Bath and Fauquier counties).

Division:	Magnoliophyta	Order:	Rosales
Class:	Dicotyledoneae	Family:	Caesalpiaceae

158. *Gymnocladus dioica* (L.) K. Koch (Kentucky Coffee Tree) - Mountains (Giles and Russell counties).

Division:	Magnoliophyta	Order:	Rosales
Class:	Dicotyledoneae	Family:	Saxifragaceae

159. *Heuchera alba* Rydb. (White-flowered Alumroot) - Mountains (Highland, Page and Warren counties).
 160. *Heuchera longiflora* Rydb. (Alumroot) - Mountains (Franklin and Highland counties).
 161. *Heuchera richardsonii* R. Br. (Alumroot) - locality unknown.

Division:	Magnoliophyta	Order:	Santalales
Class:	Dicotyledoneae	Family:	Santalaceae

162. *Nestronia umbellula* Raf. (Nestronia) - locality unknown.
-

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Oleaceae

163. *Framinus quadrangulata* Michx. (Blue Ash) - Mountains (Lee and Scott counties).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Scrophulariaceae

164. *Bacopa stragula* Fern. (Water Hyssop) - Coastal Plain (Charles City County).
165. *Chelone cuthbertii* Small (Turtleheads) - Coastal Plain (Henrico County and cities of Newport News and Suffolk).
166. *Chelone lyonii* Pursh (Turtleheads) - locality unknown.
167. *Chelone obliqua* L. (Turtleheads) - Piedmont (Fauquier and Pittsylvania counties) and Coastal Plain (Gloucester and Southampton counties).
168. *Dasistoma macrophylla* (Nutt.) Raf. (Mullein Foxglove) - locality unknown.
169. *Leucospora multifida* (Michx.) Nutt. (Leucospora) - Piedmont (Loudoun County).
170. *Limosella subulata* Ives (Mudwort) - Coastal Plain (City of Virginia Beach).
171. *Seymeria cassioides* (J. F. Gmel.) Blake (Seymeria) - Coastal Plain (Isle of Wight and Sussex counties).
172. *Veronica scutellata* L. (Marsh Speedwell) - Mountains (Augusta and Clarke counties) and Piedmont (Loudoun County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Theales
Family: Hypericaceae

173. *Hypericum adpressum* Barton (St. John's Wort) - Coastal Plain (Sussex County).

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Violales
Family: Violaceae

174. *Viola walteri* House (Violet) - Mountains (Botetourt County).

RECENTLY EXTINCT OR EXTIRPATED (11)

1. ALABAMA GRAPEFERN

Botrychium alabamense Maxon

Division: Pteridophyta
 Class: Filicopsida

Order: Ophioglossales
 Family: Ophioglossaceae

Description: A medium-sized grapefern with rather thin-textured foliage and sprawling habit. Evergreen (actually wintergreen, because the leaves die in the spring, to be replaced by new ones). Segments nearly fan-shaped (subflabellate).

Present Range: Louisiana to Virginia, mainly in the Piedmont but also Coastal Plain. Rather rare everywhere.

Distribution in Virginia: Only known from a single collection in Wise County. Has not been found recently (Figure 20).

Habitat and Mode of Life: Pine woods, often in red soil and pine needles. Also in second-growth hardwood stands and woods edges.

Reproduction: Spore dispersal only; no vegetative propagation. The sexual plant is subterranean and mycorrhizal.

Cultivation: Not known to us to be cultivated. Probably difficult.

Status: *Extirpated* (?). Exceedingly rare in Virginia. Species considered to be much rarer everywhere than its immediate relative, *Botrychium dissectum* Spreng. Should be sought, however, in new localities.

Protective Measures Proposed: This species will persist only if more or less disturbed conditions are maintained. This is no problem along pathways, roadsides, edges of fields. However, the species will ultimately disappear in late stages of succession in old hardwood forest.

Remarks: Actually a fairly poorly known species which may be conspecific with a rare grapefern of New World tropical mountains. It needs a lot of study. It probably evolved through hybridization.

References: Wagner (1962); Wherry (1964).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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2. VENUS-HAIR FERN

Adiantum capillus-veneris L.

Division: Pteridophyta
 Class: Filicopsida

Order: Polypodiales
 Family: Adiantaceae

Description: Medium-sized fern of rocky areas. Fronds tripinnate; stalks black and shiny, the ultimate ones hair-like; segments more or less fan-shaped. Sori separate, borne along margins; sporangia arising on false indusium which is a modified portion of margin that has become specialized and folded back.

Present Range: Generally considered to be cosmopolitan. Quite variable and known to have two cytotypes, diploid and tetraploid.

Distribution in Virginia: The only report has been from Pulaski County (1890) where it has been repeatedly searched for in recent years without success (Figure 20).

Habitat and Mode of Life: Usually calcareous rocks in shady, damp, protected places. Best seen in steep ravines (e.g., Ozarks) and lime-sinks (e.g., central Florida).

Reproduction: Sexual. Spreads by spores into crevices where dampness and free water droplets enable the gametophytes to be fertilized.

Cultivation: Popular in cultivation, but probably being less and less used due to the introduction of many new *Adiantum* cultivars from the tropics. Plants sometimes identified as this species in conservatories are actually *Adiantum cuneatum* Langsdorf and Fischer.

Status: Probably *Extirpated*. Further search, however, may reveal that it still exists, either in Pulaski County or in some other locality where the conditions are appropriate.

Protective Measures Proposed: If rediscovered, the habitat should be maintained.

Remarks: This species illustrates a strong disjunction from the nearest localities in southeastern North Carolina.

References: Stevens (1973); Wagner (1946) - see p. 96-99; Wherry (1964).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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3. ALABAMA LIP-FERN, SMOOTH LIP-FERN *Cheilanthes alabamensis* (Buckley) Kunze

Division: Pteridophyta
Class: Filicopsida

Order: Polypodiales
Family: Adiantaceae

Description: Small cliff fern from 15 to 25 centimeters high, twice divided, front narrowly oblong-lanceolate, pinnae oblong-lanceolate and mostly deeply pinnatifid, segments mostly oblong, rounded or pointed. Differs from eastern North American relatives in being glabrous.

Present Range: Alabama to Arizona north to Missouri; also Mexico.

Distribution in Virginia: Lee and Giles counties. Status of Lee County populations unknown. Now apparently extirpated in Giles County due to quarrying operations which destroyed the colony (Figure 20).

Habitat and Mode of Life: Associated with dry, exposed limestone cliffs.

Reproduction: Triploid apogamous fern that produces sporophytes from gametophytes without fertilization. (Compare comments on *Cheilanthes castanea*, which has the same life cycle.)

Cultivation: Not generally cultivated, but might be appropriate for rock gardens.

Status: Possibly *Extirpated*. Colonies should be sought in the area of the mountains from Lee County to Giles County. Perhaps "hiding" high on limestone bluffs at various sites but not yet discovered. The plant is quite common in parts of Tennessee.

Protective Measures Proposed: Colonies will persist so long as they are not overgrown by other vegetation and the rock is not quarried away.

Remarks: The Virginia colonies are (or were) the northeasternmost ones known.

References: Shaver (1954); Whittier (1965).

Authors: Warren H. Wagner, Jr. and Florence S. Wagner.

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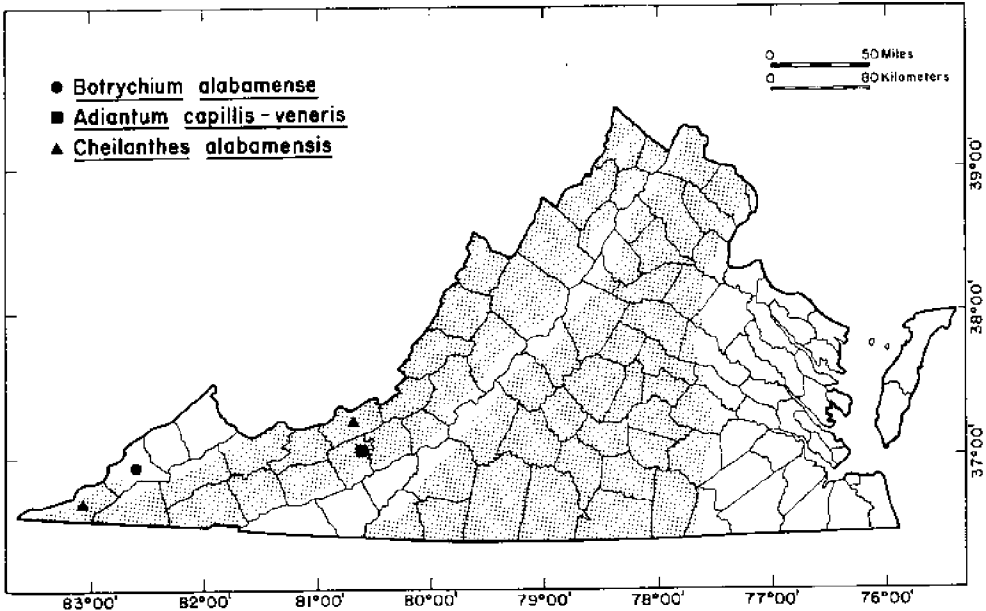


Figure 20. Distribution of *Botrychium alabamense*, *Adiantum capillis-veneris*, and *Cheilanthes alabamensis*

4. UNNAMED GRASS

Calamovilfa brevipilis (Torr.) Scribn.

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Cyperales
Family: Poaceae

Description: A densely tufted, rhizomatous perennial with a solitary, or occasionally a few, compressed culm(s), 7-12 decimeters high. The short and thick rhizomes, villous spikelets, and subpyramidal and open panicle are the major distinguishing characteristics. Leaf blades scaberulous to glabrous; spikelets 4-6 millimeters long.

Present Range: Known from the New Jersey Pine Barrens, and rarely reported from southeastern Virginia to South Carolina.

Distribution in Virginia: Reported to have occurred in Brunswick County (Piedmont) and Greensville County (Coastal Plain) in the past. These colonies apparently are no longer extant (Figure 21).

Habitat and Mode of Life: Bogs, marshes, riverbanks, and edges of swamps and savannahs.

Reproduction: Unknown.

Status: *Extirpated*. Considered to be *Threatened* by the Smithsonian Institution (Ripley, 1975).

References: Fernald (1950); Hitchcock and Chase (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); Ripley (1975); Hardin *et al.* (1977); and Mayes (in press).

Author: Richard A. Mayes.

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5. NEW JERSEY RUSH

Juncus caesariensis Cov.

Division: Magnoliophyta
Class: Monocotyledoneae

Order: Juncales
Family: Juncaceae

Description: Culms 1-few, tufted from a short crown-like rhizome, 4-9 decimeters high; leaves firm, scabrous, terete; cymes 3-17 centimeters long, greatly overtopping involucre bract; flowers 5-6 millimeters long at maturity; sepals firm, rigid, green, lanceolate; stamens 6; capsules narrowly trigonous-ovoid, tapering to acute apex; seeds 2-3 millimeters long; flowering and fruiting from July to October (after Fernald, 1950).

Illustrations: Fernald (1950), Gleason (1952).

Present Range: Southern New Jersey (pine barrens), Maryland (one county) and southeastern Virginia.

Distribution in Virginia: Coastal Plain counties of Caroline, Dinwiddie, Henrico and James City (Figure 21).

Habitat and Mode of Life: Sphagnum bogs.

Reproduction: Presumably sexual; perhaps also asexual by rhizomes.

Status: Apparently *Extirpated*. Not known to have been collected in Virginia since 1947. It was not found at the James City County locality in 1978. (D. M. E. Ware, pers. comm.). Considered to be *Threatened* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: If the species is rediscovered in Virginia, the habitat should be protected from development and pollution.

Remarks: A Coastal Plain endemic with its main populations in New Jersey, it is a disjunct reaching the southern limit of its range in Virginia.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963), Ripley (1975).

Author: Duncan M. Porter.

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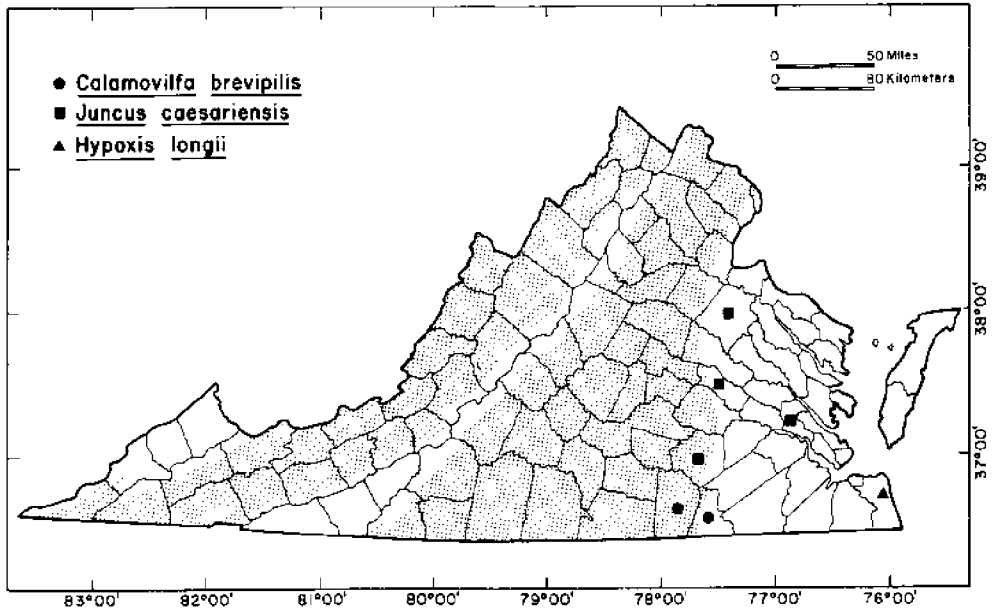


Figure 21. Distribution of *Calamovilfa brevipilis*, *Juncus caesariensis*, and *Hypoxis longii* in Virginia

6. LONG'S STARGRASS

Hypoxis longii Fern.

Division: Magnoliophyta
 Class: Monocotyledoneae

Order: Liliales
 Family: Hypoxidaceae

Description: Small, stemless, perennial herbs; leaves grass-like, to 20 centimeters long; flowers included in basal sheaths of leaves and not expanding, scapes later becoming exerted and to 6 centimeters long; sepals 3 millimeters long and less than 1 millimeter wide, densely whitish pubescent; petals white, 2 millimeters long and less than 1 millimeter wide; capsules thick-clavate, 8-10 millimeters long, promptly circumscissile and dehiscent into three membranaceous valves, beak 4 to 5.5 millimeters long; seeds olive-black, flowering June to August (mainly after Fernald, 1950).

Illustrations: Fernald (1950); Gleason (1952).

Present Range: Known only from southeastern Virginia (see "Remarks" below).

Distribution in Virginia: Known only from a single locality in Virginia Beach, on the outermost Coastal Plain (Figure 21).

Habitat and Mode of Life: Damp sandy and peaty depressions in open areas behind coastal sand dunes.

Reproduction: Presumably sexual (cleistogamous) and asexual (by rhizomes).

Status: Presumably *Extinct*. This species has not been collected since 1934 in Virginia. Considered to be *Endangered* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: If the species is rediscovered, the habitats in which it grows must be protected from pollution and disturbance. The locality from which it was collected apparently is within the boundary of the Camp Pendleton Military Reservation.

Remarks: *Hypoxis longii* has recently been reported from southeastern Oklahoma (Taylor and Taylor, 1977). The plants in question were found growing in the moist, sandy floor of a loblolly pine (*Pinus taeda* L.) forest. It was hypothesized that this locality lies near the northwestern line of the "old" (age not given) Gulf Coastal Plain, and that the species occurs along this geological feature eastward to Virginia, not having been collected elsewhere because of its inconspicuous nature. However, the Oklahoma specimens were all fruiting; no flowers were seen. Until these plants are found in flower and are indeed found to be conspecific with the Virginia plants, they are best considered as a separate taxon. In addition, there is some question as to whether *Hypoxis longii* is distinct from *Hypoxis sessilis* L. (Gleason and Cronquist, 1963), one of the yellow stargrasses.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Ripley (1975); Taylor and Taylor (1977).

Author: Duncan M. Porter.

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7. BLACK-EYED SUSAN

Rudbeckia heliopsis Torr. & Gray

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Asterales
 Family: Asteraceae

Description: Perennial herbs from stout rhizomes; stems branched, to 12 decimeters high; basal leaves oblong-ovate, three-ribbed, blades 3-13 centimeters long, petioles three to five times as long as blades, most cauline leaves similar; disc flowers purplish-black, ray flowers yellow and spreading; pappus almost absent; chaff densely pubescent; flowering from July to September (mainly after Fernald, 1950).

Illustrations: Gleason (1952); Radford *et al.* (1968); Hardin *et al.* (1977).

Present Range: Southeastern Virginia to Georgia and Alabama.

Distribution in Virginia: Prince George County (Coastal Plain) (Figure 22).

Habitat and Mode of Life: Borders of pine and oak woods.

Reproduction: Presumably sexual and asexual (by rhizomes).

Status: Presumably *Extirpated*. Has not been collected in Virginia since 1939. Apparently it occurred in only one locality. Considered also to be *Threatened* in North Carolina (Hardin *et al.*, 1977) and by the Smithsonian Institution (Ripley, 1975), and to be of *Special Concern* in Alabama (Thomas, 1976).

Protective Measures Proposed: If the species is rediscovered in Virginia, the habitat should be protected from development.

Remarks: This species reached its northern limit of range in Virginia. It is "widely scattered but only locally common." (Hardin *et al.*, 1977). It is known from only one county in Virginia, two in North Carolina, one in South Carolina, and three in Alabama. Figures for Georgia are unknown. It is one of the rarest black-eyed Susans, of which there are about 25 species.

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Radford *et al.* (1968); Ripley (1975); Thomas (1976); Hardin *et al.* (1977).

Author: Duncan M. Porter.

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8. POND-SPICE

Litsea aestivalis (L.) Fern.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Magnoliales
 Family: Lauraceae

Description: Dioecious shrubs 0.5 to 3 meters high, much-branched, deciduous; leaves entire, elliptic, 12-30 millimeters long, 5-11 millimeters wide; flowers in axillary, subterminal, umbellate clusters, peduncles 1-3 millimeters long, pedicels 3-5 millimeters long; perianth segments 6, yellow, 2-3 millimeters long; staminate flowers with 9-12 fertile stamens, pistillate with 12 or more staminodes; drupes red, globose, 4-6 millimeters in diameter; flowering in March and April before leaves appear (mostly after Radford *et al.*, 1968).

Illustrations: Radford *et al.* (1968).

Present Range: A Coastal Plain endemic occurring from Virginia (at least formerly) to Florida, Louisiana, and Tennessee. Its distribution is "very spotty" (Wood, 1958).

Distribution in Virginia: Southampton County (Figure 22).

Habitat and Mode of Life: Found around pond margins and in swamps.

Reproduction: Presumably sexual.

Status: *Extirpated*. Known from only a single Virginia collection, which was made in 1805! *Endangered* in North Carolina (Hardin *et al.*, 1977), where it is "One of our rarest shrubs" (Radford *et al.*, 1968), and *Threatened* in Georgia (McCollum and Ettman, 1977).

Protective Measures Proposed: Should this rare shrub ever be rediscovered in Virginia, its habitat must be protected from development or pollution.

References: Fernald (1950); Wood (1958); Radford *et al.* (1968); Hardin *et al.* (1977); McCollum and Ettman (1977).

Author: Duncan M. Porter.

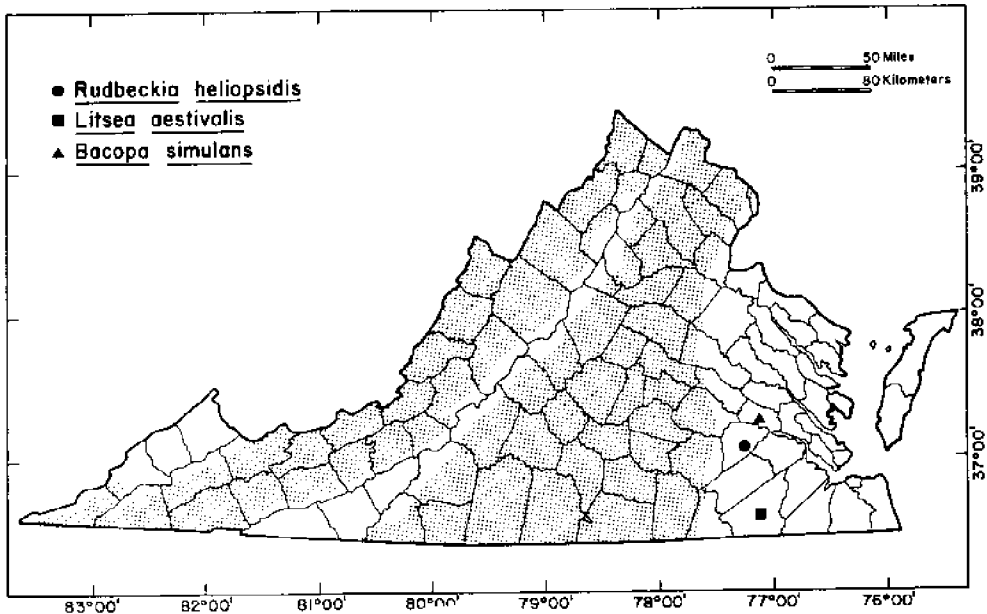


Figure 22. Distribution of *Rudbeckia heliopsisidis*, *Litsea aestivalis*, and *Bacopa simulans* in Virginia

9. WATER-HYSSOP

Bacopa simulans Fern.

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Scrophulariales
 Family: Scrophulariaceae

Description: Stems decumbent or suberect, succulent, glabrous; leaves fleshy, obscurely palmate-nerved, 1-2 centimeters long, 6-15 millimeters wide; pedicels thick, finally divergent or reflexed and 5-11 millimeters long; corolla tubular, insignificant, whitish, 4 millimeters long, approximately 2 millimeters in diameter (after Fernald, 1950). Flowering and fruiting in September.

Photographs: Fernald (1942).

Illustrations: Gleason (1952).

Present Range: Known only from the type locality.

Distribution in Virginia: Along the Chickahominy River, Charles City County (Figure 22).

Habitat and Mode of Life: Sandy and muddy tidal shores.

Reproduction: Presumably sexual.

Status: Presumably *Extinct*. Appears to have been collected only twice, the last time in 1941. Listed as *Endangered* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: If the species is rediscovered, the habitat should be protected from pollution and development.

Remarks: The genus is badly in need of revision from a modern viewpoint. The type of this species was collected in the same locality in which *Bacopa stragula* Fern. was growing. Perhaps further study will show the two to be conspecific.

References: Fernald (1942, 1950); Gleason (1952); Gleason and Cronquist (1963); Ripley (1975).

Author: Duncan M. Porter.

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10. MICRANTHEMUM

Micranthemum micranthemoides (Nutt.) Wettst.
(Syn. *Hemianthus micranthemoides* Nutt.)

Division: Magnoliophyta
 Class: Dicotyledoneae

Order: Scrophulariales
 Family: Scrophulariaceae

Description: Small creeping annuals: branches ascending to 1-6 centimeters high; leaves opposite, obovate-spatulate or oval; calyx 4-toothed, split down abaxial side to base; corolla white, falling unopened, upper lip absent, staminal appendages nearly as long as filaments; stigmas subulate (after Fernald, 1950). Flowering August to October.

Illustrations: Gleason (1952).

Present Range: New York (Hudson River) to Virginia (Chesapeake Bay).

Distribution in Virginia: Coastal Plain counties of Arlington, Charles City, New Kent, and Southampton (Figure 23).

Habitat and Mode of Life: Sandy and muddy shores of tidal rivers above influence of salt water.

Reproduction: Presumably sexual.

Status: Presumably *Extirpated*. Due to pollution and development along the streams where it was known to grow. Last known to have been collected in Virginia in 1941. Listed as *Threatened* by the Smithsonian Institution (Ripley, 1975).

Protective Measures Proposed: If the species is rediscovered, the habitat should be protected from development and pollution.

Remarks: As is true for many small aquatic plants, this species is poorly known as to habitat requirements and distribution. Fernald (1950) terms its distribution "local."

References: Fernald (1950); Gleason (1952); Gleason and Cronquist (1963); Ripley (1975).

Author: Duncan M. Porter.

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11. CHAFFSEED

Schwalbea americana L.

Division: Magnoliophyta
Class: Dicotyledoneae

Order: Scrophulariales
Family: Scrophulariaceae

Description: Erect, unbranched perennials, 3-6 decimeters high; leaves alternate, sessile, lanceolate or elliptic-lanceolate; flowers axillary, solitary; calyx tubular, two-lipped, 14-18 millimeters long, subtended by two linear bractlets; corolla yellow or purplish, two-lipped, approximately twice as long as calyx; stamens four, included; capsule narrowly ovoid, included in calyx; flowering May to June, fruiting in August. (after Radford *et al.*, 1968).

Illustrations: Radford *et al.* (1968).

Present Range: Eastern Massachusetts, Connecticut, and New York south to Florida and Louisiana, mountains of Kentucky and Tennessee.

Distribution in Virginia: Coastal Plain counties of Greenville and Sussex, the single population apparently straddling their common county line (Figure 23).

Habitat and Mode of Life: Dry, open, sandy pine and oak thickets.

Reproduction: Presumably sexual.

Status: *Extirpated*. Not collected in Virginia since 1948. According to A. M. Harvill, Jr. (pers. comm., 1978), the habitat in which it grew was destroyed, presumably by development. Possibly *Extirpated* in Tennessee (Committee for Tennessee Rare Plants, 1978).

Protective Measures Proposed: If the species is rediscovered in the state, the habitat should be protected from development.

Remarks: According to L. J. Musselman (pers. comm., 1978) this species probably has been extirpated in both Virginia and surrounding states.

References: Fernald (1950); Gleason and Cronquist (1963); Radford *et al.* (1968); Committee for Tennessee Rare Plants (1978).

Author: Duncan M. Porter.

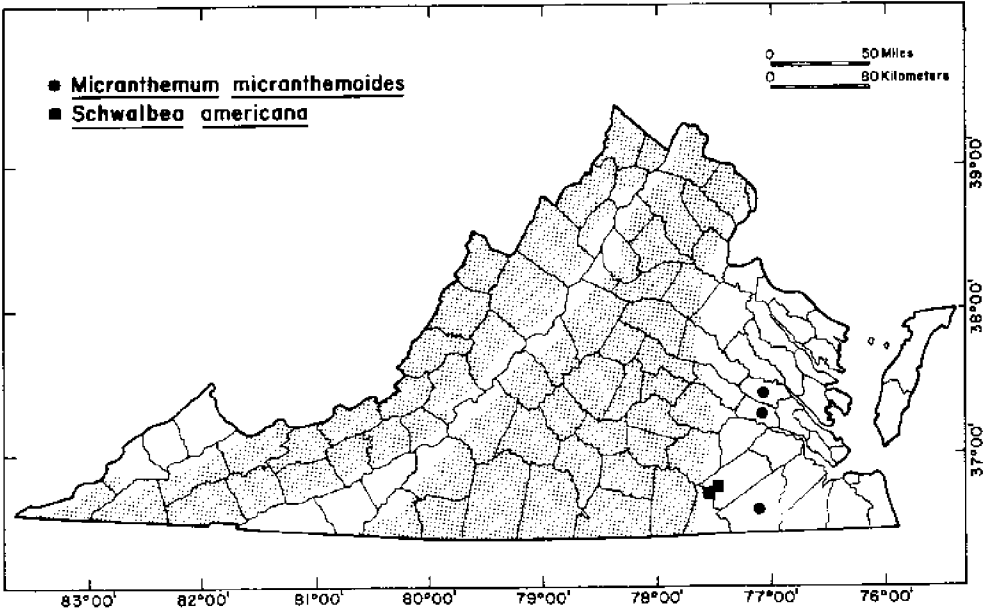


Figure 23. Distribution of *Micranthemum micranthemoides* and *Schwalbea americana* in Virginia

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FRESHWATER AND TERRESTRIAL MOLLUSCS

(EDITOR'S NOTE: As of May, 1979, the Freshwater and Terrestrial Mollusc Committee, originally chaired by David H. Stansbery, was unable to come up with a status report for inclusion in this volume. In order to avoid excluding the molluscs entirely, Sally Dennis has prepared the following summary of the Symposium meeting. Unfortunately, there has not been time since June to prepare a detailed report for this group.)

Introduction

This brief summary of the Freshwater and Terrestrial Mollusc committee meeting is presented in lieu of a detailed report in order that the molluscs not be omitted from this volume. This information represents the consensus opinion of the participants of the meeting, but is not complete in its treatment of the Virginia molluscan fauna.

While separate sections were scheduled for mussels and snails, the snail section did not meet, as its designated chairperson was not in attendance. The committee at hand focused primary attention on the freshwater mussels; however, comments on several snails have been included. Neither detailed status reports nor specific locality data are included here for each species. Hopefully this information can be organized for distribution at a later date.

Most of the mollusc species listed as *Endangered* in the state of Virginia occur in the headwaters of the Tennessee River System including portions of the Clinch, Powell and Holston river drainages. This Cumberland Plateau region, beginning in the southwest corner of Virginia and extending into Tennessee, supports many endemic molluscan species. The species richness and degree of endemism makes this region one of primary concern in the preservation of endangered species.

It was suggested that a central repository for specimens of endangered species be designated to aid researchers and collectors both in species identification and in the collation of distribution records. Participants were in agreement that the Smithsonian Institution was the logical place to house such collections.

Members of the Committee who participated in the Symposium are Steve Alstedt, John Bates, Sally Dennis, Marc Imlay, Joseph P. E. Morrison, David H. Stansbery, and Henry Van der Schalie.

Pelecypoda

A check-list of the molluscs of Virginia, based on that of Beetle (Sterkiana 49:21-35, 1973), was reviewed and the status of freshwater mussel species was discussed by participants. It was agreed that all of the mussel species occurring in the upper Tennessee River drainage should be considered *Endangered* in Virginia due to increasing pressures on their limited habitat. An attempt has been made, however, to distinguish between those species which are considered *Endangered* due to their peripheral distribution in Virginia and those which are limited in their distribution and may be *Endangered* throughout their entire range. Of particular concern are the endemic Cumberlandian species, eight of which are listed as federally *Endangered*.

The species lists presented in the following tables are based on the Beetle (1973) check-list, with some revision of taxonomy. While an attempt has been made to indicate some of the more important synonymies, it should be noted that these lists are not complete in that regard. There are a number of taxonomic problems presently surrounding the freshwater mussels of Virginia; however, no attempt has been made to address these issues here.

Those species of limited distribution are listed in Table I. These species are not only *Endangered* in Virginia, but may be considered *Endangered* throughout their range. The species which are of Cumberlandian origin have been noted with an asterisk. Federally listed *Endangered* species are also noted. Table II lists those mussel species which are widespread in distribution but which are limited in Virginia to a few localities. Most of these occur in the upper Tennessee drainage. Table III lists those species of *Uncertain Status* in Virginia.

Table I. Mussels *Endangered* in Virginia and possibly throughout their range.

* <i>Actinonaias pectorosa</i>	1,2,3
<i>Canthyria (=Elliptio) collina</i>	James River
+* <i>Conradilla oaelata (=Lemoix rimosus)</i>	1,2
* <i>Cyprogenia irrorata stegaria</i>	1
+* <i>Dromus dromas</i>	1,2
* <i>Dysnomia (=Epioblasma) brevidens</i>	1,2
* <i>Dysnomia capsaeformis</i>	1,2,3
+* <i>Dysnomia florentina walkeri</i>	South and Middle Forks, Holston River
* <i>Dysnomia haysiana</i>	1,2,3
+* <i>Dysnomia torulosa gubernaculum</i>	1,2,3
<i>Elliptio lanceolatus</i>	James River
* <i>Fusconaiia barnesiana</i> (complex)	1,2,3
+* <i>Fusconaiia cuneolus</i>	1,2,3
+* <i>Fusconaiia edgariana (=Fusconaiia cor)</i>	1,2,3
* <i>Lasmigona holstonia</i>	1,2
* <i>Lastena (=Hemistena) lata</i>	1,2
<i>Lampsilis cohongoronta</i>	Potomac River
* <i>Lexingtonia dolabelloides</i>	1,2,3
<i>Lexingtonia subplana</i>	James River
* <i>Medionidus conradicus</i>	1,2,3
* <i>Pegias fabula</i>	2,3
* <i>Pleurobema oviforme</i>	1,2,3
* <i>Ptychobranhus subtentum</i>	1,2,3
* <i>Quadrula cylindrica strigellata</i>	1,2,3
+* <i>Quadrula intermedia</i>	2
+* <i>Quadrula sparsa</i>	2
<i>Villosa (=Micromya) constricta</i>	James River
* <i>Villosa perpurpurea</i>	1,2,3
* <i>Villosa vanuxemensis</i>	1,2,3

* Cumberlandian species

+ Listed as *Endangered* by U.S. Office of Endangered Species

1) Clinch River drainage

2) Powell River drainage

3) Holston River, North Fork

Table II. Mussels *Endangered* in Virginia due to peripheral occurrence.

<i>Actinonaias carinata</i> (=Actinonaias ligamentina)
<i>Alasmidonta marginata</i>
<i>Alasmidonta viridis</i> (=Alasmidonta minor)
<i>Amblema costata</i>
<i>Carunculina moesta</i> (=Toxolasma lividus)
<i>Cumberlandia monodonta</i>
<i>Cyclonaias tuberculata</i>
<i>Dysnomia</i> (=Epioblasma) <i>triquetra</i>
<i>Elliptio crassidens</i>
<i>Elliptio dilatatus</i> ,
<i>Fusconaia subrotunda</i>
<i>Lampsilis cariosa</i>
<i>Lampsilis fasciola</i>
<i>Lampsilis ovata ventricosa</i> (complex)
<i>Lamigona costata</i>
<i>Leptodea fragilis</i>
<i>Ligumia recta latissima</i>
<i>Plethobasus cyphus</i>
<i>Pleurobema cordatum</i> (complex)
<i>Proptera alata</i>
<i>Ptychobranchus fasciolaris</i>
<i>Quadrula pustulosa</i>
<i>Tritogonia verrucosa</i>
<i>Unio merus tetralasmus</i>
<i>Villosa</i> (=Micromya) <i>iris nebulosa</i>

Table III. Mussels of *Undetermined Status* in Virginia.

<i>Alasmidonta heterodon</i>
<i>Alasmidonta varicosa</i>
<i>Anodonta imbecillis</i>
<i>Ligumia nasuta</i>
<i>Unio merus obesus</i>

Gastropoda

The aquatic snails were not addressed in detail at the Symposium and, therefore, will not be included here except to note that several pleurocerid snails which occur in the upper Tennessee River drainage in Virginia should be listed as *Endangered* as is most of that endemic fauna. The Spiny River Snail (*Io fluviatilis*) is generally considered *Endangered* throughout its range and has been proposed for federal listing as such. Two other pleurocerid species, *Anculosa subglobosa* and *Pleurocera unciatale*, from this drainage should also be considered *Endangered* in Virginia.

It was generally agreed that the terrestrial gastropods in Virginia are too poorly known at this time to be considered for *Threatened* or *Endangered* status except for the following three species:

Polygyriscus virginiana (*Endangered*), which has been listed in the *Federal Register* as nationally *Endangered*, is only known from its type locality along the New River near Radford, Virginia;

Glyphyalinia raderi (*Threatened*) is known from four localities in Virginia (Page, Pulaski, Alleghany and Craig counties); and

Hendersonia occulta (*Threatened*), a terrestrial operculate, has a scattered distribution.



FRESHWATER AND TERRESTRIAL ARTHROPODS

Paul A. Opler

Introduction

The invertebrates, next to plants which convert the sun's energy to usable chemical energy, play the most important role in most world ecosystems. In their sheer numbers and combined biomass, they surpass all other animal groups as the principal consumers and decomposers on earth. The state of Virginia has one of the richest invertebrate faunas of any state and yet, although most species in the state have been described, the geographic occurrence and abundance of most species within Virginia is sketchily known in most instances. Documenting this information for most Virginia invertebrates must be one of the highest priorities before assessments leading to conservation efforts may be made. As an example, the fine surveys and summary of the status of Virginia freshwater amphipod crustaceans by John Holsinger may be given.

The preliminary assessment of Virginia's freshwater and terrestrial arthropods given in the following sections indicates that the species in greatest jeopardy are those found in caves and springs. The southeastern portion of Virginia has an extremely rich representation of southern coastal plain endemics. This limited area, and the included species, are all threatened by the rapid, extensive development and habitat destruction occurring there. Although the status of some aquatic insects found in rivers of southwestern Virginia is poorly known, they appear in jeopardy due either to their disappearance or to pollution of those rivers.

It is hoped that the information in these sections will stimulate a renewed interest in our native invertebrates, and will lead to further investigation and conservation on behalf of these organisms which are all too often neglected by land managers and decision-makers.

Members of the Committee on Freshwater and Terrestrial Arthropods included John M. Burns, John E. Cooper, Charles V. Covell, Jr., Donald R. Davis, Douglas C. Ferguson, Lynn M. Ferguson, William D. Field, Richard L. Hoffman, John R. Holsinger, Michael Kosztarab, S. S. Nicolay, Paul A. Opler (*Chairman*), Frederick H. Rindge, Jay C. Shaeffer, F. Chris Thompson, Warren Herb Wagner, Jr., and David A. West.

FRESHWATER AND TERRESTRIAL ISOPOD CRUSTACEANS (ORDER ISOPODA)

John R. Holsinger

Introduction

Isopod crustaceans are found in both aquatic and damp terrestrial habitats and are represented by numerous species in Virginia. Three families merit consideration in a discussion of *Endangered* and *Threatened* freshwater and terrestrial arthropods of the state and include Asellidae, Cirolanidae and Trichoniscidae.

The family Asellidae is a member of the suborder Asellota and is represented by numerous freshwater species in North America (Williams, 1970). Nineteen species, representing two genera, have been reported from Virginia, but, undoubtedly, additional species remain to be described or reported. Of the 19 species recorded to date, 9 are eyeless, unpigmented forms that are restricted to subterranean water and are either obligatory cavernicoles (i.e., troglobites) or obligatory to subterranean groundwater in general (i.e., phreatobites).

The family Cirolanidae is a member of the suborder Flabellifera and is predominantly a marine group. It is represented in Virginia by one highly unusual monotypic genus that occurs in subterranean fresh water.

The family Trichoniscidae is a member of the terrestrial suborder Oniscoidea and contains the majority of the world's cavernicolous forms. Although only two cave species are considered in this report, further study should be made on the terrestrial isopods of the state to determine if any others merit consideration in the context of *Endangered* or *Threatened* biota.

This report considers only obligatory subterranean species. There are three reasons for this: (1) the epigeal species are either widely distributed and under no apparent threat at present or they are so poorly known taxonomically and ecologically that data sufficient to document their status are lacking; (2) subterranean species are usually rare, highly specialized forms with restricted ranges and low population sizes; and (3) cave ecosystems are considered sensitive and highly vulnerable to groundwater pollution and disturbance by man.

Locations of caves listed in this report are found in books by Douglas (1964) and Holsinger (1975).

SPECIES ACCOUNTS

THREATENED (2)

1. RYE COVE CAVE ISOPOD

Lirceus culveri Estes and HolsingerPhylum: Arthropoda
Class: CrustaceaOrder: Isopoda
Family: Asellidae

Description: Small, eyeless, unpigmented isopod, reaching a length of between 6.5 and 7.0 millimeters. Distinguished from *Lirceus usdagalun*, with which it is closely allied, by the diagnosis, description and figures given by Estes and Holsinger (1976).

Present Range: Known only from McDavids Cave in Rye Cove, Scott County, Virginia (Figure 1).

Habitat and Mode of Life: Troglomite. Inhabits gravel substrate of cave stream marked by riffles.

Reproduction: Ovigerous females (4.8 to 6.8 millimeters in length) have been collected in August and November. The number of eggs brooded apparently depends to some extent on size of female and varies from about 11 to 28.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. At the present time this species is known only from one small cave population and is apparently a rare, local endemic. The stream in McDavids Cave is vulnerable to groundwater pollution, although it appears to be safe at the moment.

Protective Measures Proposed: Further study is needed to determine whether populations of this species occur in other caves in Rye Cove. McDavids Cave and its associated groundwater system should be protected against pollution and severe modification.

Author: John R. Holsinger.

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2. MADISON CAVE ISOPOD

Antrolana lira BowmanPhylum: Arthropoda
Class: CrustaceaOrder: Isopoda
Family: Cirolanidae

Description: Eyeless, unpigmented isopod of typical cirolanid facies, reaching approximately 17 millimeters in length. Distinguished by the description and figures given by Bowman (1964).

Present Range: Recorded from two caves developed in the eastern side of Cave Hill just west of South River and less than one (1) mile west of Grottoes, Augusta County, Virginia (Figure 1).

Habitat and Mode of Life: Troglobite/phreatobite. This species inhabits two deep lakes of phreatic water in Madison's Saltpetre Cave and a similar habitat at the bottom of Steger's Fissure. The latter is located approximately 500 feet north of the entrance to Madison's Saltpetre Cave and consists of a single, limestone crevice about 15 feet deep. In both caves, *Antrolana lira* occurs in the company of the troglobitic amphipod, *Stygobromus stegerorum*.

Reproduction: Very little information is currently available. Large, presumably sexually mature, females do not have brood plates, possibly indicating that this species is ovoviviparous as are species in at least one other genus of the family.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened.* *Antrolana lira* is a rare, highly localized endemic known only from a single, restricted groundwater system in the Appalachian Valley. Zoogeographically, this monotypic genus is one of the most unique and interesting troglobitic isopods in the world, and it is the only subterranean, freshwater cirolanid found in North America north of Texas, Mexico and Cuba. An impressive body of evidence indicates that subterranean, freshwater cirolanids were derived from marine ancestors relict during periods of marine embayments. If this is the case with *Antrolana lira*, then it is the sole survivor of a lineage that dates back to marine invasions of the Appalachian region in late Paleozoic times.

A few individuals can usually be seen in the lakes in Madison's Saltpetre Cave and some can be attracted to bait in Steger's Fissure, but large numbers are seldom encountered. Despite extensive biological investigation of numerous caves in the Augusta-Rockingham County area of western Virginia, no other population of this form has been found. Moreover, the deep phreatic water found in Madison's Saltpetre Cave and Steger's Fissure provides a unique habitat that has not been observed in other caves of the area.

Considering the highly localized range of this species, its unique zoogeographic position, its rarity, and proximity of its aquatic habitat to the South River which was determined in 1977 to be polluted by mercury, the existence of *Antrolana lira* is regarded as *Threatened*. Fortunately, an arrangement with the owner of the caves, Mr. Lyrall O. Steger, has resulted in some protection for the caves. But groundwater pollution and other factors beyond the control of Mr. Steger are potential threats to the survival of this species.

Protective Measures Proposed: Further studies on the ecology of this species are being carried out at present, but the small number of animals and the lack of external evidence of sexual maturity of females makes the research difficult and time-consuming. It is strongly recommended that Madison's Saltpetre Cave and the associated karst groundwater aquifer be preserved on a permanent basis, with limited access to the cave only for research and education.

Author: John R. Holsinger.

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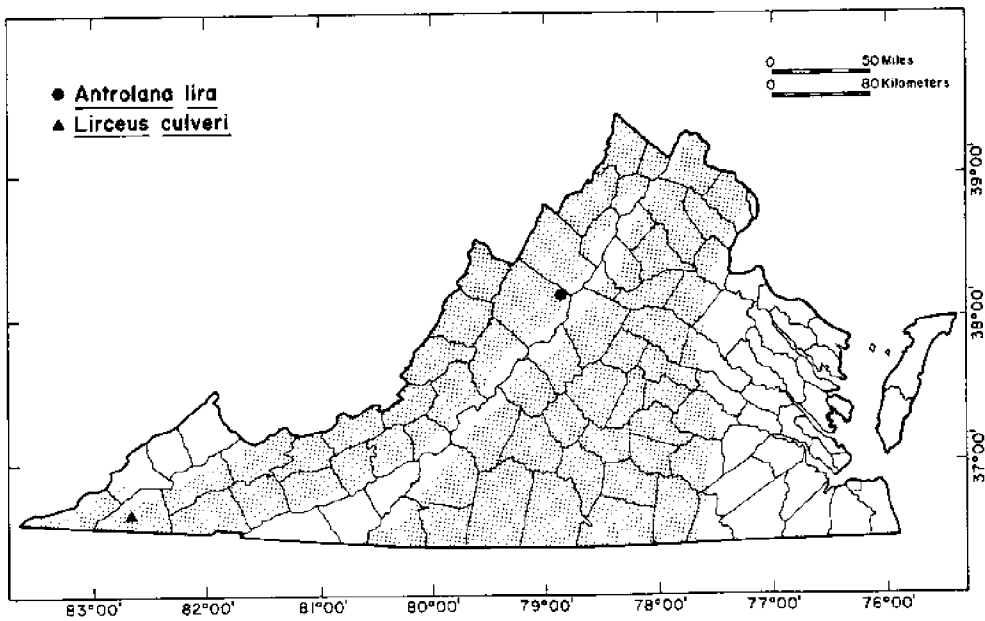


Figure 1. Present range of *Lirceus culveri* and *Antrolana lira* in Virginia

SPECIAL CONCERN (9)

1. GREENBRIER VALLEY CAVE ISOPOD *Caecidotea holsingeri* (Steeves)

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the diagnosis and figures given by Steeves (1963a). Length variable, up to 12.0 millimeters.

Present Range: The range extends from extreme western Maryland southward through eastern West Virginia to Monroe County, West Virginia; a single record is reported from Bath County, Virginia (Steeves, 1969; Holsinger and Steeves, 1971; Holsinger *et al.*, 1976).

Distribution in Virginia: Known only from Butler-Sinking Creek Cave in Bath County, Virginia (Figure 2).

Habitat and Mode of Life: Troglobite. Occurs under gravels and flat rocks in streams in Butler-Sinking Creek Cave, Bath County, Virginia.

Reproduction: No data are published.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern*. This species is fairly common and widespread in parts of West Virginia but is known only from a single cave population in Virginia. Because of its restriction to a single locality in Virginia, this species is probably of *Special Concern*. Butler-Sinking Creek Cave is presently owned and protected by the Butler Cave Conservation Society, Inc.

Protective Measures Proposed: Further investigation to determine the size of the Butler Cave population. Continued protection of Butler-Sinking Creek Cave by the above-mentioned society is recommended.

Author: John R. Holsinger.

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2. HENROT'S CAVE ISOPOD *Caecidotea henroti* (Brosson)

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the description and figures given by Brosson (1955). Length reaching 7.5 to 8.0 millimeters.

Present Range: Recorded from Smoke Hole Cave in Giles County, Virginia, and James Cave in Pulaski County, Virginia (Figure 2).

Habitat and Mode of Life: Troglobite. Collected from substrate gravels in cave streams.

Reproduction: Ovigerous females have been collected in August, but no other data are available.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern.* Presumably a rare, local endemic, known only from a few specimens collected from two caves in the New River drainage of west-central Virginia; these caves are situated approximately 12 miles apart. No protective measures in effect at present.

Protective Measures Proposed: Additional data on population sizes and limits of range would be desirable. Both James and Smoke Hole caves are large and interesting and should be protected. James Cave is located near Radford, Virginia, and may therefore be threatened by urban growth and ground water pollution in the foreseeable future.

Author: John R. Holsinger.

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3. INCURVED CAVE ISOPOD *Caecidotea incurva* (Steeves and Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the diagnosis and figures given by Steeves and Holsinger (1968). Length up to 13.5 millimeters.

Present Range: Recorded from three caves as follows: Berry Cave, Roane County, Tennessee; Gregory's Cave, Blount County, Tennessee; and McMullin Cave, Smyth County, Virginia (Steeves, 1969; Fleming, 1972).

Distribution in Virginia: Known only from McMullin Cave in Smyth County (Figure 2).

Habitat and Mode of Life: Troglobite. Inhabits pools and streams in caves.

Reproduction: No data are published.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern.* This rare species, recorded from only three localities in the upper Tennessee River basin, is known from a single cave in Virginia. There are no protective measures in effect at present.

Protective Measures Proposed: Continued biological investigation of caves in the Holston Valley in Smyth and Washington counties is needed to determine the extent of this species in Virginia. Representative populations, such as the one in McMullin Cave, should be protected.

Author: John R. Holsinger.

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4. LEE COUNTY CAVE ISOPOD *Lirceus usdagalum* Holsinger and Bowman

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Asellidae

Description: Small, eyeless, unpigmented isopod, reaching a length of approximately 7.5 millimeters. Distinguished by the diagnosis, description and figures given by Holsinger and Bowman (1973).

Present Range: Recorded from four caves in southcentral Lee County, Virginia. Three of the caves are hydrologically integrated into a single system (Figure 2).

Habitat and Mode of Life: Troglobite. This species is usually found on the surfaces of small rocks or flowstone submerged in cave streams; it may also occur among small stream gravels.

Reproduction: Ovigerous females have been collected during July and August. The average number of eggs per female was 27.5 (based on three females). Additional data are given by Holsinger and Bowman (1973).

Number in Captivity: Preserved specimens in the collections of J. R. Holsinger and the Smithsonian Institution.

Status: *Special Concern.* Although two of the four known populations of this species are relatively large, both are found in shallow cave streams that are primarily recharged from water entering sinkholes from the surface. This, along with the fact that the range is limited to one small part of a single county, emphasizes the vulnerability of this species to ground water pollution and its position as a rare, local endemic. There are no protective measures at present, although cave owners have been alerted to the presence of this unique species and have been asked to assist us in the preservation of the habitats.

Protective Measures Proposed: The ecology of this species has been studied in detail by James A. Estes, who is now preparing a thesis on the subject. Intensive biological exploration of numerous caves in the Powell Valley has led us to conclude that the range of this species is quite restricted. Some means of permanent preservation of the caves harboring this species should be sought.

Author: John R. Holsinger.

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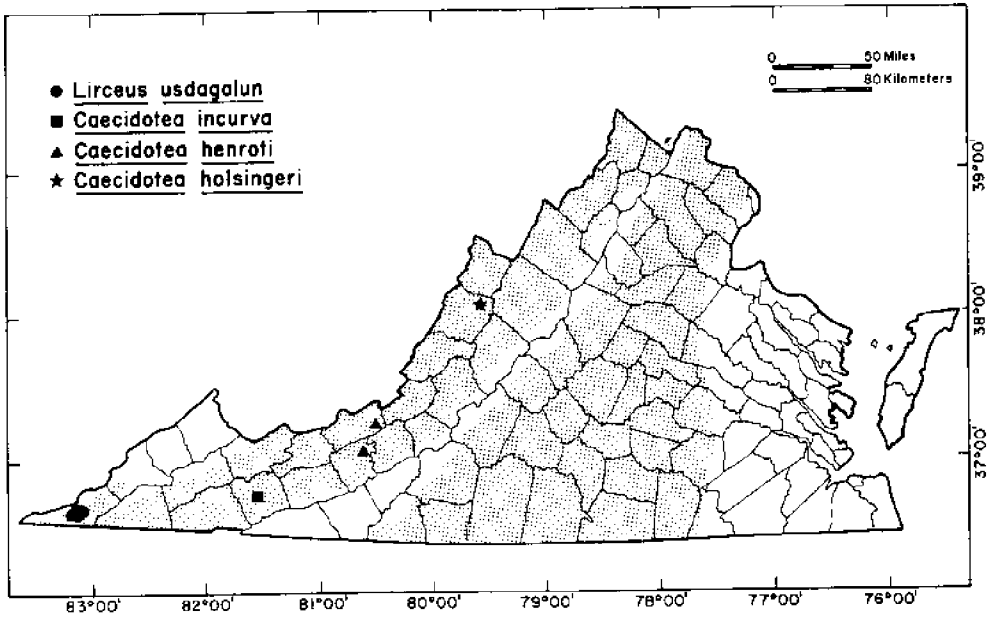


Figure 2. Distribution of *Caecidotea holsingeri*, *Caecidotea henrofi*, *Caecidotea incurva*, and *Lirceus usdagalun* in Virginia

5. PRICE'S CAVE ISOPOD

Caecidotea pricei Levi

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the description and figures given by Levi (1949) and Steeves (1960). Length up to 15 millimeters.

Present Range: The range extends from Montgomery County, Pennsylvania, westward across the Piedmont into the Valley and Ridge province of central Pennsylvania, and then southwestward through the "Great Valley" of central Maryland, northeastern West Virginia, and western Virginia to Rockbridge County in west-central Virginia (Steeves, 1969; Holsinger and Steeves, 1971).

Distribution in Virginia: Recorded from caves and related ground water habitats in the Appalachian Valley from Rockbridge County northeastward to Frederick County (Figure 3).

Habitat and Mode of Life: Troglobite/phreatobite. Frequently found under rocks, gravel and small pieces of wood in cave streams and pools; occasionally found in small springs and seeps; rarely found in wells.

Reproduction: No data are published.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern.* This species has a comparatively wide range, but most populations are small. A substantial part of the range lies within an area that is being rapidly urbanized and industrialized. Because of this, many populations will be affected by ground water pollution or other disturbances in the immediate future. No protective measures in effect at present.

Protective Measures Proposed: More study is needed on the ecology of this species. Caves with substantial or representative populations, such as Ogden's Cave in Frederick County, should be permanently preserved.

Author: John R. Holsinger.

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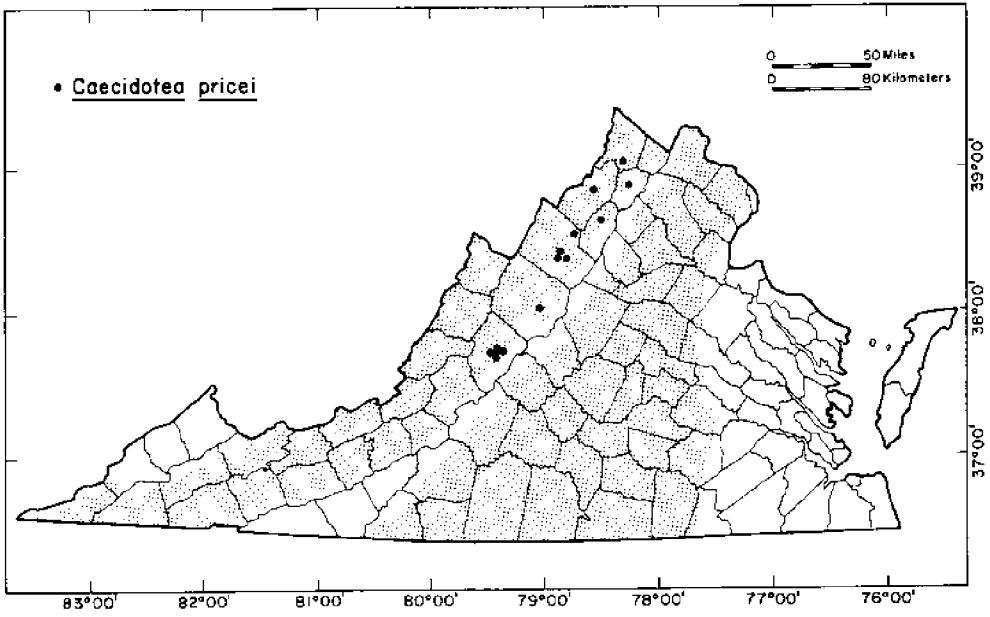


Figure 3. Distribution of *Caecidotea pricei* in Virginia

6. SOUTHWESTERN VIRGINIA CAVE ISOPOD *Caecidotea recurvata* (Steeves)

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Asellidae

Description: Eyeless, unpigmented isopod distinguished by the recurved portion of the distal podomere of the first pleopod and by the diagnosis, description and figures given by Steeves (1963b). Length up to 17.0 millimeters.

Present Range: The range extends from Knox and Union counties, Tennessee, northeastward through the Powell Valley to Wise County, Virginia, and through the Clinch Valley to Russell County, Virginia.

Distribution in Virginia: Recorded from caves in Lee, Wise, Russell and Scott counties and a single cave (questionable determination) in Smyth County (Steeves, 1963b, 1969; Fleming, 1972, 1973; Holsinger and Cuiver, manuscript in preparation) (Figure 4).

Habitat and Mode of Life: Troglóbite. This species inhabits drip-fed and seep-fed pools and the gravel substrate of small streams.

Reproduction: No data are published but numerous ovigerous females are available for study in museum collections.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Although this species occurs over a fairly broad range and is found in numerous caves, individual populations are usually small and many are vulnerable to perturbation by ground water pollution. No protective measures are in effect at present.

Protective Measures Proposed: Research is needed to learn more about the population structure and dynamics of this species. Some of the caves with substantial populations of this species should be given permanent protection.

Author: John R. Holsinger.

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7. VANDEL'S CAVE ISOPOD

Caecidotea vandeli (Bresson)

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the description and figures given by Bresson (1955). Length reaching 5.5 to 6.0 millimeters.

Present Range: The range, which is disjunct and spans parts of four drainage basins, extends from Giles and Montgomery counties, Virginia, northeastward to Bath and Botetourt counties, Virginia (Figure 5) (Steeves, 1969; Fleming, 1972).

Habitat and Mode of Life: Troglobite. Inhabits small streams and pools in caves.

Reproduction: Data are unavailable.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern*. The type-locality, Erhart Cave in Montgomery County, has been destroyed by a rock quarry operation and the five remaining populations are small and scattered. No protective measures in effect at present.

Protective Measures Proposed: Further investigation to better establish range limits and size and ecology of populations. Most of the caves inhabited by this species, such as New River, Slussers Chapel, Old Mill and Blowing caves, are significant and should be protected.

Author: John R. Holsinger.

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8. POWELL VALLEY TERRESTRIAL CAVE ISOPOD

Amerigoniscus henroti (Vandel)

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Trichoniscidae

Description: Eyeless, unpigmented trichoniscid isopod, distinguished by the diagnosis and figures given by Vandel (1950, 1977). Length up to 5.0 millimeters.

Present Range: Recorded from eight caves in the Powell Valley of Lee County, Virginia. (Figure 6). See also Vandel (1965) and Holsinger (1967a). Several records are unpublished.

Habitat and Mode of Life: Troglobite. This species is usually found on pieces of damp (to wet), rotting wood in wet parts of caves.

Reproduction: No data available at present.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Special Concern*. This species is apparently restricted to caves of central and southern Lee County, Virginia, and is usually quite rare in a given locality. Because of the limited number of populations and their small (unstable?) size, this species should be given *Special Concern*. There are no protective measures in effect at present.

Protective Measures Proposed: More data on the size and fluctuation of populations would be desirable. Very little is known of the ecology of this species. Several caves with representative populations should be protected.

Author: John R. Holsinger.

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9. RACOVITZA'S TERRESTRIAL CAVE ISOPOD *Miktoniscus racovitzai racovitzai*
Vandel

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Trichoniscidae

Description: Eyeless, weakly (?) pigmented trichoniscid isopod, distinguished by the diagnosis and figures by Vandel (1950, 1965). Length up to 5.0 or 6.0 millimeters.

Present Range: Recorded from single caves in Page, Rockbridge, Botetourt, Shenandoah and Alleghany counties, Virginia (Figure 7), and a single cave in Scott County, Kentucky. Localities listed by Vandel (1965: 384-385).

Habitat and Mode of Life: Troglobite. This species is usually found on pieces of damp, rotting wood. It is the only troglobitic member of the genus *Miktoniscus*.

Reproduction: A single ovigerous female was collected from Luray Caverns in September 1928; no other data are available at present.

Status: *Special Concern*. This rare species is known only from a few specimens collected from five caves in northwestern Virginia and one cave in north-central Kentucky. Because of the limited number of populations and their small size, this species should be given *Special Concern*. There are no protective measures in effect at present.

Protective Measures Proposed: More data on the range and extent of populations are needed. Two or three of the caves inhabited by this species (Luray, Shenandoah, and probably Buck Hill) are commercial, and the managers of these caves should be asked to assist in the protection of this species.

Author: John R. Holsinger.

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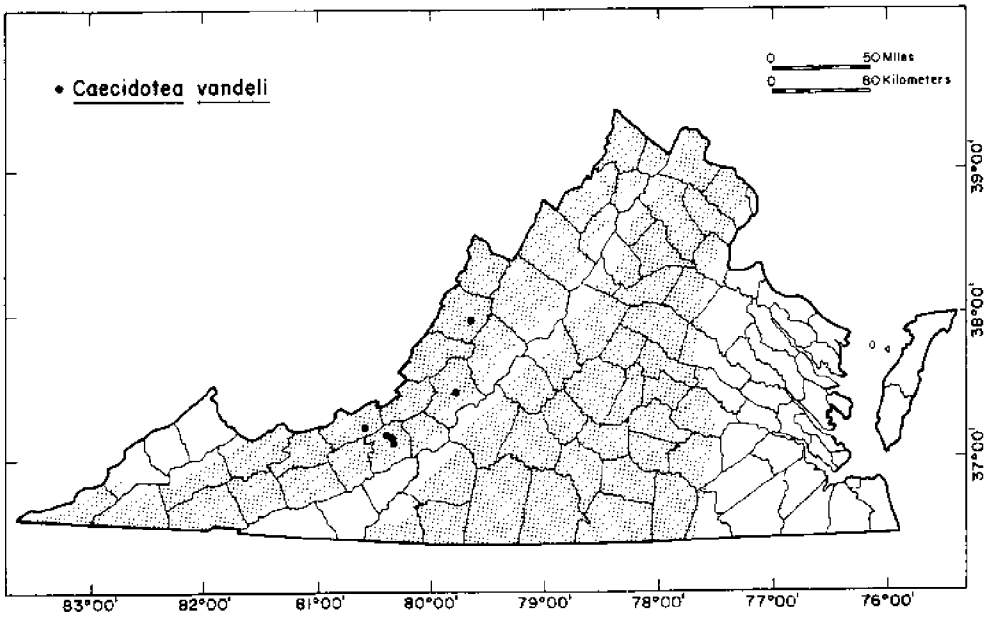


Figure 5. Present Range of *Caecidotea vandeli* in Virginia

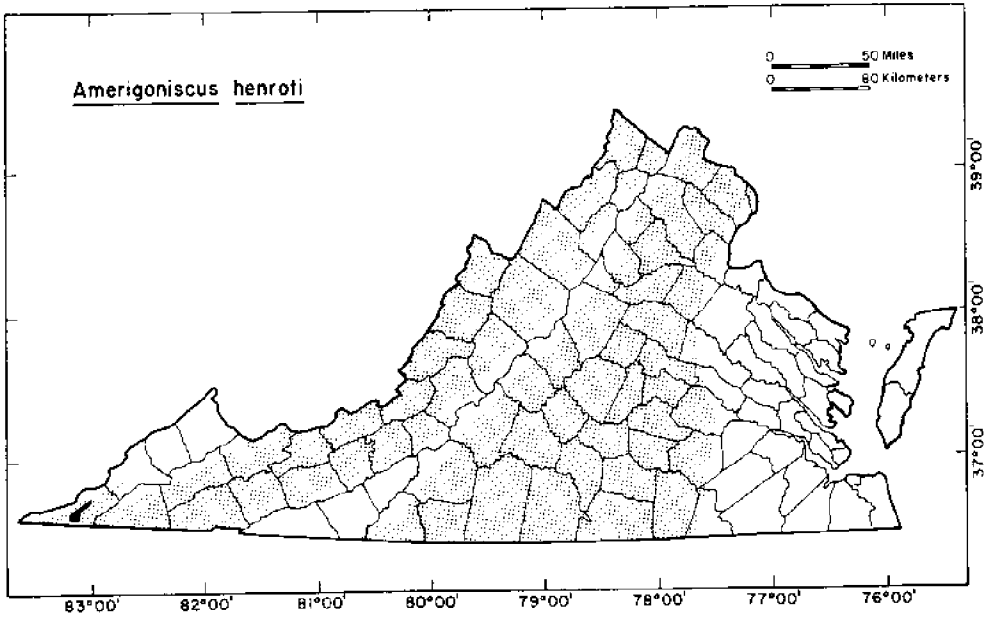


Figure 6. Present Range of *Amerigoniscus henroti* in Virginia

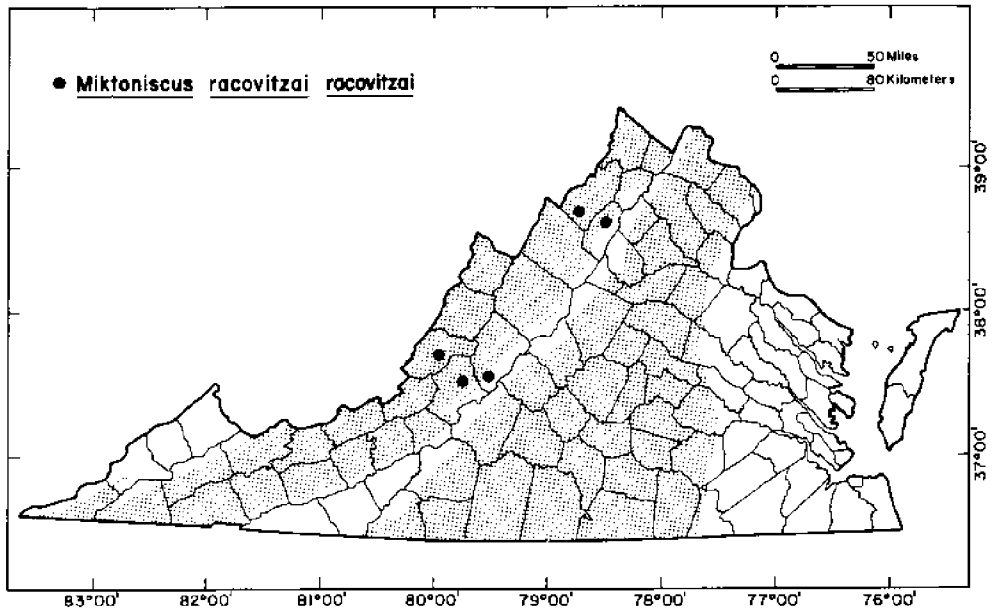


Figure 7. Present Range of *Miktoniscus racovitzai racovitzai* in Virginia

STATUS UNDETERMINED (1)

TENNESSEE VALLEY CAVE ISOPOD

Caecidotea richardsonae HayPhylum: Arthropoda
Class: CrustaceaOrder: Isopoda
Family: Asellidae

Description: Eyeless, unpigmented isopod, distinguished by the diagnosis and figures given by Steeves (1963b). Length up to 10.0 millimeters.

Present Range: Range extends from Tazewell County, Virginia, southwestward through the upper Tennessee River drainage basin into northwestern Georgia and into the eastern and central parts of Alabama (Steeves, 1969; Fleming, 1973).

Distribution in Virginia: Recorded from caves in the Powell and Clinch valleys of southwestern Virginia but more common in parts of the Clinch Valley; also recorded from a part of Tazewell County which is drained by the New River (Figure 8).

Habitat and Mode of Life: Troglobite. This species inhabits drip- and seep-fed pools and the gravel substrate of small streams.

Reproduction: No data are published, but numerous ovigerous females are available for study in museum collections.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution.

Status: *Undetermined*. The wide range of this species is misleading and may well represent a species complex of closely related forms. Virginia populations are not common except in parts of Tazewell County. In many other parts of the range, especially in the Powell Valley, *Caecidotea recurvata* appears to be the dominant species and probably excludes *Caecidotea richardsonae*. Considering the typically small size and scattered nature of populations of this species, and the vulnerability of some of them to ground water pollution, *Caecidotea richardsonae* should be given *Special Concern*. But until its taxonomy is better defined, a *Status Undetermined* designation seems more reasonable. No protective measures are in effect at the moment.

Protective Measures Proposed: Further investigations should be made on the population structure and dynamics of this species. An attempt should also be made to determine whether *Caecidotea richardsonae* is a species complex or a single species. Several caves with representative populations should be protected. Some caves in Tazewell County with this species are already protected by their owner, but no long-term plan has been worked out.

Author: John R. Holsinger.

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FRESHWATER AMPHIPOD CRUSTACEANS (ORDER AMPHIPODA)

John R. Holsinger

Introduction

Amphipod crustaceans are common in the freshwater environment of Virginia, where they are typically found in smaller bodies of water. The majority of species are associated with ground water habitats and many are obligatory cavernicoles (*i.e.*, troglobites) or obligatory to subterranean ground water in general (*i.e.*, phreatobites). Some species live in interstitial habitats, whereas others inhabit the hypotelminorheic medium which is characterized by small seep-fed or spring-fed streamlets passing through leaf litter, silt or aquatic vegetation (see also Holsinger, 1978).

The freshwater amphipod fauna in Virginia is composed of approximately 34 described species, representing three families and five genera; all are in the suborder Gammaridea. The family Crangonyctidae is represented by *Crangonyx* (4 species), *Stygobromus* (25 species), and *Synurella* (1 species); Gammaridae (s. str.) by *Gammarus* (2 species); and Hyalellidae by *Hyalella* (1 species).

Of the 34 species recorded from the state at present, 26 are highly specialized, mostly eyeless, unpigmented forms that are adapted to the subterranean environment and are found in caves, wells, seeps and small springs. Only the troglotic and/or phreatobitic species are considered in this report. There are three reasons for this: (a) the surface or epigena species are generally common and widespread and do not appear to be threatened at present; (b) cave ecosystems and related subterranean biotopes are believed to be sensitive and highly vulnerable to ground water pollution and disturbance by man; and (c) subterranean species are usually rare, highly specialized forms with restricted ranges and low population sizes.

The locations of caves listed in this report are found in books by Douglas (1964) and Holsinger (1975). All cave localities recorded for each species (except those for *Crangonyx antennatus*) are listed in papers by Holsinger (1967b, 1969, 1978).

SPECIES ACCOUNTS

THREATENED (5)

1. BIGGERS' CAVE AMPHIPOD

Stygobromus biggersi Holsinger

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous species distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 5.6 millimeters; largest female, 7 millimeters.

Present Range: The range is restricted to a part of the Potomac River basin and extends from Frederick County, Virginia, for approximately 60 miles north-northeastward through West Virginia and central Maryland to Franklin County, Pennsylvania.

Distribution in Virginia: Recorded only from Ogden's Cave in Frederick County (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Troglobite. Predominantly an inhabitant of cave pools.

Reproduction: Females with setose brood plates have been collected during all seasons of the year; ovigerous females are unknown, however.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. This species is known from only five cave populations, none of which, with the possible exception of Ogden's Cave, is of significant size. A part of the range is threatened by groundwater pollution and rapid urban growth.

Protective Measures Proposed: The single population in Virginia is at present the largest known but could easily be extirpated by groundwater pollution. In addition, this cave (Ogden's) has a moderately rich aquatic fauna consisting of several rare, local endemics and is one of the most interesting caves biologically in the northern part of the state. For these reasons, immediate measures should be taken to protect this cave and the surrounding groundwater recharge area.

Author: John R. Holsinger.

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2. ALLEGHANY COUNTY CAVE AMPHIPOD *Stygobromus hoffmani* Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 3 millimeters; largest female, 5.5 millimeters.

Present Range: Recorded from two caves located about 0.8 mile apart on the south side of the Jackson River in Alleghany County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits small, mud-bottom drip pools in caves.

Reproduction: Two females from a September collection were ovigerous, each brooding three eggs.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. This species is recorded from two caves, one of which, McElwee Cave, was completely destroyed by the construction of interstate highway 64 during the early 1960s. The other population, in Lowmoor Cave, is apparently quite small and unprotected at the present time.

Protective Measures Proposed: More field work is needed to determine if this species is as rare and restricted as it now appears. Protection of Lowmoor Cave and surrounding groundwater recharge area would hopefully ensure its preservation.

Author: John R. Holsinger.

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3. JAMES CAVE AMPHIPOD *Stygobromus abditus* Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented, cavernicolous amphipod of the *mackini* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest female, 6 millimeters; male unknown.

Present Range: Known only from James Cave in Pulaski County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. This species is found under gravels in cave streams.

Reproduction: Data are unavailable at present.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. Based on the apparent rarity and range restriction of this species, it should be considered *Threatened*. Only two specimens are known. There are no protective measures in effect at the present time.

Protective Measures Proposed: Further study is needed to determine the population size of this species and whether or not it occurs in other caves found near its type locality. Protection of James Cave and the surrounding groundwater recharge area is recommended.

Author: John R. Holsinger.

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4. LURAY CAVERNS AMPHIPOD

Stygobromus pseudospinosus Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *spinosus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 4 millimeters; largest female, 7 millimeters.

Present Range: Known only from Luray Caverns, Page County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Drip pools in cave.

Reproduction: Females with setose brood plates were collected during winter, spring and summer; ovigerous females are recorded from March and August.

Number in Captivity: Preserved specimens are deposited in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. This species is a rare, local endemic and may be threatened. In May 1964, the author made an extensive search of all of the pool areas in Luray Caverns but was able to find only three amphipods in a single pool in the Carl's Spring area. In contrast, Leslie Hubricht collected 95 specimens from various pools in August 1939 (see Holsinger, 1978). Whether this indicates a drastic decline in population size or simply a fluctuation in numbers is undetermined. There are no protective measures in effect, *per se*, except that the cave is protected by virtue of its commercialization.

Protective Measures Proposed. Research is needed to determine whether the Luray Caverns population is declining or simply fluctuating from year to year. The management of Luray Caverns should designate one or more pools with this species for permanent preservation. The groundwater recharge area above the cave should also be protected from further development.

Author: John R. Holsinger.

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5. MADISON CAVE AMPHIPOD

Stygobromus stegerorum Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 5.5 millimeters; largest female, 6.8 millimeters.

Present Range: Recorded from Madison's Saltpetre Cave and a small fissure cave (Steger's Fissure) nearby, both located near Grottoes, in Augusta County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite/phreatobite. This species inhabits deep phreatic water and occurs in the company of the cirrolanid isopod, *Antrolana lira* Bowman.

Reproduction: Females with setose brood plates have been collected in March and June.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Threatened*. This rare, local endemic is restricted to the phreatic water under Cave Hill just west of the South River near Grottoes. Biological exploration of caves in surrounding karst areas has led to the conclusion that this species is probably limited to a single, highly restricted groundwater system exposed in only two caves. Observations indicate that populations are small in size; only a few specimens have been seen or collected. Negotiations with Lyall O. Steger, owner of the cave and fissure, fortunately have been successful in getting this area some protection, but the karst groundwater aquifer under Cave Hill nevertheless remains potentially threatened by pollution.

Protective Measures Proposed: Further negotiations with Mr. Steger to ensure absolute protection are recommended. Madison's Saltpetre Cave and surrounding groundwater recharge area should be set aside as a nature preserve, not only because of its rare amphipod but also because of its rare isopod, *Antrolana lira*, and the presence of several other interesting terrestrial cave species. At present an attempt is being made by James A. Estes to determine if traces of mercury exist in the sediments of the cave lakes. This possibility seems likely inasmuch as mercury was recently detected in the nearby South River and because of the probable subterranean connection between the river and the phreatic water of Cave Hill.

Author: John R. Holsinger.

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SPECIAL CONCERN (17)

1. APPALACHIAN VALLEY CAVE AMPHIPOD

Crangonyx antennatus Packard

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Crangonyctidae

Description: A medium-sized to moderately large cavernicolous species with degenerate eyes and usually lacking pigment. Distinguished by the re-description and figures given by Shoemaker (1942) and the key of Holsinger (1972). Largest males, 10 millimeters; largest females, 13.5 millimeters.

Present Range: The range of this species extends from the upper Tennessee River basin in Lee, Scott and Wise counties, Virginia, south-southwestward to northwestern Georgia, and west along the Tennessee River valley to northwestern Alabama and extreme southcentral Tennessee (Holsinger, 1969a; 1972).

Distribution in Virginia: Caves in Lee, Wise and, occasionally, Scott counties. Most records are from caves in the Powell Valley, however (Figure 9).

Habitat and Mode of Life: Troglóbite. Inhabits drip and seep pools and small streams in caves. Further details are given by Culver (1973) and Dickson (1976).

Reproduction: Life span of at least six years and probably longer. Sexually mature females range in size from 5.5 to 13.5 millimeters but most are between 7 and 10 millimeters; sexually mature males range in size from 4.5 to 10 millimeters but most are between 5 and 8 millimeters. Newly-hatched young are on the average 1.6 millimeters long. All size classes and ovigerous females have been found throughout the year, indicating that breeding is continuous. Seasonal peaks are indicated, however, and only a very small percentage of the individuals in a given population breed at any one time. Clutch size varies with female size and ranges from 14 to 83 eggs or embryos. Additional data are given by Dickson (1976).

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger. Living cultures of approximately 10 animals are in the laboratory of J. R. Holsinger as of April, 1978.

Status. Special Concern. This species is fairly common throughout most of its range in Virginia (especially in the Powell Valley), but the majority of populations are small and subject to seasonal fluctuations. Several caves with significant populations are being monitored periodically and appear to be reasonably safe from disturbance at the moment. None of the cave populations have absolute protection, however, and all are potentially vulnerable to groundwater pollution.

Protective Measures Proposed: Several caves in the karst area of southcentral Lee County, Virginia, with significant populations of this species and other aquatic troglóbites should be permanently protected as nature preserves. The

caves and karst of Lee County are still relatively undisturbed, and protective measures should be taken now before this interesting environment is ultimately modified or changed by the activities of man.

Author: John R. Holsinger

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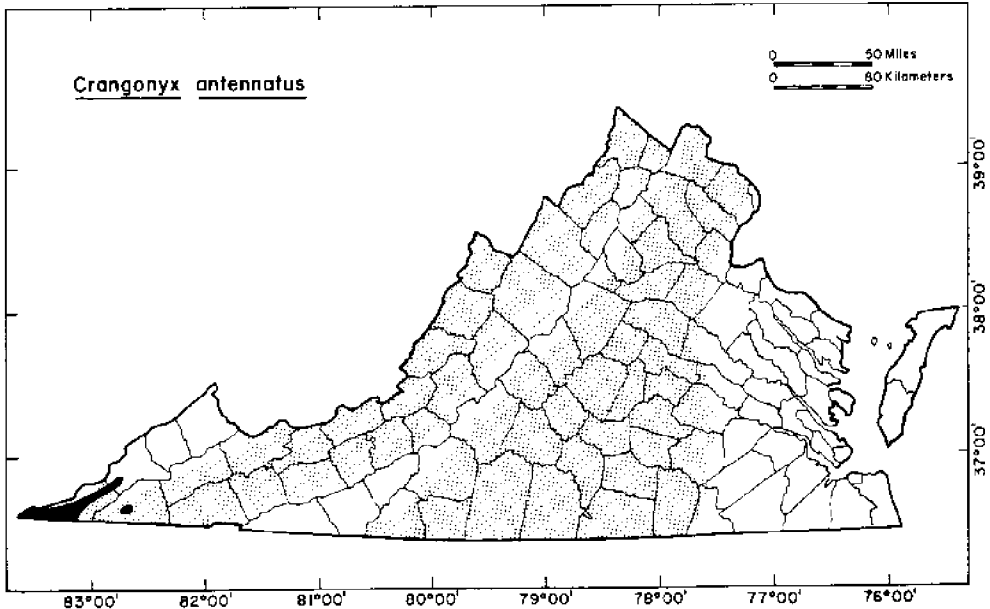


Figure 9. Distribution of *Crangonyx antennatus* in Virginia

2. BATH COUNTY CAVE AMPHIPOD

Stygobromus mundus (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod, distinguished from other members of the *emarginatus* group, to which it is assigned, by the diagnosis, descriptions and figures given by Holsinger (1967b, 1978). Largest male, 8 millimeters; largest female, 8.2 millimeters.

Present Range: Recorded from two localities in westcentral Virginia (Bath and Alleghany counties) (Holsinger, 1972). The range covers a distance of approximately 15 miles (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite/phreatobite. Inhabits a small, gravel bottom stream in Witheros Cave, Bath County, Virginia. The Alleghany County record is based on a single female taken from a tributary to the Cow Pasture River. This specimen is believed to have been flushed from an underground habitat.

Reproduction: Data are unavailable.

Number in Captivity: Preserved specimens are deposited in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. This species is apparently quite rare and is known only from four specimens. There are no protective measures in effect at present.

Protective Measures Proposed: Further attempts should be made to locate additional populations and to learn more about the ecology of this species. It is strongly recommended that Witheros Cave and associated ground water recharge area be protected.

Author: John R. Holsinger.

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3. BLUE RIDGE MOUNTAIN AMPHIPOD *Stygobromus spinosus* (Hubricht and Macklin)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented ground water amphipod, distinguished by the diagnosis, description and figures given by Hubricht and Macklin (1940) and Holsinger (1978). Largest males, 4.0 millimeters; largest females, 5.5 millimeters.

Present Range: The range is restricted to the Blue Ridge Mountains and extends from Albemarle and Augusta counties, Virginia, north-northeastward to Warren County, Virginia (Holsinger, 1969a; 1972; 1978) (see distribution map in Holsinger, 1978).

Distribution and Mode of Life: Phreatobite. Inhabits gravel substrate, leaf litter and masses of aquatic vegetation in small springs and spring-runs, generally at higher elevations. The typically ground water habitat of this species is the hypotelminorheic.

Reproduction: Females with setose brood plates have been found in collections made in March, May and June; ovigerous females have been observed in a June collection.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Although this species has a relatively long range and is sometimes abundant in certain spring runs, it is nevertheless fairly localized in distribution and is endemic to only a small part of the state. Because of the unique nature and vulnerability of its habitat to alteration, this species should be given *Special Concern*. There are no specific protective measures in effect, although most of the range lies within Shenandoah National Park.

Protective Measures Proposed: A detailed inventory of the springs and spring-runs inhabited by this species should be made, and measures should then be enacted to preserve these habitats in their natural state. A number of springs in Shenandoah National Park have been drastically modified by walling and piping. This practice is believed to be very disruptive to populations of aquatic organisms and should be stopped.

Author: John R. Holsinger.

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4. BURNSVILLE COVE CAVE AMPHIPOD *Stygobromus conradi* (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *gracilipes* group, distinguished by the diagnosis, description and figures given by Holsinger (1967b). Largest male, 4.3 millimeters; largest female, 8.2 millimeters.

Present Range: Known only from Breathing and Butler-Sinking Creek caves in Bath County, Virginia (Holsinger, 1969a; 1972, 1978) (see distribution map in Holsinger (1978)).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits streams in caves, where it appears to be very rare.

Reproduction: Data are unavailable.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. This rare, local endemic is at present known only from four specimens, two from Breathing Cave and two from Butler-Sinking Creek Cave.

Protective Measures Proposed: Further studies are recommended to determine if this species is more common in parts of Butler-Sinking Creek and Breathing caves which have not yet been biologically explored. Butler-Sinking Creek Cave is owned and protected by the Butler Cave Conservation Society and continued protection of this significant cave is strongly recommended.

Author: John R. Holsinger.

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5. CRAIG COUNTY CAVE AMPHIPOD *Stygobromus estesi* Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *ephemerus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest female, 5.8 millimeters; male unknown.

Present Range: Recorded from two caves, 1.4 miles apart, in a limestone cove at the head of Sinking Creek Valley in Craig County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits mud-bottom drip and seep pools in caves.

Reproduction: Females from an April sample had setose brood plates.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Since this species is known only from a few specimens collected from two caves, it is considered a rare, local endemic and should be given *Special Concern*. There are no protective measures in effect at present.

Protective Measures Proposed: Further study is needed to determine the range limits and population sizes of this species. Both Rufe Caldwell and New Castle Murder Hole caves, which are inhabited by this species, and the surrounding groundwater recharge area should be protected from pollution and modification.

Author: John R. Holsinger.

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6. CUMBERLAND CAVE AMPHIPOD

Stygobromus cumberlandus Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous and groundwater amphipod of the *cumberlandus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 3.3 millimeters; largest female, 4.5 millimeters.

Present Range: The range extends from the Clinch River drainage in western Scott County, Virginia, north and northwest to the Powell River drainage of southwestern Wise and northeastern Lee counties, Virginia, and then west-southwest to extreme western Lee County (see distribution map in Holsinger, 1978). Only four populations are known at present.

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite and/or phreatobite. This species has been collected from drip pools in three caves and one shallow, hand-dug well.

Reproduction: Females with setose brood plates have been collected in November.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Although this species has a relatively wide range, its distribution is disjunct and population sizes are small; only 16 specimens have been collected to date. Considering its rarity and disjunct distribution, this species should be given *Special Concern*. One of the populations occurs in Cliff Cave in Cumberland Gap National Historical Park and is thus protected; the other localities are not protected.

Protected Measures Proposed: Further study is needed to determine whether other populations can be found, and to what extent this species occupies shallow groundwater habitats outside of caves *per se*. The caves occupied by this species are significant and should be protected.

Author: John R. Holsinger.

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7. EPHEMERAL CAVE AMPHIPOD *Stygobromus ephemerus* (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *ephemerus* group, distinguished by the diagnosis, description, figures and key given by Holsinger (1969b, 1972, 1978). Largest male, 3.4 millimeters; largest female, 5 millimeters.

Present Range: Recorded from two caves, situated 2.5 miles apart, in Giles County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits mud-bottom, drip pools in caves.

Reproduction: Females with setose brood plates have been collected during summer, fall and winter.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Because of the apparent rarity and range restriction of this species, it should be given *Special Concern*. Observations to date indicate that populations in both caves are small and fluctuating. No protective measures in effect at present.

Protective Measures Proposed: Further field work may extend the range of this species but, to date, biological exploration in other Giles County caves has not resulted in the discovery of additional populations. It is suggested that both Tawney's and Canoe caves, which are inhabited by this species, and their surrounding groundwater recharge areas be protected from pollution and other modification.

Author: John R. Holsinger.

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8. MONTGOMERY COUNTY CAVE AMPHIPOD *Stygobromus fergusonii* Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *marginatus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest females, 7 millimeters; male unknown.

Present Range: Recorded from two caves located about 2.3 miles apart in a small karst area drained by the Roanoke River in Montgomery County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits small pools in caves.

Reproduction: A single, ovigerous female was collected from Old Mill Cave in October.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Because of the apparent rarity and restricted range of this locally endemic species, it should be given *Special Concern*. No protective measures are in effect at the present.

Protective Measures Proposed: More study is needed to establish the range limits and population sizes of this species. The caves with populations of this species should be protected.

Author: John R. Holsinger.

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9. LEE COUNTY CAVE AMPHIPOD

Stygobromus leensis Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *mackini* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 2.8 millimeters; largest female, 3.7 millimeters.

Present Range: Recorded from three caves in the Powell Valley of southcentral Lee County, Virginia; the range covers approximately 13 miles (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits shallow, drip and seep pools in caves.

Reproduction: Two females with setose brood plates have been collected in August.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. This species is apparently a rare, local endemic. Only five specimens from three caves have been found, although many other caves in the same vicinity have been searched intensively for aquatic organisms. No protective measures in effect at present.

Protective Measures Proposed: This species may be an inhabitant of shallow groundwaters, and an effort to find it outside of caves should be made. The caves inhabited by this species and the surrounding groundwater recharge areas should be protected from pollution and other modification.

Author: John R. Holsinger.

10. SOUTHWESTERN VIRGINIA CAVE AMPHIPOD *Stygobromus mackini* Hubricht

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *mackini* group, distinguished by the diagnosis, redescription and figures given by Hubricht (1943) and Holsinger (1978). Largest males, 7.5 millimeters; largest female, 10 millimeters.

Present Range: The range extends from Roane County, Tennessee, in the Tennessee River drainage basin north-northeast to Monroe County, West Virginia, in the New River drainage basin, and covers a linear distance of 250 miles (Holsinger, 1969a; 1972).

Distribution in Virginia: Recorded from caves in the following counties: Russell, Scott, Tazewell, Wise, Bland, Smyth and Giles. The majority of populations are found in the Clinch River drainage of Russell, Scott and Tazewell counties (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Troglobite. This species is primarily an inhabitant of small, mud-bottom drip and seep pools in caves, although a few populations have been found in small cave streams with gravel or mud substrates. Two populations have also been recorded from springs.

Reproduction: Sexually mature females have been recorded from all seasons of the year; ovigerous females have been found during the months of May, July and August. Further details given by Holsinger (1978).

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* Although this species has a wide range and is sporadically abundant in certain caves within its range, many populations are very small and disjunct and a number are potentially threatened by ground water pollution. Until the ecology of this species can be studied in more depth, it should be given *Special Concern*. Some caves inhabited by this species are in remote areas and are unthreatened, but no specific protective measures are presently in effect.

Protective Measures Proposed: Caves with representative populations of this species should be designated for protection and preservation.

Author: John R. Holsinger.

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11. MORRISON'S CAVE AMPHIPOD *Stygobromus morrisoni* (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *marginatus* group, distinguished by the diagnosis, description and figures given by Holsinger (1967b, 1978). Largest male, 6 millimeters; largest female, 8 millimeters.

Present Range: The range extends from Bath County, Virginia, north-northeastward to Hardy County, West Virginia, covering a linear distance of approximately 100 miles (Holsinger, 1969a; 1972).

Distribution in Virginia: Recorded only from Witheros Cave in Bath County (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Troglobite. Inhabits a small, gravel-bottom stream in Witheros Cave.

Reproduction: Oviparous females have been collected in the early spring.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. This species is rare and to date is known only from a few specimens collected from three caves within its range. There are no protective measures in effect at present.

Protective Measures Proposed: Additional field work is needed to establish the range extent and size of populations of this species. It is strongly suggested that Witheros Cave and surrounding groundwater recharge area be protected from pollution and modification.

Author: John R. Holsinger.

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12. PIZZINI'S GROUNDWATER AMPHIPOD

Stygobromus pizzinii (Shoemaker)

Phylum: Arthropoda

Order: Amphipoda

Class: Crustacea

Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod, distinguished by the description and figures of Shoemaker (1938, 1942) and the diagnosis, re-description and figures of Holsinger (1967b). Largest males, 18.7 millimeters; largest females, 15.7 millimeters.

Present Range: The range extends from Fairfax County, Virginia, northeastward through central Maryland to Chester and Montgomery counties in southeastern Pennsylvania (Holsinger, 1972).

Distribution in Virginia: Reported from several localities in Fairfax County (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Phreatobite. Inhabits a variety of groundwater biotopes, including seeps, small springs, small spring-fed and seep-fed streams, mines, wells and caves.

Reproduction: Data on reproductive biology are given by Holsinger (1967:52). None of these data are from populations found in Virginia, however.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern*. Only a small part of the range of this species extends into Virginia, where several small populations were sampled near Scott and Bullneck Run in the 1920's and 1930's. Although a number of springs and similar habitats have been sampled in this same area in recent years, none have produced this species.

Protective Measures Proposed: Further field work should be carried out to determine the status of the species in Fairfax County. A part of the wooded area along Scott Run is now within the boundaries of a county park and, if populations of this species can be found there, protection should be relatively easy.

Author: John R. Holsinger.

13. POTOMAC GROUNDWATER AMPHIPOD

Stygobromus tenuis potomacae
(Holsinger)Phylum: Arthropoda
Class: CrustaceaOrder: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod of the *tenuis* group, distinguished by the diagnosis, description and figures given by Holsinger (1967). Largest males, 16.5 millimeters; largest females, 9 millimeters.

Present Range: The range extends from southcentral Pennsylvania southward through central Maryland to the vicinity of Richmond, Virginia (Holsinger, 1972; 1978).

Distribution in Virginia: The majority of collections have been made in the northern Virginia suburbs of Washington, D.C., although a few samples have been taken from scattered localities near Middleburg and Richmond (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Phreatobite. An inhabitant of shallow groundwater habitats where it is frequently found in wet leaf litter in woodland seeps and bogs during wetter periods of the year. A few specimens are also recorded from shallow wells.

Reproduction: Oviparous females have been collected during March, April, May and June.

Number in Captivity: Preserved specimens in the collections of Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* This species is fairly wide-ranging but is seldom abundant at a given spot. Numerous habitats have been destroyed by urbanization in the metropolitan area of Washington, D.C. Fortunately, some of the habitats occupied by this species are now probably "safe" because of their location in park areas and green belts in Fairfax County and Alexandria.

Protective Measures Proposed: Since this species is fairly common in woodland seeps in protected park lands in Fairfax County, a concerted effort should be made to ensure preservation of habitats and surrounding watersheds by maintaining the natural condition of seeps and seep-runs.

Author: John R. Holsinger.

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14. ROCKBRIDGE COUNTY CAVE AMPHIPOD

Stygobromus barodyi HolsingerPhylum: Arthropoda
Class: CrustaceaOrder: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest males, 7 millimeters; largest female, 11.9 millimeters.

Present Range: Recorded from six caves in Rockbridge County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. Inhabits small, slow-flowing cave streams with mud or silt bottoms; also found in mud-bottom drip and seep pools in caves.

Reproduction: Females with setose brood plates have been collected during all seasons of the year.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* This species is apparently restricted to a small range in the James River basin. Of the six caves known to be inhabited by this species, one (Billy Williams) was completely destroyed by highway construction in the middle 1960's, a second (Buck Hill) is now being developed for tourists, and a third (Showalters) is easily within the southern growth limits of Lexington, Virginia. There are no protective measures in effect at present.

Protective Measures Proposed: Considering the alarming rate that the habitats of this species are being lost or drastically modified, and the fact that none of the populations are large to begin with, every effort should be made to protect the remaining caves containing this species. Bathers Cave contains the only population of significant size and should be protected first. Measures should also be taken by the developers of Buck Hill Cave to maintain the part of this cave with a stream in its natural state. Buck Hill Cave is reportedly being developed by the owners of Natural Bridge.

Author: John R. Holsinger.

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15. SHENANDOAH VALLEY CAVE AMPHIPOD *Stygobromus gracilips* (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *gracilips* group, distinguished by the diagnosis, description and figures of Holsinger (1967b, 1978). Largest males, 10.5 millimeters; largest females, 18.0 millimeters.

Present Range: The range extends from Rockingham County, Virginia, north-northeastward to Franklin County, Pennsylvania, covering a linear distance of approximately 110 miles (Holsinger, 1969a; 1972).

Distribution in Virginia: Recorded from six caves in the Shenandoah Valley (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Troglobite. Inhabits small streams and pools in caves.

Reproduction: Females with setose brood plates have been collected during fall, winter and spring. A single ovigerous female with nine embryos is recorded from a January collection from a cave in Maryland.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* Despite its comparatively long range, this species is quite rare in most of the caves in which it occurs. Except in Skyline Caverns, it is unusual to find more than one or two specimens in a cave. A

part of its range is threatened by rapid urbanization. No protective measures are in effect at present.

Protective Measures Proposed: Cooperation with the owners of Skyline and Massanutten Caverns to ensure that stream and pool habitats are protected from pollution and alteration. Some of the other caves inhabited by this species should be protected also. Two of these, Endless Caverns (a former commercial cave now up for sale) and Ogden's Cave, have unique biotas and aquatic communities and the latter has one of the richest aquatic faunas in the northern part of the state.

Author: John R. Holsinger.

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16. TIDEWATER INTERSTITIAL AMPHIPOD

Stygobromus araeus (Holsinger)

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented ground water amphipod, distinguished by the diagnosis, description and figures given by Holsinger (1969b, 1978). Largest male, 6 millimeters; largest female, 5.5 millimeters.

Present Range: The range extends from Gates County, North Carolina, approximately 75 miles northward to Mathews County, Virginia, and approximately 88 miles northwestward to New Kent County, Virginia (Holsinger, 1972; 1978).

Distribution in Virginia: Except for a single (unpublished) locality in Gates County, North Carolina, the remainder of the recorded range is in Virginia (see distribution map [excluding the recently discovered population in North Carolina] in Holsinger, 1978).

Habitat and Mode of Life: Phreatobite. This species inhabits groundwater seeps, small springs and small spring-fed streams (largely hypotelminorheic biotopes) emerging from loosely consolidated and unconsolidated Coastal Plain sediments.

Reproduction: Ovigerous females have been collected during the months of February, March and April.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* Although the range of this species is fairly wide, only a few populations of any size are known at present. A substantial part of the range of this species lies within the rapidly expanding urban area of Tidewater, Virginia, and many habitats formerly occupied have probably been destroyed by human activities such as construction of housing developments and lowering of the water table. No protective measures in effect at present.

Protective Measures Proposed: Further field work is needed to determine if this species occurs within the part of the Dismal Swamp now protected as a wildlife refuge. Areas containing significant populations should be protected by preventing pollution and severe modification of groundwater habitats.

Author: John R. Holsinger.

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17. TIDEWATER STYGONECTID AMPHIPOD

Stygobromus identatus (Holsinger)

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod of the *pizzinii* group, distinguished by the diagnosis, description and figures given by Holsinger (1967b). Largest males, 9.7 millimeters; largest females, 8.2 millimeters.

Present Range: The range extends from Isle of Wight and Nansemond counties, Virginia, southwestward to Nash County, North Carolina, covering a linear distance of 120 miles (Holsinger, 1972; 1978).

Distribution in Virginia: Recorded from three localities in the Tidewater area of southeastern Virginia (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Phreatobite. Inhabits seeps, drain outlets and shallow wells on the Coastal Plain.

Reproduction: Ovigerous females have been collected in January.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Special Concern.* This rare species is known only from a few scattered populations. Recent attempts to find it in the Virginia part of its range have been unsuccessful, although a concentrated effort to locate populations has not been made. The collections from the Virginia localities were made in the 1940's.

Protective Measures Proposed: A thorough search for this species should be made to determine its extent and number of populations. A part of its range is being encroached on by urbanization in the Tidewater area. If new populations are found they should be protected.

Author: John R. Holsinger.

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STATUS UNDETERMINED (4)

1. NEW CASTLE MURDER HOLE AMPHIPOD

Stygobromus interitus HolsingerPhylum: Arthropoda
Class: CrustaceaOrder: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented cavernicolous amphipod of the *cumberlandus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest female, 4.2 millimeters; male unknown.

Present Range: Known only from New Castle Murder Hole (cave) in Craig County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Troglobite. This species apparently inhabits cave pools.

Reproduction: Data are unavailable.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Undetermined*. This rare, local endemic is known only from two females collected in October, 1943. A recent attempt to find it in the type locality was unsuccessful. No protective measures are in effect at present.

Protective Measures Proposed: More study is needed to determine the status of this species.

Author: John R. Holsinger.

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2. NORTHERN VIRGINIA WELL AMPHIPOD

Stygobromus phreaticus HolsingerPhylum: Arthropoda
Class: CrustaceaOrder: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 6.3 millimeters; largest female, 7 millimeters.

Present Range: Recorded from two wells in Vienna and Alexandria, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Phreatobite. Apparently an inhabitant of shallow groundwater in the Fairfax County and Alexandria area of northern Virginia. Collecting data are insufficient to establish precisely the locations, depths or nature of the wells inhabited by this species.

Reproduction: Three females from a December collection had setose brood plates.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Undetermined*. This rare, local endemic is known only from two collections made 27 years apart from single wells in Vienna and Alexandria. The samples were dated 27 December 1921 (Vienna) and December 1948 (Alexandria). Attempts to find this species and the wells from which it was originally sampled have been unsuccessful to date.

Protective Measures Proposed: Additional study is needed to establish the present existence of this species. If it is rediscovered, attempts should be made to preserve any habitat in which it is found.

Author: John R. Holsinger.

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3. PITTSYLVANIA WELL AMPHIPOD

Stygobromus obrutus Holsinger

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod of the *emarginatus* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest male, 2.5 millimeters; largest females, 3.6 millimeters.

Present Range: Known only from its type locality, a shallow well in a wooded area off Mt. Cross Road, 1 mile northwest of U.S. Route 48, west of Danville, Pittsylvania County, Virginia (see distribution map in Holsinger, 1978).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: Phreatobite. Inhabits shallow groundwater in the Piedmont Province of Virginia.

Reproduction: Five of 64 females collected in December had setose brood plates.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Undetermined*. No attempt has been made to re-collect this species since it was first sampled in December 1948, and it is not known whether the type locality is still intact. Considering that many shallow water wells have been destroyed by filling and that the city of Danville has spread into surrounding rural areas in recent years, the type locality and only known locality of this species may now be obliterated. This species is a local endemic and possibly a relict member of the *emarginatus* group. All other species in this group inhabit caves far to the west in the Appalachian Valley.

Protective Measures Proposed: An attempt should be made to relocate the type locality and determine its status. The species should also be searched for in similar habitats in the surrounding area. If the woodland and the well near Danville are still intact, they should be protected.

Author: John R. Holsinger.

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4. ROCK CREEK GROUNDWATER AMPHIPOD

Stygobromus kenki Holsinger

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Crangonyctidae

Description: Eyeless, unpigmented groundwater amphipod of the *kenki* group, distinguished by the diagnosis, description and figures given by Holsinger (1978). Largest males, 3.7 millimeters; largest females, 5.5 millimeters.

Present Range: Three populations are recorded: two in Rock Creek Park in Washington, D.C., and one in Fairfax County, Virginia.

Distribution in Virginia: Known from a well, 12 meters deep, just north of Edsall Road and just west of the Alexandria-Fairfax County line (see distribution map in Holsinger, 1978).

Habitat and Mode of Life: Phreatobite. Inhabits leaf litter and mud in seeps, small springs and spring runs (hypotelminorheic medium) and wells.

Reproduction: Females from spring and summer samples had setose brood plates.

Number in Captivity: Preserved specimens in the collections of the Smithsonian Institution and J. R. Holsinger.

Status: *Undetermined*. This rare, local endemic is apparently restricted to a few localities in the Washington, D.C., area. In Virginia, it is known only on the basis of a single, immature male collected from a well in Fairfax County. This population appears to be conspecific with those in the District of Columbia but sexually mature specimens are needed to confirm this. At present the species is very rare in Virginia, and the well from which it was collected is threatened by a housing development.

Protective Measures Proposed: Further study is needed to determine the precise taxonomic status of the Virginia population and the extent of distribution of this species in Virginia. Protection of the well and groundwater recharge area might ensure protection of the species.

Author: John R. Holsinger.

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DIPLOPODS (CLASS DIPLOPODA)

Paul A. Opler and Lynn M. Ferguson

Introduction

The Appalachian region has a rich fauna of these interesting creatures, including cave-adapted endemics. The committee recommended the inclusion of two species in this report: *Threatened (1)* and *Recently Extinct or Extirpated (1)*.

SPECIES ACCOUNTS

THREATENED (1)

MILLIPEDE

Pseudotremia tuberculata Loomis

Phylum: Arthropoda

Order: Chordeumatida

Class: Diplopoda

Family: Cleidogonidae

Present Range: This millipede is known only from Cassel Farm Cave in Tazewell County, Virginia.

Distribution in Virginia: Same as above.

Status: *Threatened*. The only habitat could be destroyed by a single action, inadvertent or otherwise.

Author: Lynn M. Ferguson.

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RECENTLY EXTINCT OR EXTIRPATED (1)

MILLIPEDE

Pseudotremia cavernarum Cope

Phylum: Arthropoda

Order: Chordeumatida

Class: Diplopoda

Family: Cleidogonidae

Present Range: This millipede is known only from Erhart's Cave in Montgomery County, Virginia.

Distribution in Virginia: Same as above.

Status: *Recently Extinct or Extirpated*.

Remarks: The only known cave habitat at Ellett in Montgomery County was recently destroyed by a quarrying operation. It is not known if the species survives in adjacent underground habitats.

Author: Lynn M. Ferguson.

FRESHWATER AND TERRESTRIAL
INSECTS

Paul A. Opler

Introduction

There are about one million described species of insects in the world, more than all other life forms put together. It has been estimated that about 20,000 insect species inhabit the Commonwealth of Virginia (Kosztarab, 1969). Unfortunately, the population status of few Virginia insects is known with any degree of assurance. Thus, it is a difficult chore at this time to assess which taxa may be *Endangered*, *Threatened* or of *Special Concern*. Until such time as both extensive and intensive surveys of Virginia's rich insect fauna are carried out, only a preliminary assessment of a few taxa can be put forward. The Arthropod Committee members were almost unanimous in calling attention to this large unknown factor. The Committee's report on insects includes accounts for four butterflies, a group that has been well studied in the state. Surveys of Virginia butterflies have been reported by Clark and Clark (1951), as well as by Covell and Straley (1973).

SPECIES ACCOUNTS

SPECIAL CONCERN (15)

1. DIANA FRITILLARY

Speyeria diana (Cramer)

Phylum: Arthropoda
 Class: Insecta

Order: Lepidoptera
 Family: Nymphalidae

Description: A distinctive large fritillary butterfly, blue and black in the female, orange and black in the male. (Pictured in any eastern North American butterfly guide.)

Present Range: Centering on the central and southern Appalachians, with disjunct populations eastward on the inner coastal plain of Virginia, and westward scattered to the Ozarks. Formerly Ohio River Valley.

Distribution in Virginia: Found from Highland County south and west in the mountains, but with a scattered distribution. Despite published reports it is not found at high elevations. In Giles County, for example, it is not as high as 3,000 feet (Figure 10). A separate coastal plain population, including the species' type-locality -- Jamestown -- is seriously reduced and may be *Extirpated*.

Habitat: In the mountains; in mature forest, especially in valley bottoms. Females generally emerge from the forest to feed on flowers in openings only late in the day, and thus are often overlooked. Males fly more freely along roads and are thus seen more often.

Status: *Special Concern.* The only threat to this species is habitat destruction. It has probably been reduced in the continuity of its range by destruction of valley forest, but it is now found in many localities where that forest remains intact or has regenerated. In Poverty Hollow, Montgomery County, where collecting is perhaps at its most intense, the species seems not to have suffered any decline in numbers. In fact, the species seems to have benefited from it, since the numbers of males have remained equally high every summer over a 15-year period. The U.S. Forest Service recognized in its plan for the Poverty Creek drainage that the maintenance of a good stand of mature forest was important for the preservation of this species.

Protective Measures Proposed: A recognition of the importance of valley forest in the mountainous parts of the range; on the coastal plain appropriate measures are not clear, but the exact status should be determined.

Remarks: The female is presumed to be one of several butterflies which are Batesian mimics of the distasteful pipevine swallowtail (*Battus philenor*).

Authors: David A. West and Paul A. Opler.

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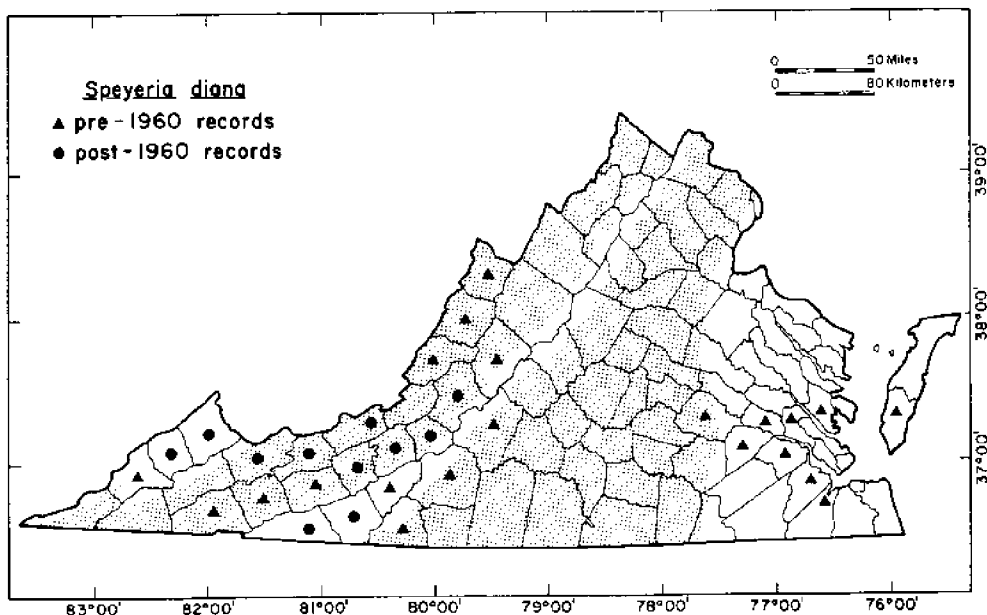


Figure 10. Distribution of *Speyeria diana* in Virginia

2. RARE SKIPPER

Problema bulenta (Boisduval and LeConte)

Phylum: Arthropoda
Class: Insecta

Order: Lepidoptera
Family: HesperIIDae

Description: A medium-sized skipper (6 centimeter wing-spread); pure golden-yellow below, and yellow above with wide dark wing margins on both wings. Female similar to the male, but slightly larger.

Present Range: Isolated populations in the coastal swamps of Georgia, South Carolina and North Carolina and a single known isolated colony in Virginia, very recently discovered.

Distribution in Virginia: Known only at a single locality along the Chickahominy River, 2 miles south of Lanexa, New Kent County (Figure 11).

Habitat: Deep, wet, grassy swamps. Nicolay has never seen the insect fly out of or leave its chosen habitat -- a wet, marshy environment. In Virginia, it is found in the wet, marshy drainage area of the mid-Chickahominy River.

Reproduction: Very possibly two-brooded, but at the moment known only from a single (Fall) brood in Virginia.

Status: *Special Concern.* No one is going to "over-collect" this uncommon, incredibly fast-flying and extremely wary insect! It is difficult to see, difficult to reach, and difficult to net. The only real threat to *Problema bulenta* is the possible destruction of its habitat. The area is fast becoming a "vacation home" building site.

Author: S. S. Nicolay.

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3. DUKE'S SKIPPER

Euphyes dukesi (Lindsey)

Phylum: Arthropoda
Class: Insecta

Order: Lepidoptera
Family: HesperIIDae

Description: A large skipper butterfly 4 centimeters in wing-span, rich dark-brown above and below, with heavy yellow overscaling on the under-surface of the hind wings and with a single yellowish ray of color crossing the center of the wing longitudinally. All wings rather rounded and full. Males with a heavy, black stiaama; females with pale, vague light spots on the forewing.

Present Range: Atlantic coastal plain (Virginia, North Carolina), Gulf Coast (Alabama, Louisiana, Mississippi), Arkansas, Michigan and Ohio.

Distribution in Virginia: Deep swamps bordering the Inland Waterway in Virginia Beach and Chesapeake; along the Blackwater River, Pocaty Creek, and wet swamps surrounding the drainage canals (Figure 11).

Habitat: The breeding habitat is deep, shaded swamps dominated by water tupelo (*Nyssa aquatica*). The caterpillar food plant is probably sedge (*Carex* sp.). The adults come out of the swamps to feed on floral nectar of pickerelweed (*Pontederia cordata*) along the canals.

Reproduction: Two adult flights occur each year; one in the Spring (June), and the second in the Fall (August and early September). Host is unknown but is probably a sedge.

Status: *Special Concern.* This is a very common species within its very special habitat, the gum-swamp. The only threat to this species is the possibility of habitat destruction. Most of the habitat of *Euphyes dukesi* lies within the city limits of Virginia Beach and it is indeed difficult to predict just what effect the incredibly rapid and unchecked growth of this city will eventually have on the habitat of this species.

Protective Measures Proposed: Protection of remaining habitat is essential.

Authors: S. S. Nicolay and Paul A. Opler.

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4. KING'S HAIRSTREAK

Satyrium kingi (Klots and Clench)

Phylum: Arthropoda
Class: Insecta

Order: Lepidoptera
Family: Lycaenidae

Description: A small hairstreak butterfly about 3 centimeters in wing span. The adult is plain dark brown above and brownish grey below, with a faint purplish sheen in fresh individuals. Readily identified only by specialists. The insect's markings beneath are best described as intermediate between those of *Satyrium liparops* and *Satyrium caryaevorus*.

Present Range: Known only from coastal states from Virginia south to northern Florida thence west to Mississippi. Usually found as isolated populations in immediate Coastal Plain, but a few populations are known from the Piedmont.

Distribution in Virginia: The King's hairstreak is known from only eight locations in Virginia (Figure 11), but has already been extirpated from one (Virginia Beach). It is likely that other populations remain to be discovered.

Habitat: Second-growth mixed deciduous and pine forests at the edge of partially cleared areas where its presumed caterpillar food plant *Symplocos tinctoria* is found.

Reproduction: A single annual generation with adults in flight during May and June. Eggs of related species are laid on host twigs, and do not hatch until the succeeding Spring whereupon the caterpillars begin their development.

Status: *Special Concern.* Since one population has been lost to development and because two others exist in southeast Virginia where rapid suburban development is taking place, further losses could occur.

Protective Measures Proposed: The distributional status of this butterfly should be more carefully investigated.

Authors: S. S. Nicolay and Paul A. Opler.

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5. HOWE'S DRAGONFLY

Ophlogomphus howei (Bromley)

Phylum: Arthropoda
Class: Insecta

Order: Odonata
Family: Gomphidae

Description: A small dragonfly (3 centimeters in length) with a yellow thorax and yellow and black abdomen with yellowish wings.

Present Range: Limited to the Susquehanna River in Pennsylvania and the New River of Virginia and North Carolina.

Distribution in Virginia: The New River in Grayson and Carroll counties between 640 and 732 meters elevation (Figure 11). A site on the New River near Galax is central to the distribution.

Habitat and Mode of Life: Nymphs are benthic inhabitants of the main river channel (Kennedy and White, 1979). Specific physical features of the stream where the nymphs are found are as follows: dissolved oxygen (D.O.) - near saturation; biological oxygen demand (BOD) - 0.01-6.15 parts per million; nitrate - 0.304-3.49 parts per million; chloride - 0.30-5.40 parts per million; hardness - 9.90-22.40.

Reproduction: A single adult generation in May. Nymphs may require two years to reach maturity (Calvert, 1924).

Status: *Special Concern.* The species has a small range in Virginia and is dependent upon the present excellent water quality of the New River. Any change in water flow or physical characteristics of the New River would require a re-evaluation of this rare dragonfly's status.

Protective Measures Proposed: Prevent any change in New River from channelization, impoundment or industrial discharge.

Author: Paul A. Opler.

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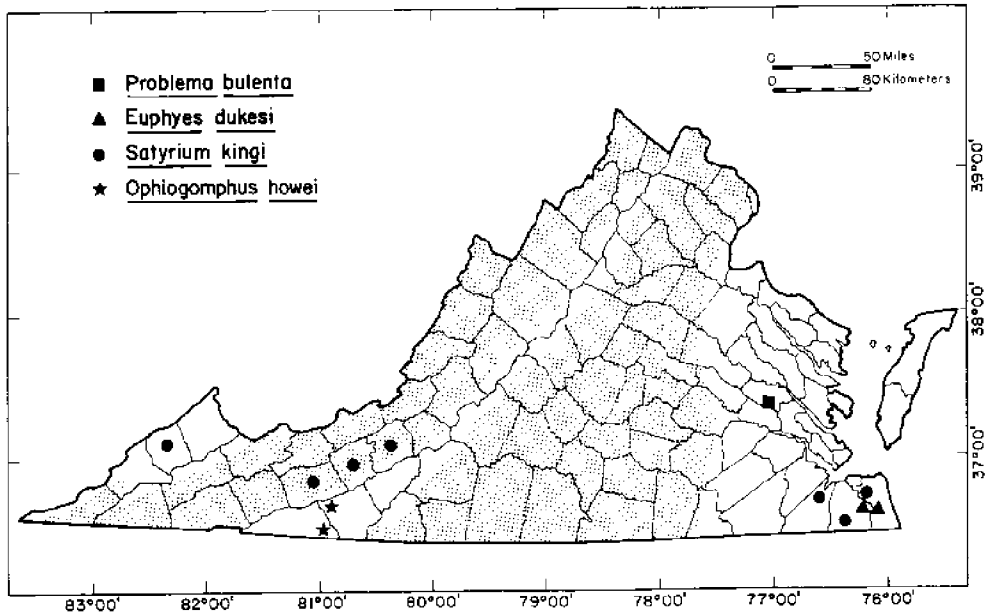


Figure 11. Distribution of *Problema bulenta*, *Euphyes dukesi*, *Satyrium kingi*, and *Ophiogomphus howei* in Virginia

6. DAMSELFLY

Calopteryx angustipennis Selys

Phylum: Arthropoda
Class: Insecta

Order: Odonata
Family: Calopterygidae

Status: *Special Concern.*

Remarks: This species is known only from the Cowpasture River in Alleghany County.

Author: Paul A. Opler.

7. THOREY'S GRAYBACK DRAGONFLY *Tachopteryx thoreyi* (Hagen)

Phylum: Arthropoda
Class: Insecta

Order: Odonata
Family: Petaluridae

Description: A large clear-winged dragonfly, 7-8 centimeters in length, 11 centimeters in wingspan. The thorax is yellowish-green, legs are black, and the abdomen is black with orange saddlemarks.

Present Range: Locally distributed in 17 states from New Hampshire and Michigan south to Florida and Alabama.

Distribution in Virginia: Restricted to boggy sites in mountainous areas of about 10 Virginia counties. Usually rare where found.

Habitat and Mode of Life: Small spring-fed boggy sites or seepage areas in mountains. Adults are found in sunny openings in woods, often alighting flat against a tree trunk or stone.

Reproduction: Females lay their eggs among roots of dense grasses in wet and decaying vegetable matter above water surface.

Status: *Special Concern.* A rare, localized species with a fragile habitat.

Protective Measures Proposed: Protect known habitats by agreement or acquisition.

Author: Paul A. Opler.

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8. BUG *Stachyocnemus apicalis* (Dallas)

Phylum: Arthropoda
Class: Insecta

Order: Hemiptera
Family: Alydidae

Status: *Special Concern.*

Remarks: Only a single Virginia specimen is known. It is said to occur only in dry sandy places and is chiefly austral in the East. Small local populations could be wiped out by urbanization or exploitation of sand pits for construction material.

Author: Paul A. Opler.

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9. SQUASH BUG *Chelinidea vittiger* Uhler

Phylum: Arthropoda
Class: Insecta

Order: Hemiptera
Family: Coreidae

Status: *Special Concern.* Status in Virginia is very poorly known. Only one firm record for Fairfax County has not been repeated in recent decades.

Remarks: The species occurs only on prickly pear cactus, but is very spotty and not all cactus colonies have the bug. Existing colonies could easily be extirpated by "clean-up" during agricultural practices, along highway right-of-ways, etc. Extensive fieldwork needed to establish actual present status of the species.

Author: Paul A. Opler.

10. GROUND BEETLE *Sphaeroderus schauini shenandoah* Barr

Phylum: Arthropoda Order: Coleoptera
Class: Insecta Family: Carabidae

Status: *Special Concern.*

Remarks: This snail-eating beetle is a relict in Virginia, known only from two sites on the Blue Ridge (Stony Man Mountain and Apple Orchard Mountain). The first is secure in the Shenandoah National Park, the second less so, and the immediate vicinity of the only known find has been, and still is, subject to clear-cutting by the Jefferson National Forest. A formal petition was submitted to that agency several years ago, asking that an area on Apple Orchard Mountain be spared further disturbance. This same site is the southern-most known locality for the sub-boreal millipede *Semtonellus placidus* (also restricted to the Blue Ridge in Virginia).

Author: Paul A. Opler.

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11. DIPLURAN *Plusiocampa* sp. A, undescribed species

Phylum: Arthropoda Order: Diplura
Class: Insecta Family: Campodeidae

Description: The only *Plusiocampa* known from this particular area; the genus can be distinguished by unequally sized claws with slender, smooth pretarsal setae. This species has latero-tergal crests on the claws and lacks medial anterior macrochaetae on the abdominal tergites. Similar to *Plusiocampa cookei* (Packard), but has posterior macrochaetae on tergites II-III.

Present Range: Known from two caves in Rye Cove, Scott County, Virginia (Ferguson, 1971; 1973).

Distribution in Virginia: Same as Present Range - see Figure 12.

Habitat and Mode of Life: Hypogean. Inhabits caves, particularly the silt and mud banks of underground streams. Feeds on detritus, fungi, and small arthropods.

Reproduction: Little known. Insemination occurs by females picking up stalked spermatophores placed at random on the substratum by the males. One species (*Campodea remyi*) known to suspend four to nine large eggs from a stalk in a brood chamber within the soil. Number of instars unknown. Young similar in appearance to adults.

Number in Captivity: None.

Status: *Special Concern.* Exists in only one small geographic area, and its existence may become *Endangered* due to the destruction or drastic modification of its habitat. Population apparently large. Living males and females of *Plusiocampa* sp. B have been maintained by the author for approximately one year on two occasions. No young appeared during these intervals in captivity.

Protective Measures Proposed: None at present.

Remarks: Also called two-pronged bristletails, twin-tails, and forktails. Possibly a major component of the ecosystem in caves of this area.

Author: Lynn M. Ferguson.

12. DIPLURAN

Plusiocampa sp. B ssp. A, undescribed species and subspeciesPhylum: Arthropoda
Class: InsectaOrder: Diplura
Family: Campodeidae

Description: The only *Plusiocampa* known from this particular area; the genus can be distinguished by unequally-sized claws with slender, smooth pretarsal setae. This species is without latero-tergal crests on the claws, males are without glandular hairs on the posterior border of abdominal sternite I, and the medial anterior macrochaetae of the abdomen are not reaching, or barely reaching, the posterior border of the tergites. Similar to *Plusiocampa fieldingi* Condé, but lacks medial anterior and medial posterior macrochaetae on tergites VIII-IX, respectively.

Present Range: Known from caves in Wards Cove, Tazewell County, Virginia.

Distribution in Virginia: Same as Present Range - see Figure 12.

Habitat and Mode of Life: Hypogean. Inhabits caves, particularly the silt and mud banks of underground streams. Feeds on detritus, fungi, and small arthropods.

Reproduction: Same as for *Plusiocampa* sp. A.

Number in Captivity: None.

Status: *Special Concern.* Populations appear to be very small; otherwise same as for *Plusiocampa* sp. A.

Protective Measures Proposed: None at present.

Remarks: *Plusiocampa* sp. B is known from 10 caves in Virginia and one cave in West Virginia. The caves are located in the valleys between Walker Mountain and Copper Ridge or Big Stone Ridge. Subspecific rank uncertain; this form from Scott County may represent a distinct species within a larger species group. Further investigation needed.

Author: Lynn M. Ferguson.

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13. DIPLURAN

Plusiocampa sp. B ssp. B, undescribed species and subspeciesPhylum: Arthropoda
Class: InsectaOrder: Diplura
Family: Campodeidae

Description: The only *Plusiocampa* known from this particular area; the genus can be distinguished by the unequally-sized claws with slender, smooth pretarsal setae. This species is without latero-tergal crests on the claws, males with glandular hairs on the posterior border of abdominal sternite I, and the medial anterior macrochaetae of abdomen never reach the posterior border of the tergites. Similar to *Plusiocampa fieldingi* Condé, but lacks medial anterior and medial posterior macrochaetae on tergites VIII-IX, respectively.

Present Range: Known from caves in Wards Cove, Tazewell County, Virginia.

Distribution in Virginia: Same as Present Range - see Figure 12.

Habitat and Mode of Life: Same as for *Plusiocampa* sp. A.

Reproduction: Same as for *Plusiocampa* sp. A.

Number in Captivity: Approximately 10; being used in an electrophoretic analysis of genetic variation.

Status: *Special Concern.* Some populations are very large. Exists in only one small geographic area, and its existence may become *Endangered* due to the destruction or drastic modification of its habitat. Living males and females of this form have been maintained by the author for approximately one year on two occasions. No young appeared during these intervals in captivity.

Protective Measures Proposed: None at present.

Remarks: Same as for *Plusiocampa* sp. B. ssp. A. Subspecific rank uncertain; this form from Tazewell County may represent a distinct species within a larger species group. Further investigation underway. Also a major component of the ecosystem in caves of this area.

Author: Lynn M. Ferguson.

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14. DIPLURAN

Plusiocampa sp. B ssp. C, undescribed species and subspecies

Phylum: Arthropoda
Class: Insecta

Order: Diplura
Family: Campodeidae

Description: The only *Plusiocampa* known from this particular area; the genus can be distinguished by unequally-sized claws with slender, smooth pre-tarsal setae. This species is without latero-tergal crests on the claws, males are without glandular hairs on the posterior border of abdominal sternite I, and the medial anterior macrochaetae of abdomen always extend beyond the posterior border of the tergites. Similar to *Plusiocampa fieldingi* Condé, but lacks medial anterior and medial posterior macrochaetae on tergites VIII-IX, respectively.

Present Range: Known from two caves in Burkes Garden, Tazewell County, Virginia.

Distribution in Virginia: Same as Present Range - see Figure 12.

Habitat and Mode of Life: Same as for *Plusiocampa* sp. A.

Reproduction: Same as for *Plusiocampa* sp. A.

Number in Captivity: Approximately 10; being used in an electrophoretic analysis of genetic variation.

Status: *Special Concern.* Exists in only one small geographic area and its existence may become *Endangered* due to the destruction or drastic modification of its habitat. One population large. Living males and females of this form have been maintained by the author for approximately one year. No young appeared during this interval in captivity.

Protective Measures Proposed: None at present.

Remarks: Same as for *Plusiocampa* sp. B ssp. A. Subspecific rank uncertain; this form from Tazewell County may represent a distinct species within a larger species group. Further investigation underway. Also a major component of the ecosystem in caves of this area.

Author: Lynn M. Ferguson.

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15. DIPLURAN

Plusiocampa sp. C, undescribed species

Phylum: Arthropoda
Class: Insecta

Order: Diplura
Family: Campodeidae

Description: The only *Plusiocampa* known from this particular area; the genus can be distinguished by the unequally-sized claws with slender, smooth pre-tarsal setae. This species is without latero-tergal crests on the claws and lacks dorsal macrochaetae on femur III. Similar to *Plusiocampa fieldingi* Condé except for the above.

Present Range: Known from four caves, one each in Smyth, Wythe, Pulaski, and Montgomery counties.

Distribution in Virginia: Same as Present Range - see Figure 12.

Habitat and Mode of Life: Same as for *Plusiocampa* sp. A.

Reproduction: Same as for *Plusiocampa* sp. A.

Number in captivity: None.

Status: *Special Concern*. Known from only a few locations. Not enough material is presently available to check for geographic variation within species. Three populations appear to be quite small, the fourth moderate in size. All but one of the caves are small (few hundred feet long). The longest has a length of about 1 mile, but only two diplurans have been collected here. The population in Vicker Road Cave in Montgomery County is in a unique location for the species, east of New River -- it might represent a distinct subspecies. This cave is located in an area near Blacksburg which is experiencing a housing boom. The construction of a new road has placed the cave within range of this housing development. The population in James Cave in Pulaski County is near the city of Radford and also subject to the effects of urbanization.

Protective Measures Proposed: None at present.

Remarks: The caves inhabited by *Plusiocampa* sp. C are located in the valleys between Walker Mountain and the western Blue Ridge Mountains (Iron Mountain and others). A closely related species is known from caves in eastern Tennessee; it is not known if the range of *Plusiocampa* sp. C extends into Tennessee.

Author: Lynn M. Ferguson.

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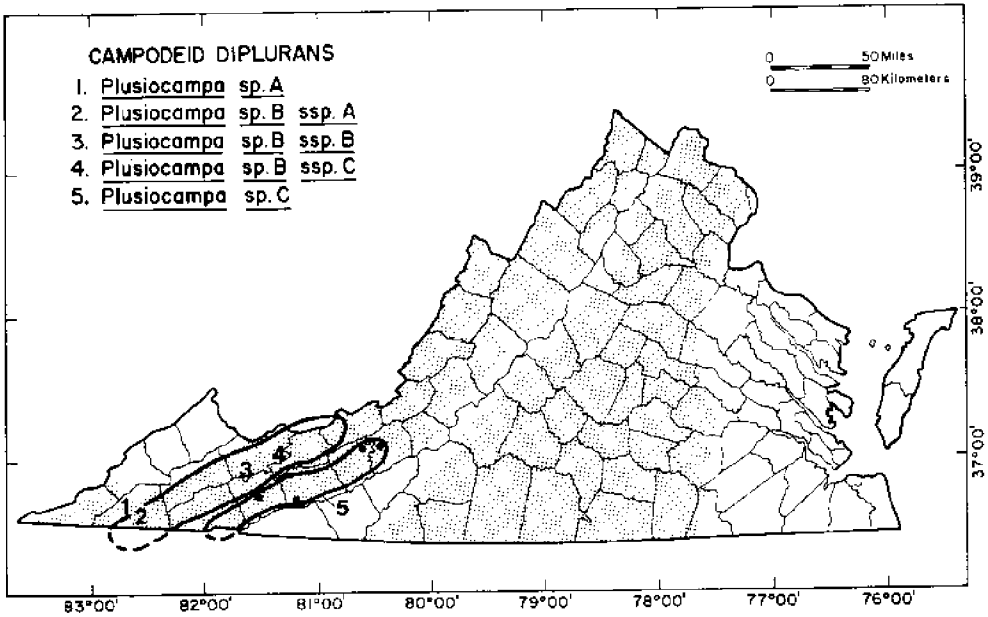


Figure 12. Distribution of *Plusiocampa* in Virginia

STATUS UNDETERMINED (1)

LEAF-MINING MOTH

Tischeria perplexa Braun

Phylum: Arthropoda
Class: Insecta

Order: Lepidoptera
Family: Tischeriidae

Status: *Undetermined.*

Remarks: Described from and known only from Falls Church, Fairfax County. This small leaf-mining moth fed on American chestnut (*Castanea dentata*). If the moth is still extant and is a chestnut specialist, it is probably in extreme jeopardy due to the reduction of its host due to chestnut blight.

Author: Paul A. Opler.

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RECENTLY EXTINCT OR EXTIRPATED (1)

CLEAR-WING MOTH

Synanthedon castaneae (Busck)

Phylum: Arthropoda
Class: Insecta

Order: Lepidoptera
Family: Sesiidae

Status: *Recently Extinct or Extirpated.*

Remarks: This clear-wing moth once ranged from southern New York and Pennsylvania south through the Appalachians and Piedmont to South Carolina. This moth fed only on American chestnut (*Castanea dentata*), mature trees of which were largely destroyed by chestnut blight fungus (*Endothia parasitica*) during the early portion of the present century. Although known only from Falls Church, Fairfax County in Virginia, the species probably occurred wherever its host was found. The last specimen in Virginia was collected in 1914, while the species was recorded as late as 1936 in South Carolina. Recent intensive sampling effort utilizing sesiid pheromone have failed to recover any individuals of *Synanthedon castaneae*.

Author: Paul A. Opler.

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SUBTERRANEAN FRESHWATER PLANARIANS (ORDER SERIATA)

John R. Holsinger

Introduction

Four species of eyeless, unpigmented planarians or flatworms are considered in this report. All are members of the triclad family Kenkiidae. Two species are known only from caves in western and southwestern Virginia; the other two species are recorded from a single walled spring in Fairfax County.

SPECIES ACCOUNTS

ENDANGERED (3)

1. BIGGERS' GROUNDWATER PLANARIAN

Sphalloplana subtilis Kenk

Phylum: Platyhelminthes
Class: Turbellaria

Order: Seriata
Family: Kenkiidae

Description: Eyeless, unpigmented planarian, distinguished by the description, figures and photograph given by Kenk (1977). Length up to 16 millimeters.

Present Range: This species is known only from a walled spring on the property formerly owned by J. W. Biggers at 6278 Edsall Road, Fairfax County, Virginia. (See Figure 1 and also Figures 27-28 in Kenk, 1977.)

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: This species inhabits shallow groundwater that comes to the surface by way of a small spring. The spring basin is enclosed by a brick structure with a removable concrete cover. The spring is also inhabited by another planarian, *Sphalloplana holsingeri* (discussed below). *Sphalloplana subtilis* is a highly specialized, phreatobitic species (*i.e.*, restricted to subterranean groundwater) whose relatives typically occur in caves farther west in the Appalachians and Interior Low Plateaus.

Reproduction: Three sexually mature specimens were collected between 18 March and 12 August 1973.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution.

Status: *Endangered*. This rare, highly localized endemic is known only from a single spring in an area that will soon be developed for housing. The extinction of this unusual species through the destruction of its habitat will almost certainly result if protective measures are not carried out immediately.

Protective Measures Proposed: In order to preserve the spring habitat of this species, it is recommended that the spring and a part of the groundwater recharge area be maintained in its present natural condition.

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2. HOLSINGER'S GROUNDWATER PLANARIAN

Sphalloplana holsingeri Kenk

Phylum: Platyhelminthes
Class: Turbellaria

Order: Seriata
Family: Kenkiidae

Description: Eyeless, unpigmented planarian, distinguished by the description given by Kenk (1977). Length up to 15 millimeters.

Present Range: This species is known only from a walled spring on the property formerly owned by J. W. Biggers at 6278 Edsall Road, Fairfax County, Virginia (Figure 1) (also Figures 27-38 in Kenk, 1977).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: This species inhabits shallow groundwater that comes to the surface by way of a small spring. The spring basin is enclosed by a brick structure with a removable concrete cover. The spring is also inhabited by another planarian, *Sphalloplana subtilis* (discussed above). *Sphalloplana holsingeri* is a highly specialized, phreatobitic species (*i.e.*, restricted to subterranean groundwater) whose relatives typically occur in caves farther west in the Appalachians and Interior Low Plateaus.

Reproduction: Sexually mature specimens have been collected from the type locality.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution.

Status: *Endangered*. This rare, highly localized endemic is known only from a single spring in an area that will soon be developed for housing. The extinction of this unusual species through the destruction of its habitat will almost certainly result if protective measures are not carried out immediately.

Protective Measures Proposed: In order to preserve the spring habitat of this species, it is recommended that the spring and the surrounding groundwater recharge area be maintained in its present natural condition.

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3. ROCKBRIDGE COUNTY CAVE PLANARIAN

Sphalloplana virginiana Hyman

Phylum: Platyhelminthes
 Class: Turbellaria

Order: Seriata
 Family: Kenkiidae

Description: Eyeless, unpigmented planarian distinguished by the description of Hyman (1945) and the redescription of Kenk (1977). Length up to 12.0 millimeters.

Present Range: This species is known only from its type-locality, Showalter's Cave, 2.2 miles southwest of the center of Lexington in Rockbridge County, Virginia (Figure 1).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: This species is a troglobite (*i.e.*, obligatory cavernicole) and has been collected from the mud substrate and pieces of wood debris in a pool fed by groundwater seepage in the type-locality.

Reproduction: Sexually mature specimens were apparently collected in October, 1943.

Number in Captivity: Preserved specimens are in the collections of the American Museum of Natural History and Smithsonian Institution.

Status: *Endangered*. Showalter's Cave is a small, shallow cave located just east of Route 251 and only 0.7 mile from the city limits of Lexington, Virginia. If not protected, the cave and its associated groundwater will almost certainly be adversely affected by urban growth in the near future. *Sphalloplana virginiana* is apparently an extremely rare, highly localized endemic. Although searched for rather thoroughly in other caves of Rockbridge County, to date this species has not been found outside of its type locality. Moreover, despite a number of visits by biologists to Showalter's Cave in the past 16 years, the species has not been seen there since the spring of 1961 when a few specimens were observed in a temporary mud-bottom pool at the bottom of a sump. There are no protective measures in effect at present.

Protective Measures Proposed: Showalter's Cave and surrounding groundwater recharge area should be set aside and permanently protected as a nature preserve. In addition to being inhabited by a rare planarian, the cave contains troglobitic isopod crustaceans (*Caecidotea prioei*), amphipod crustaceans (*Stygobromus baroodyi*) and beetles (undescribed species of *Pseudonophthalmus*).

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SPECIAL CONCERN (1)

POWELL VALLEY CAVE PLANARIAN

Sphalloplana consimilis KenkPhylum: Platyhelminthes
Class: TurbellariaOrder: Seriata
Family: Kenkiidae

Description: Eyeless, unpigmented planarian, distinguished by the description, figures and photograph given by Kenk (1977). Length up to 14.0 millimeters.

Present Range: This species is recorded from five caves in central Lee County, Virginia, and one cave in neighboring Claiborne County, Tennessee (Figure 1) (also list of cave localities in Kenk, 1977).

Distribution in Virginia: See Present Range.

Habitat and Mode of Life: This species is a troglobite (*i.e.*, obligatory cavernicole) and has been collected from the gravel substrate of small cave streams and from mud-bottom drip and seep pools.

Reproduction: Sexually mature specimens have been collected from several caves.

Number in Captivity: Preserved specimens are in the collections of the Smithsonian Institution.

Status: *Special Concern.* This species is apparently restricted to cave habitats in a part of the Powell Valley, and although occasionally sporadically abundant in a given cave, it is not common throughout its limited range. Most of the caves inhabited by this species are potentially vulnerable to groundwater pollution. No protective measures are in effect at present.

Protective Measures Proposed: Further research is needed to learn more about the population dynamics of this species. Several caves with representative populations should be permanently protected from pollution and destruction.

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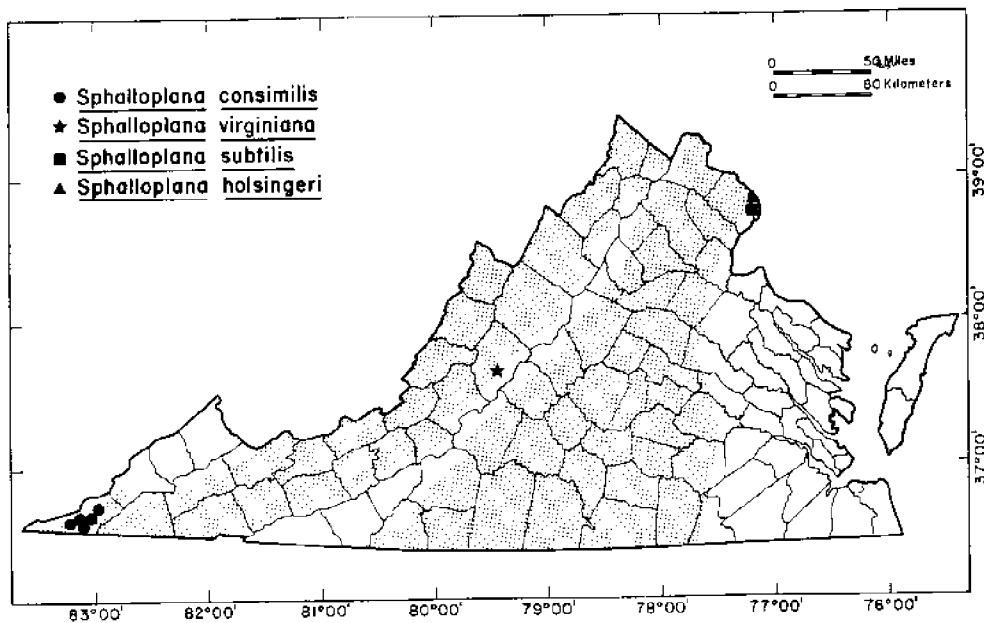


Figure 1. Distribution of *Sphalloplana subtilis*, *Sphalloplana holsinger*, *Sphalloplana virginiana*, and *Sphalloplana consimilis* in Virginia

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MARINE INVERTEBRATES

Marvin L. Wass

Introduction

Marvin L. Wass and Jay D. Andrews

Virginia and Maryland are favored with the largest estuary in the United States--the Chesapeake Bay. The Bay is 289 kilometers (173 miles) long and 47.6 kilometers (28.6 miles) wide near Smith Point. The estuary is relatively shallow, with an average depth of 8.05 meters (26.4 feet) and a maximum depth of 53 meters (174 feet) at Blood Point Light in Maryland. The greatest depth in Virginia is near Smith Point: 44 meters (144 feet) (Wolman, 1968). While this deep hole has probably never been sampled for benthos, many rare species have been collected in an area just south of Smith Point (Figure 1).

Several environmental parameters affect Bay species. Most of the freshwater input comes from montane and Piedmont areas to the north and west. The Susquehanna supplies 51% of the input, the Potomac 18%, the James 14%, the Rappahannock 4% and the York 2%, leaving 10% from lesser sources, such as the Piankatank, Patuxent and Eastern Shore. The rivers typically have a sill at the mouth, behind which anaerobic conditions often occur in summer. Fine sediments are deposited in the freshwater and oligohaline reaches of the rivers tributary to the Bay, except when catastrophic rains produce excess sediments, mainly along the western shore.

Chesapeake Bay lies in a temperate zone but has a severe continental climate. Seasonal water temperature fluctuate from very cold in winter (-1°C or 30°F) to very warm in summer (30°C or 90°F) in some years. Ice is formed in the upper sector of rivers during most years and sometimes freezes over the upper Bay and lower zones of rivers (*e.g.*, 1917-18 and 1976-77). Seasonal fluctuations in the Bay exceed the 20°C spread found in the ocean along the mid-Atlantic coast.

Average precipitation is well distributed seasonally with about 4 inches in each warm month and 3 inches in cold months. However, in reality it is frequently distributed irregularly to provide wet and dry seasons or years, and this situation is accentuated by tropical storms or hurricanes. River run-off is greatest in late winter and spring, with low flows in fall. Average annual freshwater inflows have ranged from rates of 49,000 cubic feet per second in 1965 to 132,800 cubic feet per second in 1972, the latter augmented by Tropical Storm Agnes.

Salinities follow run-off patterns with lowest values in spring (April-May) and highest in fall. An annual range of salinities from 10 to 15 parts per thousand and up to 5 parts per thousand daily in tidal cycles is typical of many areas of Chesapeake Bay waters (Andrews, 1973). These wide fluctuations of salinities at any one site tend to make values of 10 parts per thousand and 25 parts per thousand critical for survival of mesohaline and polyhaline species, respectively. In the authors' opinion the Venice System (Anonymous, 1958) does not fit observed distributions well in Chesapeake Bay. In dry years, for example, the salt wedge in the James River may reach Hopewell, with opportunistic species following the salty waters upriver in the warm season. The cold season brings fresh water downstream well below Jamestown to mile 20 or lower, and only very tolerant species or those tolerant of microaerophilic or anaerobic conditions survive. Tides and winds combine to mix waters of varying temperatures and salinities in the shallow rivers and to redistribute nutrients and silt. Much suspended material in the freshwater run-off is precipitated at the juncture with salty waters, necessitating regular dredging of channels.

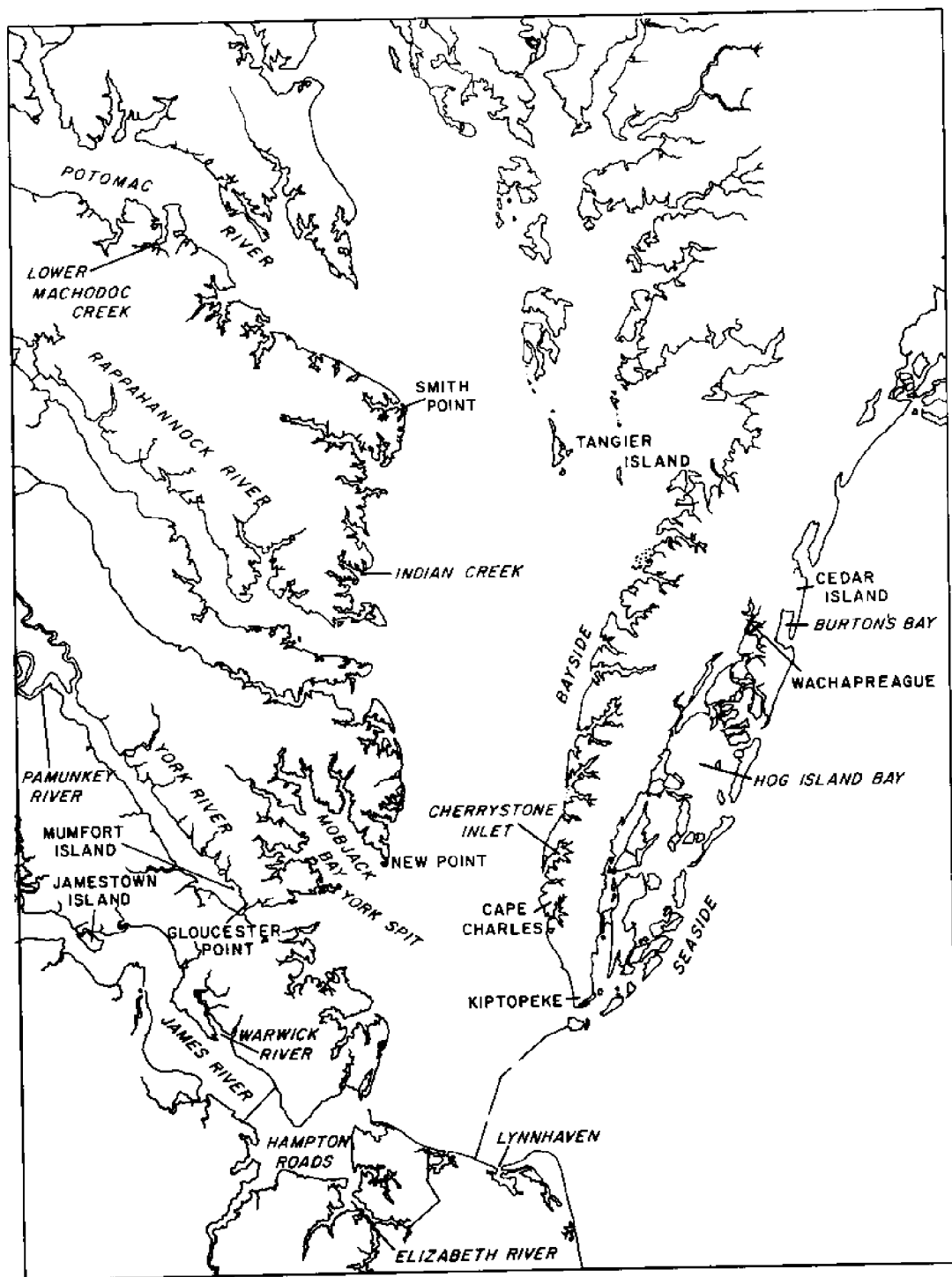


Figure 1. Areas mentioned in species accounts.

Invertebrate Strategies for Reproduction and Distribution

Benthic invertebrates populate estuaries, marshes and beaches by asexual and sexual means, with pelagic and non-pelagic larvae being produced. Roughly two-thirds of benthic temperate species have planktonic larvae (Carriker, 1967). Many of the macrobenthic estuarine species produce abundant larvae which spend one to several weeks in the plankton, depending on temperatures and finding suitable settling sites. This contrasts with lecithotrophic (high yolk content) larvae which remain in the oceanic plankton for up to four months and may thus be carried by currents for long distances before metamorphosing (Scheltema, 1968).

Eelgrass beds favor non-planktonic "crawl-away" larvae by having suitable substrates available, but some species may require years to recolonize habitats disturbed by catastrophes such as the "Agnes" disaster.

Larvae of Chesapeake Bay species may derive from two general sources, the ocean and the Bay. From the ocean, two prominent boreal species -- the barnacle, *Balanus balanoides*, and the blue mussel, *Mytilus edulis* -- set sparsely in lower Chesapeake Bay, and have reached Beaufort, North Carolina in winter but rarely produce significant populations. *Mytilus* occasionally reaches Gloucester Point when cool temperatures and high salinities prevail. Occasionally, it sets heavily on oysters and blue crabs at the Bay mouth. Among warm-water species, Chanley (1969) showed that the coquina clam, *Donax variabilis*, repopulates the Eastern Shore beaches from Virginia Beach to Long Island every summer.

Regular visitors to Chesapeake Bay waters include several species of decapod crustaceans in autumn: four penaeid shrimps enter the Bay and two portunid crabs explore seaside bays. These are warm temperate strays. Two canceroid boreal crabs (genus *Cancer*) move south and inshore to the Bay mouth in winter in high-salinity waters. The Portuguese man-o-war occasionally reaches the Virginia coast in autumn, along with *Glaucus atlantica*, a striking, blue-striped nudibranch. Many pelagic species occur seasonally in the Bay, particularly cladocerans and chaetognaths. Over 90% of the fishes known from Chesapeake Bay are seasonal and mostly of southern origin.

Eelgrass Beds

Most vulnerable and fascinating of Bay ecosystems is that of the eelgrass (*Zostera*) community (Marsh, 1976). Eelgrass is boreal, beginning its annual growth in spring and reaching a vegetative peak in June, after which the grass soon exfoliates, leaving the turions to produce a new crop.

Although faunistically poor by comparison with coral reefs, the eelgrass system has many more species than can be found in any comparable area elsewhere in the Bay. A few dominant species comprise most of the individuals, but these vary greatly in abundance with water depth and season.

Zostera has exhibited several periods of general or localized declines. Many scientists believe that the circumboreal die-off of *Zostera* in the early 1930's was due to a plant disease (Renn, 1936). Some investigators now think climatic warming may have been a more important cause. There appears to be some correlation with sunspot activity that produces warm periods (Rasmussen, 1973). The demise of the grass following "Agnes" in June, 1972, was certainly due in part to lowered salinity and oxygen levels. Subsequent die-backs in 1973-76, however, presumably were due to another cause. The sudden return of colder winters in 1976-1977 has not permitted increases of *Zostera* in Chesapeake Bay. An immediate return cannot be expected -- it took over 15 years after the 1932 die-off for eelgrass to start increasing (Figure 2).

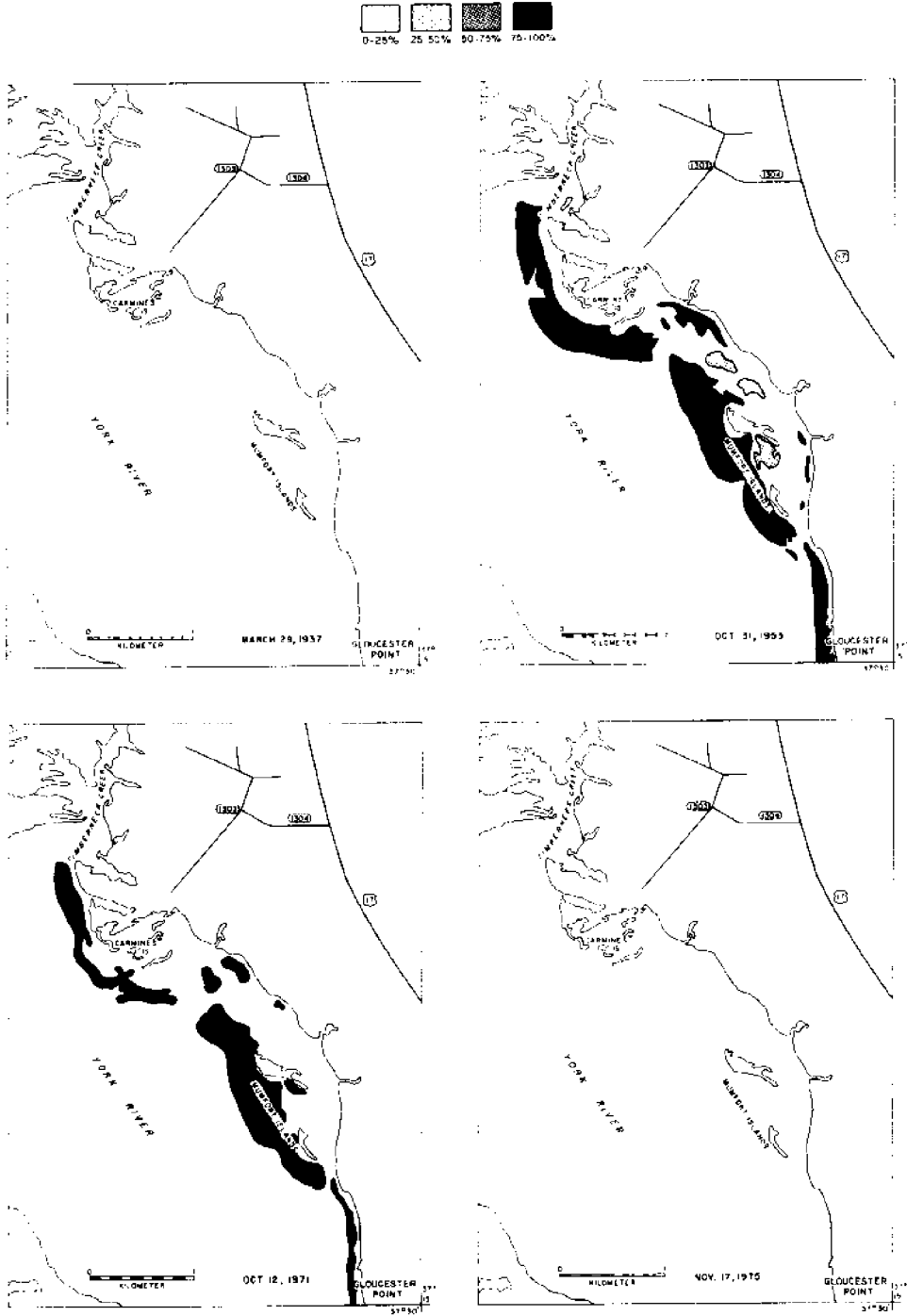


Figure 2. Changes in eelgrass distribution in the York River, 1937-1975.

Marsh (1973) did his classic study of eelgrass epifauna at Mumfort Island (Figure 1), one mile above the York River Bridge. This study covered a 14-month period during 1969-70. Marsh found 112 species, 100 of which resided on the grass without consuming it. Eelgrass beds likely serve invertebrates by acting as current traps to catch larvae and food organisms, thus providing a dense "forest" habitat for survival of early stage invertebrates. By 1973, the eelgrass had disappeared from this site (Orth, pers. comm.), and Marsh (pers. comm.) found none in 1978.

The 1932-33 eelgrass decline decimated the scallop industry in Chesapeake Bay and in the Eastern Shore seaside bays. The scallop depended on eelgrass for setting of larvae and protection. Scallops have been planted in these areas, but without the grass beds, to little avail.

Marsh (1973) and Orth (1973) speculated that three genera, in addition to the scallops, were largely or obligatorily associated with eelgrass: *Diastoma* (*Bittium*), *Crepidula* and *Paracercaris*. These evaluations are supported by the near obliteration of these species during the early 1970's in areas where eelgrass disappeared, such as the York River, Virginia (Orth, 1976). Recruitment of these species into new eelgrass beds is hampered by limited dispersal mechanisms from populations in remote grass beds, since they produce benthic "crawl-away" larvae.

Various motile species, including juvenile fish, depend on eelgrass for protection during part of their life cycle. *Zostera* also provides cover for many small fishes such as seahorses, pipefish and sticklebacks, as well as large invertebrates including blue crabs that shed and mate there.

Problems other than temperature, disease and low salinity confront the eelgrass beds. Beginning in 1973, cownosed rays invaded the remaining *Zostera* beds to feed on the soft clam, *Mya*, and caused significant destruction of the beds. The resident oyster toadfish, *Opsanus*, dig under grass beds for shelter, depositing their eggs on the roofs of their burrows (Orth, 1975).

Waterfowl depend heavily on eelgrass for winter food. Now, the grass is so depleted that several species of diving ducks have decreased in the Bay, although they have increased in other areas.

Commercial Aspects of Depletion

Three bivalves -- the Virginia oyster (*Crassostrea virginica*), the hard clam (*Mercenaria mercenaria*), and the surf clam (*Spisula solidissima*) -- are considered in this work, in accordance with the North Carolina symposium report (Schwartz *et al.*, 1977) which listed alosid fishes as *Depleted*. Of these molluscs, the Virginia oyster has been the commercial mainstay of invertebrate seafoods in Chesapeake Bay throughout history. The oyster maintains its position by the aid of man to a great extent, since seed has long been moved between rivers. A large oyster may produce 50 million eggs per year, but few larvae survive to set. If spatfall is one in a thousand, the year class is at once beset by predators and, later, diseases. Boring snails (*Urosalpinx* and *Eupleura*) and oyster leeches (*Stylochus*) destroy most spat. Later, *Boccardia hamata* and *Polydora websteri* invade the shells and boring sponges fragment older valves. In spring, *Polydora ligni* may smother oyster spat by accreting silt. Finally, the diseases caused by *Perkinsia marinus* (= *Dermocystidium marinum*) and *Minchinia* spp. infect oysters and later kill them.

Hard clams (*Mercenaria*) occupy a wider range of substrates in the Bay than oysters do, but in most areas they occur in numbers too low for commercial production. Recruitment is better in Eastern Shore bays, and mariculture for the quahog has begun there. Relatively easy hatchery culture and the use of coarse aggregate enhances survival of this clam. Conchs appear to be the main predator on

seaside (John Kraeuter, pers. comm.), whereas blue crab and demersal fishes devastate clams in the Bay and rivers (Virstein, 1977). Nevertheless, *Mercenaria* that attain a size of 2 to 3 inches have low death rates and may live to an age of 25 years.

Hard clam mariculture cannot come too soon, since surf clams are being over-exploited offshore. The fishery for this large oceanic clam was once centered off New England. Offshore Virginia is now the southern limit of its range and within a few years it has been depleted to the extent that harvesting restrictions have been imposed. It is normally scarce at the Bay mouth.

Soft clams (*Mya*), along with hard clams, constitute an important recreational resource in Chesapeake Bay. They grow quickly, breed in spring and fall, and seldom fail to produce a set. They are commercially utilized from Maryland to Maine. Crabs may be their worst enemy, although fish consume the young and later nibble siphons.

Three species of large conchs (*Busycon*) are taken for marketing in the New York area. Since adults are 90% females in Virginia and North Carolina and require about 8 years to mature (John Kraeuter, pers. comm.), it seems obvious that a fishery will not last long. The winter crab-dredging fishery has always taken some. Conchs are bivalve predators that feed largely on hard clams.

Other potential food species from the Bay and marshes are the ribbed mussel (*Geukensia demissus*) and the periwinkle (*Littorina*). Two recently arrived species in Virginia, living mainly in the oligohaline sector of the James River, are *Rangia cuneata* and *Corbicula manilensis*, which dominate the biomass in their habitats.

Still other uses of invertebrates are made by man. Bloodworms (*Glycera*) and squid are taken in small numbers in Virginia, but are mostly imported. Also, any sizable bivalve provides bait for sport fishing. Finally, the ancient (*Limulus*) is regularly bled. Its serum being superior for some biochemical studies to that of the rabbit.

Natural Catastrophes

"Red tides" of diatoms and/or dinoflagellates occur frequently in the Bay, with severe outbreaks having been recorded in the mid-60's, a dry period. The vernal blooms are typically composed of diatoms, whereas dinoflagellates dominate late summer blooms. Spring blooms stimulate zooplankton and provide abundant food for oysters, whereas warm water blooms inhibit many species, particularly filter feeders.

Most Chesapeake invertebrates seem well adapted to normal weather changes but not to the extremes produced by tropical storms or hurricane rains. While coastal winter and spring storms cause havoc to beach residents and early nesting birds, it is the "tropical storm" deluges of rain which more seriously affect invertebrates. In August 1969, "Camille" destroyed thousands of bushels of oysters by lowering salinity and oxygen. Three years later "Agnes" crossed Virginia with heavy rains peaking on June 23, 1972 (Schubel, 1976). "Agnes" caused the greatest flood on record in Chesapeake Bay by dumping 31 million metric tons of clay and silt into the upper Bay. Even the Rappahannock received a million tons of soil, 98% of it remaining in the river (Nichols *et al.*, 1976). While most of the sediment stayed in tributaries and the upper Bay, fresh water -- mainly from the Susquehanna -- kept sea water from entering Chesapeake Bay significantly for almost a month. This caused both salinity and dissolved oxygen to be too low for many invertebrates.

Introduction of Exotic Species

Another insidious threat to Virginia waters is the introduction of exotic (foreign) species. While several of our East Coast species have been transplanted

to Europe and to our West Coast, we have been the recipient of only a few exotic transplants. Some exotics have become exceptionally abundant in Virginia in the past two decades: the wedge clam, *Rangia cuneata*; the Manila clam, *Corbicula manilensis*; and the parasitic sacculinid barnacle, *Loxothylacus panopei*, in mud crabs. Many believe that *Rangia* was endemic to the southeast Atlantic coast, but its explosive appearance, where none were seen before Harry Wells (1961) noted them, belies the relict tenet. More likely, once the clams reached the Atlantic coast from the Gulf, fishermen using them for bait soon extended their range. The Asiatic *Corbicula* took decades to cross the continent and it now dominates the tidal freshwater rivers to the joy of muskrats, gulls and Waltonians.

Microbial exotics are not so readily observed. Oyster diseases produce the most severe effects (Andrews, 1968), being responsible for a sustained long-term decline of the industry in higher salinities. Less disastrous than the oyster diseases was the introduction (Van Engel *et al.*, 1966) of a parasitic barnacle (sacculinid) which presumably entered from the Gulf of Mexico with Louisiana oysters brought into Virginia. It soon decimated the populations of two species of mud crabs. One, *Eurypanopeus depressus*, is particularly threatened because its salinity tolerance encompasses the entire range of the parasite. Once the most abundant of the five xanthid crabs in the Bay, this mud crab perhaps now exists in only 10% of its former numbers. *Rhithropanopeus harrisi* survives by living in waters fresher than those tolerated by the parasite.

Effects of Pollution

The Virginia Institute of Marine Science has been observing the Bay fauna for only 38 years, yet conspicuous changes in occurrence and abundance of fauna have been noted. Regular harmful dinoflagellate blooms occur every year, particularly in April-early May and July-August. Indeed, it is now apparent that some species of dinoflagellates inhibit oyster feeding (Andrews, pers. comm.) for periods up to six weeks.

In many cases one can only document changes, without knowing the causative factors. Benthic invertebrates sampled during 1960-66 off Gloucester Point, Virginia, comprised a diverse assemblage, which in the late 1960's underwent a reduction in diversity and a dramatic change in dominant species (Boesch *et al.*, 1976). Pristine environments in Chesapeake Bay no longer exist if, for example, one considers the fate of the bay scallops and sturgeons. Nevertheless, many environments still support numerous species.

The decrease of certain species may allow others to dominate. The York and other rivers typically have fine black mud smelling strongly of sulfides in deeper waters in summer. In recent years, channel muds have often produced no benthos in grab samples, whereas large holothurians, sponges and whip corals once occurred there commonly.

Inshore along the VIMS beach and shallows, large numbers of *Nassarius obsoletus* and *Nassarius vibex* abounded until 1976. Other common species were *Pagurus longicarpus* (in late summer), *Leptosynapta tenuis*, *Enoplobranchus sanguineus* and *Glycera* (bloodworms - two species). None of these have been found recently, and *Nereis succinea*, probably the most ubiquitous Bay species, has not been seen swarming in early summer or in fouling on structures. In 1976 and again in 1977, large spills of No. 6 oil fouled local beaches in late June, but studies were not conducted to demonstrate petroleum hydrocarbons as the cause of species disappearance. Soon after that spill the only benthic invertebrate found by digging near VIMS piers was the hemichordate, *Saccoglossus kowalewskii*, and no mud snails or other conspicuous invertebrates were found.

In the York River one early source of possible pollution involved heated water discharged from the Virginia Electric and Power Company's electric generating station below Yorktown (Warinner and Brehmer, 1966). The lower York also receives water from the American Oil Company refinery. In the warm water area only two benthic species were recorded, both common polychaetes taken in August when the temperature reached 35°C. This situation has since been corrected by discharging the heated water through a diffuser at a depth of 30 feet. However, there remains a conspicuous lack of eelgrass along that reach. Boesch (1975) found great differences between September-October and November-December samples, with the latter period having almost twice as many individuals but averaging only one more species. At Little Creek, lower numbers in warm months can be attributed to low dissolved oxygen levels.

In the late spring of 1973, 1974, and 1975, major fish kills in the lower James River were attributed to chlorine residuals introduced from sewage treatment plants (Bellanca and Bailey, 1977). Chlorine residuals well below levels observed during the fish kills have been shown to be toxic to oyster larvae, copepods and several fishes (Roberts *et al.*, 1975; Bender *et al.*, 1977; Roberts and Gleeson, 1978). Thus, chlorination of sewage discharges may be having subtle effects on faunal community structure in the James River.

The most serious perceived pollution now is the Kepone contamination of the James River, first recognized in 1975. There is no evidence of acute toxic effects within the James River, but various sublethal effects can be inferred. Low levels of Kepone cause a "bent back" syndrome in fishes (Couch *et al.*, 1977) similar to a pathological condition often encountered in fish from the James. Significant accumulation of Kepone in fish, oyster and crab tissues has resulted in restrictions on commercial and recreational fishing in order to protect human health. The effect of observed Kepone body burdens on the health of estuarine fauna remains to be fully elucidated. One might expect, however, significant effects on reproductive success, feeding activity, migratory patterns, and possible disease incidence, all of which ultimately affect population survival and community structure.

Explanation of Lists and Species Accounts

The Marine Invertebrates Committee has divided the affected species into six categories in order of their threatened status (Table 1). The categories and criteria for inclusion are as follows:

A. *Endangered*

1. Not seen in Virginia for 10 years.

B. *Threatened*

1. Ten or fewer specimens taken in last 10 years.
2. Species in the path of dredging or development that has limited geographic or habitat distribution. This qualification is independent of the number of individuals.

C. *Depleted*

1. Commercial species depressed from former abundance by over-harvesting.

D. *Special Concern*

1. Species not yet described.
2. Species collected on one or two occasions and species depressed by natural phenomena, commercial development, or causes unknown.
3. Species found only in Virginia or with limited geographic or habitat distributions.

E. *Status Undetermined*

1. Species about which little is known.
2. Species reported in literature but for which specimens are not extant.

F. *Recently Extinct or Extirpated*

1. Not seen since described from Virginia.
2. No longer occurs in Virginia.

Table 1. Number and Percentage of Species in Each Category

	<i>Endangered</i>	<i>Threatened</i>	<i>Special Concern</i>	<i>Undetermined</i>	<i>Depleted</i>	<i>Extirpated</i>	TOTAL
Porifera	--	--	3	1	--	--	4
Cnidaria	3	--	2	--	--	--	5
Rhynchocoela	7	2	4	2	--	--	15
Annelida	10	10	13	9	--	--	42
Oligochaeta	--	--	--	1	--	--	1
Mollusca							
Gastropoda	10	5	6	3	--	1	25
Bivalvia	2	1	8	5	3	1	20
Arthropoda							
Cladocera through Isopoda	2	1	10	5	--	--	18
Amphipoda	1	1	6	5	--	--	13
Decapoda	--	2	10	--	--	1	13
Echiurida through Chordata	1	1	6	--	--	2	10
TOTAL	36	23	68	31	3	5	166
<i>Percentage</i>	<i>21</i>	<i>14</i>	<i>41</i>	<i>20</i>	<i>1</i>	<i>2</i>	<i>100</i>

Endangered species logically should come first, although from a jaundiced viewpoint and with the passage of time these species may have little relevance to man's gustatory desires. Most of the *Endangered* species are small, but at least one, the bay scallop, once supported a thriving fishery on the Eastern Shore of Virginia. The bay scallop has now been extirpated from the Bay for 45 years.

Only 23 species are listed as *Threatened*. Further investigations now being done in the Bay may clarify the status of the listed species or at least put them in a category of less concern as more collections are made. Some *Threatened* species may become *Endangered* if large-scale dredging for channels and spoil deposition continues. Fortunately, many of these altered areas have been investigated during the past decade.

Special Concern is the largest category because it has so many avenues of entry (Table 2). Several large or conspicuous species have been included because they can no longer be found near VIMS. Two common species, the wharf isopod, *Ligia exotica*, and the common hermit crab, *Pagurus longicarpus*, returned in August, 1978, but only as juveniles. However, most of those included are "refugees" from *Zostera* beds. Many more were apparently affected in the late 1960's by low dissolved oxygen levels or other deleterious factors. Later, the "Agnes" storm reduced many species and the warm, wet years following prevented reestablishment of the populations of many species.

The *Status Undetermined* category contains 31 species, 9 of which are polychaetes. A great many polychaete species (at least 115) occur in Chesapeake Bay or in seaside bays. Many of these are minute, ranging down to meiofaunal (0.5 millimeters) size, and numerous others obviously have very restricted habitats, so it is understandable that we know little about these highly diverse worms. Lower Chesapeake Bay should hold many surprises for meiofaunal studies. In North Carolina, Gardiner (1975) has listed 340 polychaetes, but oceanic species are included. Only within the last 18 years have many polychaetes become known from Chesapeake Bay, mainly through the work of Marian Pettibone (1963) at the National Museum of Natural History. Continued efforts should reduce the *Status Undetermined* category.

The three *Depleted* species are all bivalve molluscs. Although three common bivalves are listed, the oyster, hard clam and surf clam will never be as endangered as the bay scallop. Oysters and surf clams produce much less food than they once did, and even conchs may soon require this category. There are only five *Extirpated* species, all of which were once seemingly well-established in the Bay, but have now been absent for several years. One, the introduced sea squirt (*Ecteinascidia turbinata*) occurred at the mouth of the York River, but has not been seen for several years -- a possible victim of "Agnes."

Members of the Committee besides the authors were Donald F. Boesch, Daniel M. Dauer, Robert J. Diaz, Robert J. Orth and Anthony J. Provenzano, some of whom contributed species accounts or provided portions of the introduction. Morris H. Roberts critically reviewed the introduction and provided the information on chlorine and Kepone pollution.

Only three committee members -- Andrews, Dauer, and Wass -- were able to attend the Symposium. Individuals attending the committee meeting expressed concern about some common species now depleted. The only critical issue dealt with categorization of the chosen species. Dauer was helpful in separating *Endangered* and *Threatened* species according to elapsed time and numbers of individuals (see Criteria, p. 200).

All bivalve illustrations are from a thesis by Donna Turgeon. Gastropod drawings were produced by Prudence Huddleston, formerly at VIMS. The drawing of *Rhithropanopeus* was taken from *Marine Invertebrates of Scandinavia* by M. E. Christiansen (1969). All other illustrations were produced by the Art Department at VIMS.

Table 2. Most Probable Cause for Designation as *Special Concern Species*

	Low salinity, low oxygen	Seagrass loss	Northern limit	Oil spills; Pollution	Scarce Commensal	Southern limit	Erratic species	Development danger	Parasitism
<i>Mycale cecilia</i>	-	x	-	-	-	-	-	-	-
<i>Microciona prolifera</i>	x	-	-	-	-	-	-	-	-
<i>Craniella laminaris</i>	x	-	-	-	-	-	-	-	-
<i>Leptogorgia virgulata</i>	x	-	-	-	-	-	-	-	-
<i>Edwardsia elegans</i>	x	-	-	-	-	-	-	-	-
<i>Amphiporus ochraceus</i>	-	x	-	-	-	-	-	-	-
<i>Tetrasterma candidum</i>	-	x	-	-	-	-	-	-	-
<i>Tetrasterma elegans</i>	-	x	-	-	-	-	-	-	-
<i>Zygonemertes virescens</i>	-	x	-	-	-	-	-	-	-
<i>Arenicola cristata</i>	-	-	-	x	-	-	-	-	-
<i>Aglaophamus circeinatus</i>	-	-	-	-	-	x	-	-	-
<i>Ancistrosyllis jonesi</i>	x	-	-	-	-	-	-	-	-
<i>Brania clavata</i>	-	x	-	-	-	-	-	-	-
<i>Cirriformia grandis</i>	x	-	-	-	-	-	-	-	-
<i>Cistena gouldi</i>	x	-	-	-	-	-	-	-	-
<i>Enoplobranchus sanguineus</i>	-	-	-	x	-	-	-	-	-
<i>Eumida sanguinea</i>	-	x	-	-	-	-	-	-	-
<i>Nephtys incisa</i>	x	-	-	-	-	-	-	-	-
<i>Phyllodoce castanea</i>	-	-	x	-	-	-	-	-	-
<i>Platynereis dumerilli</i>	-	x	-	-	-	-	-	-	-
<i>Schistomeringos caeca</i>	-	-	-	-	-	x	-	-	-
<i>Scoloplos rubra</i>	-	-	x	-	-	-	-	-	-
<i>Amygdalum papyrium</i>	x	-	-	-	-	-	-	-	-
<i>Anomia simplex</i>	x	-	-	-	-	-	-	-	-
<i>Barnea truncata</i>	-	-	-	-	-	-	x	-	-
<i>Cuspidaria glypta</i>	-	-	x	-	-	-	-	-	-
<i>Noetia ponderosa</i>	x	-	-	-	-	-	-	-	-
<i>Pandora trilineata</i>	-	-	x	-	-	-	-	-	-

(continued)

	Low salinity, low oxygen	Seelgrass loss	Northern limit	Oil spills; Pollution	Scarce Commensal	Southern limit	Erratic species	Development danger	Parasitism
<i>Petricola pholadiformis</i>	-	-	-	-	-	-	-	x	-
<i>Solenya velum</i>	-	x	-	-	-	-	-	-	-
<i>Crepidula comexa</i>	-	x	-	-	-	-	-	-	-
<i>Diastoma varium</i>	-	x	-	-	-	-	-	-	-
<i>Doris verrucosa</i>	x	-	-	-	-	-	-	-	-
<i>Elysia catulus</i>	-	x	-	-	-	-	-	-	-
<i>Stiliger fuscatus</i>	-	x	-	-	-	-	-	-	-
<i>Triphora nigrocincta</i>	-	x	-	-	-	-	-	-	-
<i>Cylindroleberis mariaae</i>	x	-	-	x	-	-	-	-	-
<i>Loxoconcha impressa</i>	-	x	-	-	-	-	-	-	-
<i>Sarsiella texana</i>	x	-	-	-	-	-	-	-	-
<i>Sarsiella zostericola</i>	x	-	-	-	-	-	-	-	-
<i>Mysidopsis bigelowi</i>	-	x	-	-	-	-	-	-	-
<i>Cyclaspis varians</i>	-	x	-	-	-	-	-	-	-
<i>Edotea triloba</i>	-	x	-	-	-	-	-	-	-
<i>Erichsonella attenuata</i>	-	x	-	-	-	-	-	-	-
<i>Idotea balthica</i>	-	x	-	-	-	-	-	-	-
<i>Ligia exotica</i>	-	-	-	x	-	-	-	-	-
<i>Acanthohaustorius intermedius</i>	x	-	-	-	-	-	-	-	-
<i>Ampithoe longimana</i>	-	x	-	-	-	-	-	-	-
<i>Cerapus tubularis</i>	x	-	-	-	-	-	-	-	-
<i>Colomastix halichondriiae</i>	-	-	-	-	x	-	-	-	-
<i>Cymadusa compta</i>	-	x	-	-	-	-	-	-	-
<i>Rudilemboidea nageli</i>	-	x	-	-	-	-	-	-	-
<i>Alpheus heterochaelis</i>	-	-	x	-	-	-	-	-	-
<i>Alpheus normanni</i>	-	-	x	-	-	-	-	-	-
<i>Eurypanopeus depressus</i>	-	-	-	-	-	-	-	-	x
<i>Hippolyte pleuracantha</i>	-	x	-	-	-	-	-	-	-
<i>Lepidopa websteri</i>	-	-	x	-	-	-	-	-	-

(continued)

	Low salinity, low oxygen	Eelgrass loss	Northern limit	Oil spills; Pollution	Scarce commensal	Southern limit	Erratic species	Development danger	Parasitism
<i>Ocyrode quadrata</i>	-	-	-	-	-	-	-	x	-
<i>Pagurus longicarpus</i>	-	-	-	x	-	-	-	-	-
<i>Pinnixa retinens</i>	-	-	x	-	-	-	-	-	-
<i>Pinnotheres maculatus</i>	-	-	-	-	x	-	-	-	-
<i>Rhithropanopeus harrisi</i>	-	-	-	-	-	-	-	-	x
<i>Thalassema hartmani</i>	-	-	x	-	-	-	-	-	-
<i>Leptosynapta tenuis</i>	-	-	-	x	-	-	-	-	-
<i>Pentamera pulcherrima</i>	x	-	-	-	-	-	-	-	-
<i>Sclerodactyla briareus</i>	x	-	-	-	-	-	-	-	-
<i>Botryllus schlosseri</i>	x	-	-	-	-	-	-	-	-
<i>Perophora viridis</i>	x	-	-	-	-	-	-	-	-
TOTAL	21	24	9	6	2	2	1	2	2



Marine Invertebrates - List of Species by Categories

ENDANGERED

Phylum Cnidaria

Aiptasia eruptaurantia
Haloclava producta
Nematostella vectensis

Phylum Rhynchozoela

Amphiporus caecus
Amphiporus rubropunctus
Lineus bicolor
Lineus pallidus
Micrura rubra
Parapolia aurantiaca
Tetrastemma jeani

Phylum Annelida

Amphiduros sp.
Cabira incerta
Cossura sp.
Lysilla alba
Nereis acuminata
Nereis grayi
Orbinia ornata
Pherusa affinis
Pista maculata
Sigambra wassi

Phylum Mollusca; Gastropoda

Anachis avara
Aplysia willecoxi
Cyclostremiscus pentagonus
Diodora cayenensis
Hermaea cruciata
Melanella intermedia
Pyramidella candida
Solariorbus infraearinata
Teinostoma cryptospira
Vermicularia sp.

Phylum Mollusca; Bivalvia

Argopecten irradians
Paramya subovata

Phylum Arthropoda; Isopoda

Chiridotea caeca
Ptilanthura tenuis

Phylum Arthropoda; Amphipoda

Lembos smithi

Phylum Echiurida

"White echiurid"

THREATENED

Phylum Rhynchozoela

Lineus socialis
Tetrastemma vermiculus

Phylum Annelida

Brania wellfleetensis
Fabricia sabella
Harmothoe imbricata
Lepidasthenia commensalis
Parahesionia luteola
Paranaitis speciosa
Samythella eliasoni
Schistomeringos rudolphi
Sthenelais boa
Travisia carnea

Phylum Mollusca; Gastropoda

Acanthodoris pilosa
Epitonium multistriatum
Marginella roscida
Phyllaplysia engeli
Sayella fusca

Phylum Mollusca; Bivalvia

Diplothyra smithi

THREATENED (cont.)

Phylum Arthropoda; Isopoda

Paracerseis caudata

Phylum Arthropoda; Amphipoda

Ampithoe valida

Phylum Arthropoda; Decapoda

Macrobrachium ohione
Dissodactylus mellitae

Phylum Echinodermata; Echinoida

*Mellita quinquesperforata*DEPLETED

Phylum Mollusca; Bivalvia

Crassostrea virginica
Mercenaria mercenaria
*Spisula solidissima*SPECIAL CONCERN

Phylum Porifera

Mycale cecilia
Microciona prolifera
Craniella laminaris

Phylum Cnidaria

Leptogorgia virgulata
Edwardsia elegans

Phylum Rhynchocoela

Amphiporus ochraceus
Tetrastemma candidum
Tetrastemma elegans
Zygonemertes virescens

Phylum Annelida

Aglaophamus circinata
Ancistrogyllis jonesi
Arenicola cristata
Brania clavata
Cirriformia grandis
Cistena gouldi
Enoplobranchus sanguineus
Eurida sanguinea
Nephtys incisus
Phyllodoce castanea
Platynereis dumerilli
Schistomeringos caeca
Scoloplos rubra

Phylum Mollusca; Gastropoda

Crepidula convexa
Diaxoma varium
Doris verrucosa
Elysia catulus
Stiliger fuscatus
Triphora nigrocineta

Phylum Mollusca; Bivalvia

Amygdalum papyrium
Anomia simplex
Barnea truncata
Cuspidaria glyptea
Noetia ponderosa
Pandora trilineata
Petricola pholadiformis
Solemya velum

Phylum Arthropoda; Crustacea; Ostracoda

Cylindroleberis mariae
Sarsiella texana
Sarsiella astericola
Loxococoncha impressa

Phylum Arthropoda; Mysidacea

Mysidopsis bigelowi

Phylum Arthropoda; Cumacea

Cyclaspis varians

SPECIAL CONCERN (cont.)

Phylum Arthropoda; Isopoda

Idotea triloba
Erichsonella attenuata
Idotea balthica
Ligia exotica

Phylum Arthropoda; Amphipoda

Acanthohaustorius intermedius
Ampithoe longimana
Cerapus tubularis
Colomastix halichondriacae
Cymadusa compta
Ruätillerboides nageli

Phylum Arthropoda; Decapoda

Alpheus heterochaelis
Alpheus normanni
Hippolyte pleuracantha
Pagurus longicarpus
Lepidopa websteri
Eurypanopeus depressus
Rhithropanopeus harrisi
Pinnixa retinens
Pinnotheres maculatus
Cyrtode quadrata

Phylum Echiurida

Thalassema hartmani

Phylum Echinodermata; Holothuroidea

Leptosynapta tenuis
Pentamera pulcherrima
Sclerodactyla briareus

Phylum Chordata; Ascideacea

Botryllus schlosseri
Perophora viridis

STATUS UNDETERMINED

Phylum Porifera

Craniella crania

Phylum Rhynchocoela

Oerstedia dorsalis
 "White Nemertean"

Phylum Annelida

Aricidea wassi
Autolytus prolifer
Eamothoe acanellae
Lepidonotus squamatus
Marphysa sanguinea
Microphthalmus szelkowi
Notocirrus spiniferus
Proceraea cornuta
Sthenelais limicola

Phylum Oligochaeta

Pontodrilus bermudensis

Phylum Mollusca; Gastropoda

Caecum pulchellum
Ercolania sp.
Tenellia sp.

Phylum Mollusca; Bivalvia

Dosinia discus
Martesia cuneiformis
Myrella planulata
Pitar morrhuanus
Solen viridis

Phylum Arthropoda; Crustacea; Cladocera

Ilyocryptus sordidus
Simocephalus excipinosus

Phylum Arthropoda; Stromatopoda

Squilla empusa

Phylum Arthropoda; Mysidacea

Heteromysis formosa

Phylum Arthropoda; Isopoda

Chiridotea almyra

Phylum Arthropoda; Amphipoda

Corophium aquafuscum
Idunella sp.
Lysianassa alba
Microprotopus raneyi
Parapleustes aestuarius

RECENTLY EXTINCT OR EXTIRPATED

Phylum Mollusca; Gastropoda

Terebra dislocata

Phylum Mollusca; Bivalvia

Polymesoda caroliniana

Phylum Arthropoda; Decapoda

Ogyrides alphaerostris

Phylum Echinodermata; Ophiuroidea

Ophiothrix angulata

Phylum Chordata; Ascidiacea

Ecteinascidia turbinata

Marine Invertebrates - Phylogenetic List of Species

Status

- E = Endangered
 T = Threatened
 SC = Special Concern
 U = Undetermined
 X = Extirpated
 D = Depleted

Phylum Porifera

- SC *Mycale caecilia*
 SC *Microciona prolifera*
 SC *Craniella laminaris*
 U *Craniella crania*

Phylum Cnidaria

- E *Aiptasia eruptaurantia*
 E *Haloelava producta*
 E *Nematostella vectensis*
 SC *Leptogorgia virgulata*
 SC *Edwardsia elegans*

Phylum Rhynchocoela

- E *Amphiporus caecus*
 E *Amphiporus rubropunctus*
 E *Lineus bicolor*
 E *Lineus pallidus*
 E *Micrura rubra*
 E *Parapolia aurantiaca*
 E *Tetrastemma jeani*
 T *Lineus socialis*
 T *Tetrastemma vermiculus*
 SC *Amphiporus ochraceus*
 SC *Tetrastemma candidum*
 SC *Tetrastemma elegans*
 SC *Zygonemertes virescens*
 U *Oerstedtia dorsalis*
 U "White nemertean"

Phylum Annelida

- E *Amphiduros* sp.
 E *Cabira incerta*
 E *Cossura* sp.

- E *Lysilla alba*
 E *Nereis acuminata*
 E *Nereis grayi*
 E *Orbinia ornata*
 E *Pherusa affinis*
 E *Pista maculata*
 E *Sigambra wassi*
 T *Brania wellfleetensis*
 T *Fabricia sabella*
 T *Harmothoe imbricata*
 T *Lepidasthenia commensalis*
 T *Parahelesione luteola*
 T *Paranaitis speciosa*
 T *Samythella eliasoni*
 T *Schistomeringos rudolphi*
 T *Sthenelais boa*
 T *Travista carnea*
 SC *Aglaophamus circinata*
 SC *Ancistrosyllis jonesi*
 SC *Arenicola cristata*
 SC *Brania clavata*
 SC *Cirriiformia grandis*
 SC *Cistena gouldi*
 SC *Enoplobranchus sanguineus*
 SC *Eumida sanguinea*
 SC *Nephtys incisa*
 SC *Phyllodoce castanea*
 SC *Platynereis dumerilli*
 SC *Schistomeringos caeca*
 SC *Scoloplos rubra*
 U *Aricidea wassi*
 U *Autolytus prolifer*
 U *Harmothoe acanellae*
 U *Lepidonotus squamatus*
 U *Marphysa sanguinea*
 U *Microphthalmus szcelkowi*
 U *Notocirrus spiniferus*
 U *Proceraea cornuta*
 U *Sthenelais limicola*

Phylum OligochaetaU *Pontodrilus bermudensis*Phylum Mollusca; Gastropoda

E *Anachis avara*
 E *Aplysia willeowi*
 E *Cyclostreniscus pentagonus*
 E *Diodora cayenensis*
 E *Hermaea eruciata*
 E *Melanella intermedia*
 E *Pyramidella candida*
 E *Solariorbus infracarinata*
 E *Teinostoma cryptospira*
 E *Vermicularia* sp.
 T *Acanthodoris pilosa*
 T *Epitonium multistriatum*
 T *Marginella rosida*
 T *Phyllaplysia engeli*
 T *Sayella fusca*
 SC *Crepidula convexa*
 SC *Diastoma varium*
 SC *Doris verrucosa*
 SC *Elysia catulus*
 SC *Stiliger fuscatus*
 SC *Triphora nigrocincta*
 U *Caecum pulchellum*
 U *Ercolania* sp.
 U *Tenellia* sp.
 X *Terebra dislocata*

Phylum Mollusca; Bivalvia

E *Argopecten irradians*
 E *Paramya subovata*
 T *Diplothyra smithi*
 D *Crassostrea virginica*
 D *Mercenaria mercenaria*
 D *Spisula solidissima*
 SC *Amygdalum papyrium*
 SC *Anania simplex*
 SC *Barnea truncata*
 SC *Cuspidaria glypta*
 SC *Noetia ponderosa*
 SC *Pandora trilineata*
 SC *Petricola pholadiformis*
 SC *Solemya velum*
 U *Dosinia discus*
 U *Martesia cuneiformis*
 U *Myrella planulata*
 U *Pitar morrhuanus*
 U *Solen viridis*
 X *Polymesoda caroliniana*

Phylum Arthropoda; Crustacea; Cladocera

U *Ilyocryptus sordidus*
 U *Simocephalus excruciosus*

Phylum Arthropoda; Crustacea; Ostracoda

SC *Cylindroleberis mariae*
 SC *Sarsiella texana*
 SC *Sarsiella zostericola*
 SC *Loxococoncha impressa*

Phylum Arthropoda; StomatopodaU *Squilla empusa*Phylum Arthropoda; Mysidacea

SC *Mysidopsis bigelowi*
 U *Heteromysis formosa*

Phylum Arthropoda; CumaceaSC *Cyclaspis varians*Phylum Arthropoda; Isopoda

E *Chiridotea caeca*
 E *Ptilanthura tenuis*
 T *Paracerceis caudata*
 SC *Edotea triloba*
 SC *Erichsonella attenuata*
 SC *Idotea balthica*
 SC *Ligia exotica*
 U *Chiridotea almyra*

Phylum Arthropoda; Amphipoda

E *Lembos smithi*
 T *Amphithoe valida*
 SC *Acanthohauistorius intermedius*
 SC *Amphithoe longimana*
 SC *Cerapus tubularis*
 SC *Colomastix halichondriae*
 SC *Cymadusa compta*
 SC *Rudilemboidea nageli*

Phylum Arthropoda; Amphipoda (cont.)

- U *Corophium aquafuscum*
- U *Idunella* sp.
- U *Lysianassa alba*
- U *Microprotopus raneyi*
- U *Parapleustes aestuarius*

Phylum Arthropoda; Decapoda

- T *Macrobrachium ohione*
- T *Dissodactylus mellitae*
- SC *Alpheus heterochaelis*
- SC *Alpheus normanni*
- SC *Hippolyte pleuracantha*
- SC *Pagurus longicarpus*
- SC *Lepidopa websteri*
- SC *Eurypanopeus depressus*
- SC *Rhithropanopeus harrisi*
- SC *Pinnixa retinens*
- SC *Pinnotheres maculatus*
- SC *Ocypode quadrata*
- X *Ogyrides alphaerostris*

Phylum Chordata; Ascideacea

- SC *Botryllus schlosseri*
- SC *Perophora viridis*
- X *Ecteinascidea turbinata*

Phylum Echiurida

- E "White echiurid"
- SC *Thalassema hartmani*

Phylum Echinodermata; Holothuroidea

- SC *Leptosynapta tenuis*
- SC *Pentamera pulcherrima*
- SC *Sclerodactyla briareus*

Phylum Echinodermata; Echinoida

- T *Mellita quinquiesperforata*

Phylum Echinodermata; Ophiuroidea

- X *Ophiothrix angulata*

SPECIES ACCOUNTS

ENDANGERED (36)

1. SEA ANEMONE

Aiptasia eruptaurantia (Field)

Phylum: Cnidaria
Class: Anthozoa

Order: Actiniaria
Family: Aiptasiidae

Description: Column cylindrical, dome-shaped when constricted. Two color types: pinkish green and pinkish yellow; 10 to 12 bright vermilion warts, with 2 to 5 warts per row (Field, 1949).

Present Range: Chesapeake Bay to Beaufort, North Carolina.

Distribution in Virginia: York River; rare.

Reproduction: Unknown.

Status: *Endangered*. Not found for 12 years.

Protective Measures Proposed: None.

Remarks: One of several estuarine anemones needing more taxonomic and life history studies.

Author: Marvin L. Wass.

2. SEA ANEMONE

Haloclava producta (Simpson)

Phylum: Cnidaria
Class: Anthozoa

Order: Actiniaria
Family: Ilyanthidae

Description: Elongate burrowing species. Upper column has 20 rows of papillae; tentacles stubby, swollen at tips (Gosner, 1971).

Present Range: Chesapeake Bay to Beaufort, North Carolina.

Distribution in Virginia: York River channel off Yorktown.

Habitat and Mode of Life: Burrows in deeper waters in Virginia.

Reproduction: Unknown.

Status: *Endangered*.

Protective Measures Proposed: None.

Remarks: More searching needed.

Author: Marvin L. Wass.

3. SEA ANEMONE

Nematostella vectensis Stephenson

Phylum: Cnidaria
 Class: Anthozoa

Order: Actiniaria
 Family: Edwardsiidae

Description: Undoubtedly the most eye-catching of all small Chesapeake anemones. Tentacles vary from 12 to 18, usually 14. It is essentially transparent, showing eight macronemes through body wall. Throat and tentacles splotted with white (Stephenson, 1935; Gosner, 1971).

Present Range: State of Washington, California, Massachusetts, Virginia and England.

Distribution in Virginia: Machodoc Creek, Chesapeake Bay.

Habitat and Mode of Life: In soft sediments of tidal creek choked with *Myriophyllum spicatum*. Evidently very euryhaline.

Reproduction: Unknown.

Status: *Endangered*. Not found elsewhere in Virginia.

Protective Measures Proposed: Further sampling in oligohaline waters.

Remarks: Reported in California tide pool with 60 parts per thousand salinity.

Author: Marvin L. Wass.

* * * * *

4. RIBBON-WORM (NEMERTEAN)

Amphiporus caecus (Verrill)

Phylum: Rhynchocoela
 Class: Anopla

Order: Haplonemertini
 Family: Amphiporidae

Description: Blind species, lacking ocelli. Neck with whitish furrow. Two red spots show through head. Animal scarlet with dark red dorsal stripe and pale orange sides (McCaul, 1963; Gosner, 1971).

Present Range: From depth of 35 meters off coast of Massachusetts.

Distribution in Virginia: Single specimen dredged from coarse sand at depth of 6 meters in Chesapeake Bay.

Habitat and Mode of Life: Dredged from coarse sand at 6 meters in Chesapeake Bay.

Reproduction: Unknown.

Status: *Endangered*. Known in Virginia from a single specimen.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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5. RIBBON-WORM (NEMERTEAN)

Amphiporus rubropunctus McIntosh

Phylum: Rhynchocoela
 Class: Anopla

Order: Haplonemertini
 Family: Amphiporidae

Description: Body elongate, little flattened. Head vaguely marked from body by narrow neck. Color ochre, margins darker or greenish from intestine. Dominant feature is skin specked with bright red spots. Ten to twelve ocelli on each side (McCaul, 1963).

Present Range: York River near Yorktown bridge.

Distribution in Virginia: As above.

Habitat and Mode of Life: Occurs on eelgrass.

Reproduction: Unknown.

Status: *Endangered*. Known only from type locality in York River.

Protective Measures Proposed: Protect eelgrass.

Author: Marvin L. Wass.

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6. RIBBON-WORM (NEMERTEAN)

Lineus bicolor (Verrill)

Phylum: Rhynchocoela
 Class: Anopla

Order: Heteronemertini
 Family: Lineidae

Description: Body little rounded; head sharply pointed, wider than body. Ground color ochre; head and forebody olive-green, brain bright red. Faint lengthwise striations cover body. Ocelli about 10, scattered. Proboscis long and very slender (Verrill, 1892; McCaul, 1963).

Present Range: Cape Cod to Virginia.

Distribution in Virginia: Lower York River.

Habitat and Mode of Life: Dredged from muddy bottom at depth of 13 meters. Usually associated with hydroids, algae and tunicates.

Reproduction: Unknown.

Status: *Endangered*. Caused by deteriorating deeper waters. Unrecorded since 1963.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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7. RIBBON-WORM (NEMERTEAN)

Linus collidus (Verrill)

Phylum: Rhynchocoela
 Class: Anopla

Order: Heteronemertini
 Family: Lineidae

Description: Body long, filiform. Head distinct from body, 70 millimeters long, 1 millimeter wide. Cephalic grooves indistinct. Body white anteriorly to pale yellow-pink posteriorly (McCaul, 1963).

Present Range: Cape Ann, Massachusetts to Virginia.

Distribution in Virginia: One specimen taken at a depth of 2 meters in Burton's Bay, Eastern Shore.

Habitat and Mode of Life: Dredged from sandy mud.

Reproduction: Unknown.

Status: *Endangered*. Unless other records have been overlooked, this must be a rare species.

Protective Measures Proposed: None feasible.

Author: Marvin L. Wass.

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8. RIBBON-WORM (NEMERTEAN)

Micrura rubra (Verrill)

Phylum: Rhynchocoela
 Class: Anopla

Order: Heteronemertini
 Family: Lineidae

Description: Body somewhat flattened, head indistinctly demarcated. Worm fragments easily. Cephalic grooves long, indistinct. Color pale reddish brown (Verrill, 1892; McCaul, 1963; Gosner, 1971).

Present Range: Bay of Fundy to Chesapeake Bay; maximum depth 70 meters.

Distribution in Virginia: Middle of Chesapeake Bay, depth 15 meters.

Habitat and Mode of Life: Dredged from muddy bottom.

Reproduction: Unknown.

Status: *Endangered*. Single specimen taken.

Protective Measures Proposed: None feasible.

Author: Marvin L. Wass.

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9. RIBBON-WORM (NEMERTEAN)

Parapolia aurantiaca (Coe)

Phylum: Rhynchocoela
 Class: Anopla

Order: Paleonemertini
 Family: Lineidae

Description: Cephalic grooves oblique. Color orange to vermillion. Body 10 millimeters by 250 millimeters (Gosner, 1971).

Present Range: Probably Cape Cod to Chesapeake Bay.

Distribution in Virginia: Euhaline. Known only from Hog Island Bay.

Habitat and Mode of Life: From sand-silt substrate.

Reproduction: Unknown.

Status: *Endangered*. Only one specimen taken in Virginia.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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10. RIBBON-WORM (NEMERTEAN)

Tetrastemma jeani (McCaul)

Phylum: Rhynchocoela
 Class: Anopla

Order: Haplonemertini
 Family: Tetrastemmatidae

Description: Body slender, long, rounded in cross-section. Head set off by slender neck, posterior pointed. Ocelli form a square. Body 0.7 millimeter by 14.0 millimeters. Color uniform dark brown dorsally (McCaul, 1963).

Present Range: Eelgrass beds off Mumfort Island, York River, Virginia.

Distribution in Virginia: As above.

Habitat and Mode of Life: Found on eelgrass leaves.

Reproduction: Unknown.

Status: *Endangered*. Known from only one small area; only six found.

Protective Measures Proposed: Foster eelgrass.

Author: Marvin L. Wass.

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11. POLYCHAETE

Amphiduros sp.

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Hesionidae

Description: Genus has eight pairs of tentacular cirri. Parapodia biramous. Pharynx reversible, fimbriated distally, lacking jaws. Antenna medial (Fauchald, 1977).

Present Range: Chesapeake Bay, Rappahannock Shoals Channel, X1-63, five specimens.

Distribution in Virginia: As above.

Habitat and Mode of Life: Found in silty clay.

Reproduction: Unknown.

Status: *Endangered*. Only one record.

Protective Measures Proposed: None.

Remarks: Evidently has very restricted habitat.

Author: Marvin L. Wass.

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12. POLYCHAETE

Cabira incerta Webster

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Pilargidae

Description: Body long, 18 millimeters by 1.5 millimeters; segments to 54, subcylindrical, narrowed anteriorly. Parapodia small, indistinct. Proboscis cylindrical, three-ringed, with large papillae around opening of distal ring. Skin quite smooth, with few papillae (Pettibone, 1966).

Present Range: Webster (1879) described this species from Northampton County, Virginia in 1879. It was not seen again until Wass found five specimens in one grab off the Rappahannock River on July 21, 1961. None have been found since.

Distribution in Virginia: Chesapeake Bay off Rappahannock River, 6 fathoms, mud, July 21, 1961, five specimens.

Habitat and Mode of Life: Lives in dark, gray mud.

Reproduction: Unknown.

Status: *Endangered*. Found only in Chesapeake Bay.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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13. POLYCHAETE

Cossura sp.

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Phyllodocidae

Description: Tiny worm, only a few millimeters long; has one long tentacle, lacks branchiae (Fauchald, 1977).

Present Range: Apparently known only from Chesapeake Bay.

Distribution in Virginia: Taken in York Spit Channel lower Chesapeake Bay, November 21, 1963; Gloucester Point, September 25, 1963.

Habitat and Mode of Life: Found in silty sediments.

Reproduction: Unknown.

Status: *Endangered*. Only one specimen found at each locality.

Protective Measures Proposed: None.

Remarks: Undescribed species determined to genus by Dr. Marian Pettibone.

Author: Marvin L. Wass.

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14. POLYCHAETE

Lysilla alba Webster

Phylum: Annelida
 Class: Polychaeta

Order: Terebellida
 Family: Terebellidae

Description: Segments ill-defined; body usually with transverse lines of papillae. Setae absent or few, resembles translucent holothurian *Leptosynapta* (Pettibone, 1964; Fauchald, 1977).

Present Range: Unknown.

Distribution in Virginia: Gloucester Point, 1972, one specimen, M. L. Wass.

Habitat and Mode of Life: In *Zostera* bed.

Reproduction: Unknown.

Status: *Endangered*.

Protective Measures Proposed: None.

Remarks: None seen since 1972. At Woods Hole made surface depressions in muddy sand after manner of *Leptosynapta*.

Author: Marvin L. Wass.

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15. POLYCHAETE

Nereis acuminata (Ehlers)

Phylum: Annelida
Class: Polychaeta

Order: Phyllodocida
Family: Nereidae

Description: Size 70 x 4 millimeters; segments to 75. Prostomium squarish, front strongly convex. Tentacular cirri short, reaching setigers 3-9. Parapodia long throughout. Brown, curved jaws of proboscis hold 6 to 15 teeth. Alive, color is white, transparent, or bright pink with brown and purple (Pettibone, 1963 - as *Nereis arenaceodonta*; Gardner, 1975).

Present Range: Massachusetts to Florida, California, Mexico, Philippines, Australia, New Zealand, Tasmania, South Africa and India.

Distribution in Virginia: Chesapeake Bay, one off Rappahannock River, 37 feet, sand. Identified by Marian H. Pettibone. Dauer found three off Cape Charles, 1978.

Habitat and Mode of Life: At Woods Hole found among algae, tunicates and in tubes on rocks (Pettibone, 1963). In North Carolina in shell with hermit crab; also in fine sand (Gardiner, 1975).

Reproduction: Spawning preceded by four months of couple formation, a period of fighting with same sex. Male and female construct single tube with many openings. Eggs laid and fertilized in tube, after which female leaves tube and dies or is eaten by male.

Status: *Endangered*. Rare in Chesapeake Bay. Also found in Chincoteague Bay.

Protective Measures Proposed: None.

Remarks: It seems very unusual that this species should not have been taken a great many times in Chesapeake Bay.

Author: Marvin L. Wass.

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16. POLYCHAETE

Nereis grayi Pettibone

Phylum: Annelida
Class: Polychaeta

Order: Phyllodocida
Family: Nereidae

Description: Body thread-like. Tentacular cirri long, reaching setiger 6. Parapodia similar throughout. Proboscis with brown amber-colored jaws (Pettibone, 1963).

Present Range: Massachusetts to North Carolina.

Distribution in Virginia: Chesapeake Bay, off Rappahannock River, June 1961, 37 feet.

Habitat and Mode of Life: At Woods Hole in mud; in elongate mud tubes of *Maldanopsis elongata*. Dredged in 10 fathoms in silty clay and fine sand. In Virginia in fine sand.

Reproduction: Unknown.

Status: *Endangered*. Only two specimens found.

Protective Measures Proposed: None.

Remarks: Identified by Marian H. Pettibone.

Author: Marvin L. Wass.

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17. POLYCHAETE

Orbinia ornata Verrill

Phylum: Annelida
Class: Polychaeta

Order: Orbiniida
Family: Orbiniidae

Description: Length to 250 millimeters, width to 7 millimeters; segments to 300. Reddish, middorsal glandular areas begin at setigers 7-8. Thoracic setigers about 24. Crotchets golden to brown. Anal ring with pair of long anal cirri. Extended proboscis soft, saclike around mouth. Color yellow-orange to reddish brown (Pettibone, 1963).

Present Range: Massachusetts (Cape Cod) to Florida, Gulf of Mexico and California. Low water to 18 fathoms.

Distribution in Virginia: Eastern Shore, poly-euhaline.

Habitat and Mode of Life: In sand.

Reproduction: Sexually mature in June and early July. Eggs pale or yellow.

Status: *Endangered*. Rare.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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18. POLYCHAETE

Pherusa affinis (Leidy)

Phylum: Annelida
Class: Polychaeta

Order: Flabelligerida
Family: Flabelligeridae

Description: Body covered with short papillae; hooked neurosetae begin at fifth setiger (Pettibone, 1964).

Present Range: From at least Woods Hole to Cape Hatteras offshore. More common offshore than in estuaries (Gary Gaston, pers. comm.).

Distribution in Virginia: Chesapeake Bay, near York Spit Channel, east of York Spit Light.

Habitat and Mode of Life: At Woods Hole, taken in mud, shallow water and by night light from docks.

Reproduction: Unknown.

Status: *Endangered*. Only one specimen found.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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19. POLYCHAETE

Pista maculata (Dalyell)

Phylum: Annelida
 Class: Polychaeta

Order: Terebellida
 Family: Terebellidae

Description: Single pair of branched branchiae; eyespots numerous. Thoracic setigerous segments 16 (Pettibone, 1964).

Present Range: Massachusetts to Chesapeake Bay.

Distribution in Virginia: Off Rappahannock River, one specimen.

Habitat and Mode of Life: Probably in deeper waters of estuaries and sublittoral shores.

Reproduction: Unknown.

Status: *Endangered*.

Protective Measures Proposed: None.

Remarks: None found since 1962.

Author: Marvin L. Wass.

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20. POLYCHAETE

Sigambra wassi Pettibone

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Pilargidae

Description: Incomplete body had 192 segments; large, 70 x 4 millimeters. Body flattened, convex dorsally, flattened ventrally. Skin smooth; wrinkled and areolated, especially in front and mid-sections. Proboscis cylindrical; papillae around mouth (Pettibone, 1966).

Present Range: Chesapeake Bay, off Rappahannock River.

Distribution in Virginia: As above.

Habitat and Mode of Life: Sand; depth 6 fathoms.

Reproduction: Unknown.

Status: *Endangered*. Only two taken in June, 1962; not seen since then. Similar species found elsewhere.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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21. GREEDY DOVE-SHELL

Anachis avara Say

Phylum: Mollusca
Class: Gastropoda

Order: Neogastropoda
Family: Columbellidae

Description: Shell lengthy, spire somewhat ovate. Lower half of body-whorl marked with about 15 smooth lengthwise ribs, breaking series of fine revolving lines. Small aperture narrow, oval; both lips toothed inside margins. Length about 15 millimeters (Abbott, 1974).

Present Range: Massachusetts to Florida and Texas.

Distribution in Virginia: Lower Bay.

Habitat and Mode of Life: Reported as common on eelgrass (Abbott, 1974). Not found in Chesapeake Bay for at least two decades.

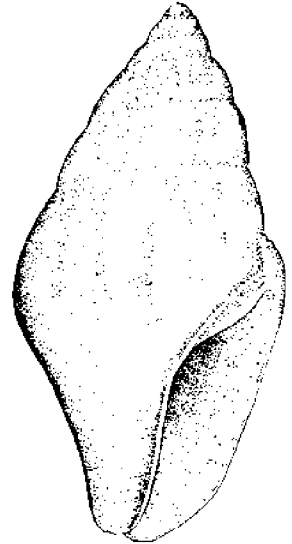
Reproduction: Abbott (1974) refers to this species as "A very common, low-tide, eelgrass species..."

Status: *Endangered*. Not found in Alex Marsh's thorough study of eelgrass associates at Mumfort Island, York River, Virginia (Marsh, 1973). Collected from VIMS beach by W. G. Hewatt in 1958 and from Hog Island Bay, Eastern Shore in 1963 by M. Wass. More recently, Robert Orth has not found it in his eelgrass-bed studies. It was found at the York River Bridge by J. D. Andrews shortly after completion of the bridge.

Protective Measures Proposed: None.

Remarks: It seems impossible that this species could have completely disappeared from Chesapeake Bay.

Author: Marvin L. Wass.



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22. WILLCOX'S SEA HARE

Aplysia willcoxi Heilprin

Phylum: Mollusca
Class: Gastropoda

Order: Aplysiomorpha
Family: Aplysiidae

Description: Adult large, to 30.5 centimeters long. Cephalic tentacles and erect rhinophores present. Eyes anterior to rhinophores and near surface. Internal amber shell horny. Mantle flaps large, overlapping back when not swimming. Head greenish, body olive green to brown, with black reticulations; gill and mantle edges light purple. Extrudes ink when annoyed (Abbott, 1974).

Present Range: Cape Cod, Massachusetts to Florida.

Distribution in Virginia: One animal taken from seaside lagoon, Eastern Shore, Virginia (Vogel, 1977).

Habitat and Mode of Life: Fed only on sea lettuce (*Ulva*), rejecting other algae.

Reproduction: Unknown.

Status: *Endangered*.

Protective Measures Proposed: Knowledge of habits lacking.

Author: Marvin L. Wass.

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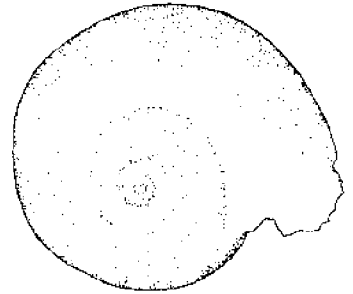
23. TRILIX VITRINELLA

Cyclostremiscus pentagonus (Gabb)

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Vitrinellidae

Description: Width 3 millimeters, height 1 millimeter. Disc-shaped, with small glassy knob a little above older whorls. Umbilicus deep, funnel-shaped. Operculum many-spiraled (Abbott, 1974).



Present Range: Chesapeake Bay and North Carolina to Florida, Texas and West Indies.

Distribution in Virginia: Found only in York River off Gloucester Point from 30 to 60 feet. Specimen identified by Robert Work.

Habitat and Mode of Life: In silt-clay sediments.

Reproduction: Unknown.

Status: *Endangered*. Very rare. At northern limit of range. Industrial effluents may have eliminated this species by now in the York River.

Protective Measures Proposed: None.

Remarks: Could also have perished earlier from 1972 low salinity and low oxygen combination.

Author: Marvin L. Wass.

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24. CAYENNE KEYHOLE LIMPET

Diodora cayenensis (Lamarck)

Phylum: Mollusca
Class: Gastropoda

Order: Archaeogastropoda
Family: Fissurellidae

Description: Length to 25 millimeters. Cone-shaped shell has keyhole slot at elevated peak. Radiating ribs crossed by striae produce lattice pattern. Color ranges from gray to yellow, with radiating dark bands (Abbott, 1974).

Present Range: Maryland to southern Florida, Brazil and Bermuda.

Distribution in Virginia: Only found on seaside of Eastern Shore.

Habitat and Mode of Life: Intertidal to fairly deep water.

Reproduction: Unknown.

Status: *Endangered*. Only on Eastern Shore and very rare there. J. D. Andrews has seen hundreds of shells in piles on seaside of Eastern Shore.

Protective Measures Proposed: Don't collect live limpets.

Remarks: A very interesting animal to study because of its unusual structure, habits and rarity.

Author: Marvin L. Wass.

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25. CRUCIATE HERMES

Hermaea cruciata Gould

Phylum: Mollusca
Class: Gastropoda

Order: Sacoglossa
Family: Hermaeidae

Description: Adult aeolidiform; 10 millimeters long; body slender, with dorsal cerata and with digestive gland diverticula at distal end. Background color pale green. Wart-like spots cover epidermis. Rolled rhinophores have brown on dorsal side. Eyes posterior to base of rhinophores (Abbott, 1974).

Present Range: Massachusetts and Chesapeake Bay.

Distribution in Virginia: York River, upper meso-lower polyhaline (Vogel, 1977).

Habitat and Mode of Life: Found in *Zostera* community. Feeds on algae.

Reproduction: Mates and lays eggs in October. Larvae free-swimming.

Status: *Endangered*. Extremely rare due to dearth of eelgrass.

Protective Measures Proposed: Replant eelgrass.

Remarks: Only three specimens found in Chesapeake Bay.

Author: Rosalie M. Vogel.

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26. CUCUMBER MELANELLA

Melanella intermedia Cantraine

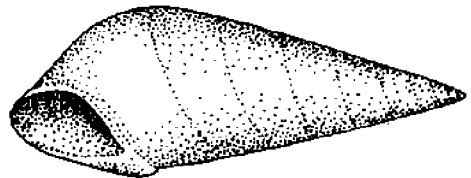
Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Melanellidae

Description: Length 6-12 millimeters, with 10-13 whorls tapering to apex. Entrance narrow with thin, sharp outer lip (Abbott, 1974).

Present Range: New Jersey to Brazil, Bermuda and Europe.

Distribution in Virginia: Found only in Hampton Roads area.



Habitat and Mode of Life: Abbott (1974) says this species is parasitic on *Holothuria impatiens*, but in Chesapeake Bay it would have to be on *Thyone briareus*.

Reproduction: Unknown.

Status: *Endangered*. Knowledge lacking on host-commensal relationship.

Protective Measures Proposed: Search for hosts.

Remarks: More studies should be made in the laboratory on commensal relationships.

Author: Marvin L. Wass.

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27. BRILLIANT PYRAM

Pyramidella candida Morch

Phylum: Mollusca
Class: Gastropoda

Order: Aplysiomorpha
Family: Pyramidellidae

Description: Length 12-14 millimeters. Shell conic, sides flat, shiny white. Suture grooved, crenulated. Columella has three strong, spiral plaits. Operculum thin, tannish (Abbott, 1974).

Present Range: Virginia to Brazil.

Distribution in Virginia: Off Rappahannock River; Gloucester Point.

Habitat and Mode of Life: Evidently parasitic on some invertebrate, which must also be scarce (Boss, 1965).

Reproduction: Unknown.

Status: *Endangered*. Only found twice in Virginia.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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28. GABB'S VITRINELLA

Solariorbus infracarinata Gabb

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Vitrinellidae

Description: Broad, low-spiraled shape. Height 1 millimeter, width 1.8 millimeters. Umbilicus widening to one-fifth of shell width. Two strong cords below keel, base smooth (Abbott, 1974).

Present Range: Until found in the lower York River, its range was south half of Florida, Texas and the Caribbean.

Distribution in Virginia: Only in York River off Gloucester Point.

Habitat and Mode of Life: Found in soft sediments.

Reproduction: Unknown.

Status: *Endangered*. Tremendous distance between Chesapeake Bay and south Florida seems very unusual.

Protective Measures Proposed: None feasible.

Remarks: Specimen was identified by Robert Work.

Author: Marvin L. Wass.

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29. CRYPTIC TEINOSTOME *Teinostoma cryptospira* Verrill

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Vitrinellidae

Description: Tiny, 2 to 3 millimeters in diameter. Shell depressed, white, smooth, and with umbilical callus. Operculum chitinous (Abbott, 1974).

Present Range: Chesapeake Bay to West Indies.

Distribution in Virginia: York River, off Gloucester Point, 30 to 60 feet in silt-clay.

Habitat and Mode of Life: Unknown.

Reproduction: Unknown.

Status: *Endangered*. In Virginia found in only one small area. Oil refinery and electric generating plant within two and one-half miles.

Protective Measures Proposed: Too difficult.

Remarks: Possibly more might have been taken if one-half millimeter sieve sizes had been used. Determined by Robert Work.

Author: Marvin L. Wass.

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30. WORM-SHELL *Vermicularia* sp.

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Turritellidae

Description: Resembles *knorri*. Closely spiraled for about 6 centimeters, then random to form mass 25 centimeters long by 12 centimeters high.

Present Range: Unknown.

Distribution in Virginia: In ocean about 20 miles off Accomack County, upper end of Virginia's Eastern Shore.

Habitat and Mode of Life: At least two other mollusc species were embedded in the colony. Area from which taken was probably quite rich.

Reproduction: Unknown.

Status: *Endangered*, possibly extinct. Due to massive dredging for surf clams off the Virginia coast in recent years.

Protective Measures Proposed: None feasible.

Remarks: *Vermicularia knorri* occurs from North Carolina to Florida, but does not resemble the specimens taken off Virginia as closely as does *Vermicularia spirata*.

Author: Marvin L. Wass.

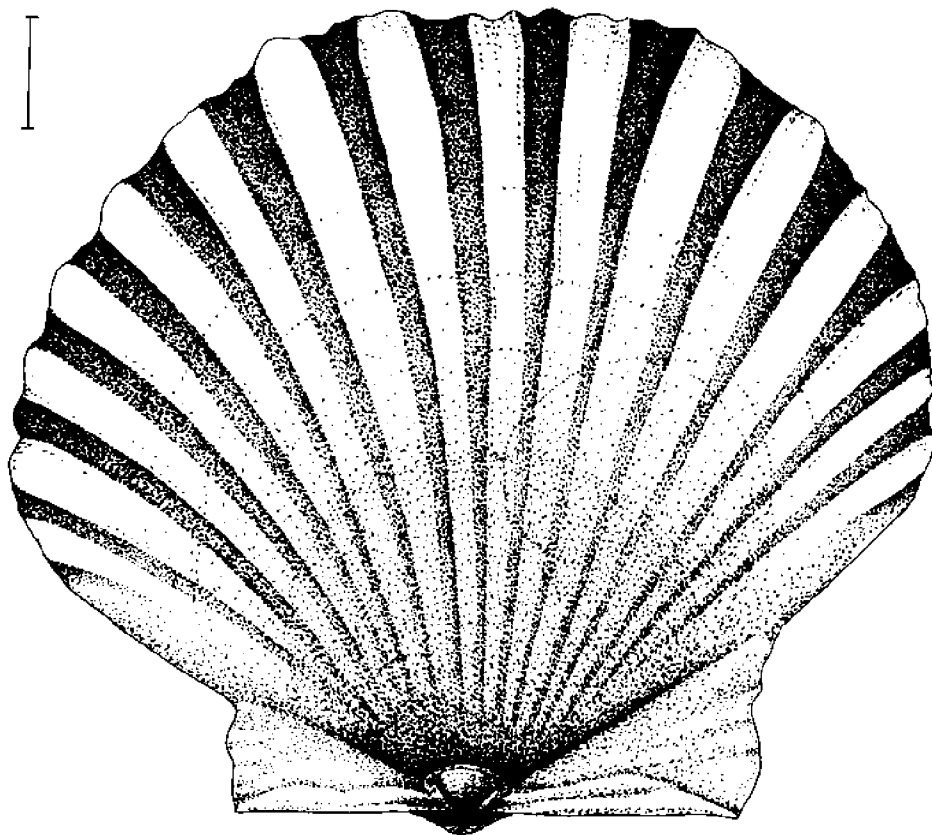
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31. BAY SCALLOP

Argopecten irradians Lamarck

Phylum: Mollusca
Class: Bivalvia

Order: Pteronochida
Family: Pectinidae



Description: Length to 75 millimeters. Shell circular, with projecting ears; strong, inflated. Inequivalve, ears unequal, left valve most convex. Sculpture 12-21 low, square radial ribs. Margin deeply scalloped at ventral margin. Periostracum absent; color much varied with white, orange, red-brown, purple and black seen (Abbott, 1974). Appears as *Pecten irradians* in Pierce (*In*: Brown, 1950).

Present Range: Nova Scotia to north Florida and Texas.

Distribution in Virginia: Seaside of Eastern Shore; formerly from Yorktown to mouth of Bay before 1930-31 when eelgrass was decimated by a wasting disease.

Habitat and Mode of Life: Free-living after spat stage, usually in groups on shallow beds, particularly where tides are diminished by eelgrass beds. Erratic in occurrence.

Reproduction: Hermaphrodites release spawn in water for larval dispersal. Young spat attach on vertical surfaces such as eelgrass. Mature in one year.

Status: *Endangered*. None in Chesapeake Bay now. Scarce and without adequate brood stock on Eastern Shore. Hatchery breeding and juvenile penning has been successful on a small scale.

Protective Measures Proposed: Protection and re-establishment of eelgrass beds is essential to scallop culture in the wild. Farming scallops is feasible biologically, if not economically. Breeding sanctuaries may be possible but control of predators (crabs and drills) would be necessary.

Author: Jay D. Andrews.

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32. SUBOVATE SOFT CLAM

Paramya subovata (Conrad)

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Corbulidae

Description: Length 10 millimeters. Shell small, subquadrate, beaks anterior to midline. Hinge teeth and anterior ligament lacking. Hinge has resilium; latter borders of pit may be carinated. Pallial line somewhat broken; no sinus present (Abbott, 1974).

Present Range: Delaware to Florida and Texas.

Distribution in Virginia: Found only once, off north end of Parramore Island, February, 1970.

Habitat and Mode of Life: Commensal with the echiurid *Thalassema hartmani* in North Carolina (Jenner and McCrary, 1970). Same relationship has not been found in Virginia.

Status: *Endangered*. Both host and commensal could be eliminated by dredging, spoiling, or (in York River) by low oxygen, low salinity or oil spills.

Protective Measures Proposed: None.

Remarks: Only water quality maintenance will save such rare species.

Author: Marvin L. Wass.

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33. ISOPOD

Chiridotea caeca Say

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Idoteidae

Description: Length 15 millimeters.

Body broadly ovate, thorax flattened, abdomen half length of body, tapering to acute telson. Abdomen has four segments, last forming sharp telson. Color varied, mottled gray to dark (Schultz, 1969).

Present Range: Nova Scotia to Florida; surface to 3 meters.

Distribution in Virginia: Only found in Pamunkey River; offshore in plankton.

Habitat and Mode of Life: Free-living, presumably burrowing shallowly.

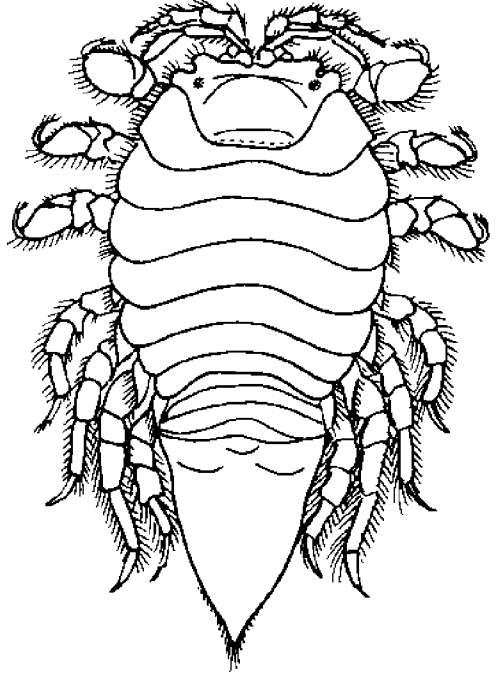
Reproduction: Unknown.

Status: *Endangered*. Not seen in Virginia since 1960.

Protective Measures Proposed: None.

Remarks: Further searching needed.

Author: Marvin L. Wass.



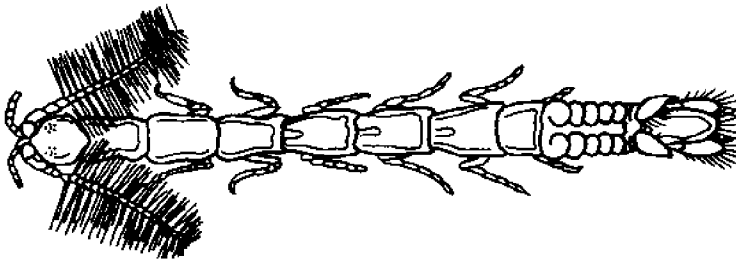
34. ISOPOD

Ptilanthura tenuis Harger

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Anthuridae

Description: Length of males 11 millimeters. Head and body long, narrow, ending in projection. Eyes small. First antennae short in female; second antennae in male fringed with long setae. Uropods narrow, pointed. Color mottled brown (Schultz, 1969).



Present Range: Bay of Fundy to Chesapeake Bay; perhaps to Cape Hatteras.

Distribution in Virginia: One record, off Rappahannock River.

Habitat and Mode of Life: Sandy bottom, deep water.

Reproduction: Unknown.

Status: *Endangered*. Species very rare.

Protective Measures Proposed: None.

Remarks: Probably on upper oceanic shelf.

Author: Marvin L. Wass.

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35. AMPHIPOD

Lembo smithi Holmes

Phylum: Arthropoda
Class: Crustacea

Order: Amphipoda
Family: Aoridae

Description: Length 5-6 millimeters. Eye small, black, oval. Antenna 1 slender, long; antenna 2 heavier, flagellum short. Male gnathopods longer, more expanded than carpus. Second gnathopod has smaller subchelate propodus. Last pair of pereopods longest. Body reddish brown to black; dorsal side orange through purple (Bousfield, 1973).

Present Range: Cape Cod to northern Florida.

Distribution in Virginia: One specimen from Hog Island Bay, Eastern Shore; four from Gloucester Point, February 1967.

Habitat and Mode of Life: At Gloucester Point, found among *Zostera* roots and detritus. Ovigerous May-September (Bousfield, 1973).

Reproduction: Unknown.

Status: *Endangered*. Only five taken.

Protective Measures Proposed: None feasible, except enhancement of eelgrass.

Author: Marvin L. Wass.

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36. ECHIURID

"White echiurid"

Phylum: Echiurida

Order: Unknown

Family: Unknown

Description: Small white worm less than 1 inch in length. Integument translucent white, revealing large number of fecal pellets within. Skin rather "warty."

Present Range: Known only from York River below the bridge in fine sediment and deep water.

Distribution in Virginia: As above.

Habitat and Mode of Life: Presumably burrows and feeds on fine sediments.

Reproduction: Unknown.

Status: *Endangered*. Inhabits area where many effluents enter river.

Protective Measures Proposed: Seemingly impossible.

Remarks: Almost certainly undescribed.

Author: Marvin L. Wass.

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THREATENED (23)

1. RIBBON-WORM (NEMERTEAN)

Lineus socialis (Leidy)Phylum: Rhynchocoela
Class: AnoplaOrder: Heteronemertini
Family: Lineidae

Description: Body very long, thread-like, width to 8 millimeters, length to 25 centimeters. Six pairs of tiny eyespots. Worm dark from olive-green to red or black. Occasionally in tangled masses (Miner, 1950; Pratt, 1951; Gosner, 1971).

Present Range: New England to Virginia.

Distribution in Virginia: York River near Yorktown (McCaul, 1963).

Habitat and Mode of Life: In subtidal sand, may feed on psammofauna.

Reproduction: Unknown.

Status: *Threatened*. Evidently quite scarce.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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2. RIBBON-WORM (NEMERTEAN)

Tetrastemma vermiculus (Quatrefages)Phylum: Rhynchocoela
Class: AnoplaOrder: Haplonemertini
Family: Tetrastemmatidae

Description: Body rounded throughout. Head broad, anteriorly truncated; posterior blunt. Head not set off from body. Notch marks rhynchopore. Body round, 14 by 0.5 millimeters. Ocelli form square. Proboscis long, slender. Color irregular mottlings of brown pigment (McCaul, 1963; Gosner, 1971).

Present Range: Bay of Fundy to Florida; also European coast.

Distribution in Virginia: On eelgrass in shallow water of York River; to 70 meters in deeper water.

Habitat and Mode of Life: On eelgrass in shallow water; unknown in deeper water in Virginia.

Reproduction: Unknown.

Status: *Threatened*. Due to decrease of eelgrass and possible damage from oil spills.

Protective Measures Proposed: Protect eelgrass.

Remarks: Evidently quite rare in Virginia.

Author: Marvin L. Wass.

3. POLYCHAETE

Brania wellfleetensis Pettibone

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Syllidae

Description: Another tiny species, 7 x 0.4 millimeters, segments to 31.
 Prostomium with two pairs of eyes, anterior pair larger. Proboscis with anterior tooth. Body colorless. Females bear large eggs, one per segment, attached ventrally on setigers 14 to 29 or so (Pettibone, 1963).

Present Range: Massachusetts to Chesapeake Bay.

Distribution in Virginia: Chesapeake Bay, Rappahannock Shoals channel, 1963, one specimen.

Habitat and Mode of Life: Low water to 10 fathoms. Substrate unknown.

Reproduction: Unknown.

Status: *Threatened*. Known only from very busy ship channel slated for dredging to depth of 50 feet during next 9 years.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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4. POLYCHAETE

Fabricia sabella (Ehrenberg)

Phylum: Annelida
 Class: Polychaeta

Order: Sabellida
 Family: Sabellidae

Description: Body minute; with 10 to 12 setigerous segments; eyes two pairs, on antipodal segments. Branchiae 6, on first segment.

Present Range: New England to Chesapeake Bay.

Distribution in Virginia: Mouth of York River on spider crab, *Libinia*, Willis Hewatt; lower Bay, D. F. Böesch, one, 1970; lower James River, Peter Larsen, one, 1973.

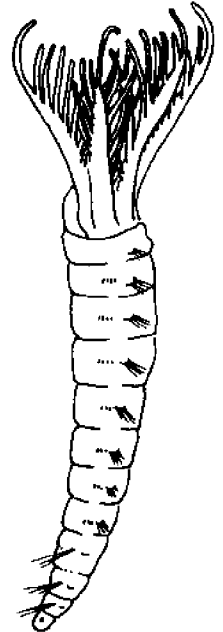
Habitat and Mode of Life: Poorly known. Only sabellid able to leave its tube.

Reproduction: Unknown.

Status: *Threatened*. Obviously rare.

Protective Measures Proposed: None.

Author: Marvin L. Wass.



5. SCALE WORM

Harmothoe imbricata Linne

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Polynoidae

Description: Large species; up to 65 millimeters long and 19 millimeters in width. Prostomium has distinct cephalic peaks. Elytra have conical micro-tubercles. Neurosetae have long spinous regions. Dorsal color gray to dark green, brown, or black (Pettibone, 1963).

Present Range: Ubiquitous. One of most common polynoids in all northern waters. Found both intertidally and dredged.

Distribution in Virginia: Only in Elizabeth River.

Habitat and Mode of Life: Lives commensally with many other invertebrates. Has long planktotrophic life. Semipelagic until grown. Tolerates wide range of salinities.

Reproduction: Eggs carried under elytra from mid-April through May.

Status: *Threatened*. Found once, in Elizabeth River; one specimen taken by Michael Richardson. Elizabeth River seems unable to harbor many scarce species.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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6. SCALE WORM

Lepidasthenia commensalis Webster

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Polynoidae

Description: Large species; up to 100 millimeters long, 9 millimeters wide. Body long, wormlike, much flattened. Elytra 30-50. Notoetae few, delicate; neurosetae stout, amber. Color dark reddish purple, gray or black (Pettibone, 1963).

Present Range: Massachusetts to North Carolina.

Distribution in Virginia: Rappahannock Shoals, June, 1962, 34 feet, one; Gloucester Point, September 25, 25 feet, one.

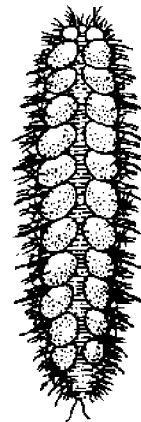
Habitat and Mode of Life: Active crawler; usually intertidal; lives commensally with other polychaetes, mostly terebellids. Occurs on flats of muddy sand and coarse gravel with mud. Often in tubes of *Amphitrite ornata* and *Diopatra cuprea*.

Reproduction: Unknown.

Status: *Threatened*. Occurs at mid-depth and on inshore bottoms where serious oil spills have occurred in the York River. Not taken recently.

Protective Measures Proposed: None.

Author: Marvin L. Wass.



7. POLYCHAETE

Parahesionia luteola Webster

Phylum: Annelida
 Class: Polychaeta

Order: Nereidiformia
 Family: Hesionidae

Description: Small species; length to 15 millimeters; segments to 45. Body widest in middle. One dorsal tentacular segment, six pairs of cirri crowded. Proboscis with large basal portion. Color reddish yellow (Pettibone, 1963).

Present Range: Massachusetts to Gulf of Mexico in low water.

Distribution in Virginia: Lower York River and James River oyster beds; also Elizabeth River.

Habitat and Mode of Life: Found in *Zostera* and oyster beds (Larsen, 1974).

Reproduction: Unknown.

Status: *Threatened*. Only two found in Lower York River by Robert Orth in July, 1969; 16 in James River oyster bed after more than a year's quarterly sampling at eight sites in oyster beds of James River; one found in Elizabeth River.

Protective Measures Proposed: Conservation of oyster rocks and eelgrass.

Remarks: Apparently only in eelgrass and oyster beds in Chesapeake Bay.

Author: Marvin L. Wass.

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8. POLYCHAETE

Paranaitis speciosa Webster

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Phyllodocidae

Description: Length to 18 millimeters, width 3 millimeters; segments to 55. Body widest in middle, tapering gradually, more so anteriorly. Proboscis narrow, cylindrical, papillated. Color varies: iridescent, greenish yellow with red spots mid-dorsally, with reddish band on segments 9 and 10 (Pettibone, 1963).

Present Range: Maine to Chesapeake Bay. Low water to 100 fathoms.

Distribution in Virginia: Found once in Sarah's Creek, near Gloucester Point.

Habitat and Mode of Life: Found at low water in sand in beds of *Mytilus edulis* and on tubes of *Diopatra*. Dredged from shallow bottoms of sand, clay, mud and shells in New England. In mud-detritus bottom.

Reproduction: Unknown.

Status: *Threatened*. Only one specimen found. Determined by Marian H. Pettibone.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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9. POLYCHAETE

Samythella eliasoni Day

Phylum: Annelida
 Class: Polychaeta

Order: Terebellida
 Family: Ampharetidae

Description: Length 10 millimeters; in fragile mud tube. Prostomium flattened triangular lobe overhanging mouth; one pair of tiny eyes. Branchial ridge with three-paired gills (Day, 1973).

Present Range: Chesapeake Bay, Virginia, North Carolina and Sweden.

Distribution in Virginia: Found only at Cherrystone Island near Cape Charles in 1965.

Habitat and Mode of Life: Unknown.

Reproduction: Unknown.

Status: *Threatened*. Species in an area where oil spills threaten.

Protective Measures Proposed: Surveillance.

Author: Marvin L. Wass.

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10. POLYCHAETE

Schistomeringos rudolphi Delle Chiaje

Phylum: Annelida
 Class: Polychaeta

Order: Eunicida
 Family: Dorvilleidae

Description: Length to 50 millimeters, width 3 millimeters; segments to 80. Living worms have reached 70 millimeters long, 0.7 millimeter wide; very contractile. Body as in *Schistomeringos caeca*. Prostomium with two or three rings. Antennae with 5-12 articles. Fore eyes larger, between bases of antennae and palps (Pettibone, 1963, as *Stauronereis*).

Present Range: Virginian Province to depth of 263 meters.

Distribution in Virginia: First found in Virginia at Gloucester Point at 15 feet by Wass; later in the Elizabeth River by Michael Richardson. Only one specimen each time. Dauer found two in Lynnhaven in 1978.

Habitat and Mode of Life: In fine sand at Gloucester Point.

Reproduction: Unknown.

Status: *Threatened*. Only four specimens taken from perhaps 2,000 grab samples.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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11. POLYCHAETE

Sthenelais boa (Johnston)

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Sigalionidae

Description: Length to 200 millimeters, width to 5 millimeters; segments to 200 or more. Elytra subreniform or lunate, with deep emargination in anterior border. Color: elytra varied, mottled gray on most, with dark brown mid-dorsally, darker bands on borders (Pettibone, 1963).

Present Range: Massachusetts (Cape Cod) to Brazil, Norway to Mediterranean, Indian Ocean and Japan.

Distribution in Virginia: Rappahannock Shoals, 1962, one specimen; York River, Vepco area, 1964, one specimen. Two off Cape Charles, 1978, by Dan Dauer.

Habitat and Mode of Life: Shallows to 75 feet; silt.

Reproduction: Unknown.

Status: *Threatened*.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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12. POLYCHAETE

Travisia carnea Verrill

Phylum: Annelida
 Class: Polychaeta

Order: Opheliida
 Family: Opheliidae

Description: Length about 75 millimeters; oblong or torpedo-like, pointed at both ends. Setae small, slender; branchiae begin on third setigerous segment, continuing to 20th. Color light red to deep flesh-color, with branchiae bright red (Miner, 1950).

Present Range: Martha's Vineyard, Massachusetts to Chesapeake Bay.

Distribution in Virginia: Chesapeake Bay, off Rappahannock River, 23 feet, one specimen; five individuals off Cape Charles by Dauer.

Habitat and Mode of Life: Lives in sand.

Reproduction: Unknown.

Status: *Threatened*. Rare.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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13. PILOSE DORIS

Acanthodoris pilosa (Abildgaard)

Phylum: Mollusca
Class: Gastropoda

Order: Nudibranchia
Family: Onchidorididae

Description: Adults 7-25 millimeters long. Rhinophores and gills retract into pits and angled rearward, with about 15 perfoliations on distal one-third. Gills seven, bipinnate, in median dorsal area around anal and renal openings. Mantle covers body with conical-shaped papillae over entire dorsum. Foot wider than body. Eye spots invisible. Genital openings on right side between mantle and foot (Abbott, 1974).

Present Range: Labrador to Chesapeake Bay.

Distribution in Virginia: Cherrystone Creek on bayside of Eastern Shore and from seaside (Vogel, 1977).

Habitat and Mode of Life: Feeds on various ectoprocts, including *Aleyonidium verrilli* and *Electra crustulenta*.

Reproduction: Large numbers of eggs produced, which hatch in 5-10 days.

Status: *Threatened*. Only six adults have been found.

Protective Measures Proposed: None.

Remarks: Species breeds in April and May. Could be more widespread unless euhaline.

Author: Marvin L. Wass.

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14. MANY-RIBBED WENTLETRAP

Epitonium multistriatum Say

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Epitoniidae

Description: Eight whorls cover crowded ribs from aperture to tip of spire; crowned by tiny protoconch. Color quite white (Abbott, 1974).

Present Range: Massachusetts to Bermuda, Florida and Texas, to 120 fathoms.

Distribution in Virginia: Lower Chesapeake Bay.

Habitat and Mode of Life: Unknown.

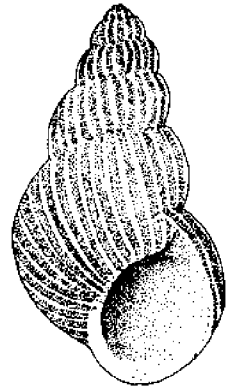
Reproduction: Unknown.

Status: *Threatened*. Only found once in Chesapeake Bay.

Protective Measures Proposed: None.

Remarks: Needs laboratory study of habits and prey.

Author: Rosalie M. Vogel.



15. BOREAL MARGINELLA

Marginella roscida Redfield

Phylum: Mollusca
Class: Gastropoda

Order: Neogastropoda
Family: Marginellidae

Description: Length 12 millimeters. Outer lip not sinuate, usually marked by four spots. Spire high, cream colored, with three faint spiral bands of purplish orange. Nucleus white (Abbott).

Present Range: Massachusetts to South Carolina..

Distribution in Virginia: Formerly at York Spit. Last seen at Cape Charles.

Habitat and Mode of Life: Found on sand in shallow water.

Reproduction: Unknown.

Status: *Threatened*. Due to nearness of considerable extensive development. The 1976 oil spill covered this area.

Protective Measures Proposed: None.

Remarks: There is a possibility that this species could have been *Marginella apicina* Menks, but specimens have been lost.

Author: Marvin L. Wass.

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GASTROPOD

Phyllaplysia engeli Marcus

Phylum: Mollusca
Class: Gastropoda

Order: Aplysiomorpha
Family: Aplysiidae

Description: Length to 26 millimeters. Parapodia form small openings over pallial cavity. Oral tentacles and rhinophores rolled. Eyes at surface next to rhinophore bases. Mouth with paired oral lobes anterior to openings. Animal has brown cuticular shell or none. Color green with tiny white, or pink to purple papillae on body. Rhinophores clear, with pink rings. Foot and gill green (Abbott, 1974).

Present Range: Virginia to Brazil.

Distribution in Virginia: Mouth of Cherrystone Creek, lower polyhaline (Vogel, 1977).

Habitat and Mode of Life: Found on *Zostera*; feeds on blade epiphytes.

Reproduction: Spawns in fall, lays flat mass of eggs. None seen in Virginia.

Status: *Threatened*. Extremely rare.

Protective Measures Proposed: Protect *Zostera*.

Author: Rosalie M. Vogel.

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17. BROWN SAYELLA

Sayella fusca C. B. Adams

Phylum: Mollusca
 Class: Gastropoda

Order: Megogastropoda
 Family: Pyramidellidae

Description: Minute, 5 millimeters. Shell translucent, elongate. Periostracum glossy. Whorls with growth lines and fine spiral striations. Sutures marked. Aperture flaring, with fold inside (Abbott, 1974).

Present Range: Prince Edward Island to Florida.

Distribution in Virginia: Lower Chesapeake Bay; York River.

Habitat and Mode of Life: Parasitic on invertebrates, probably annelids.

Reproduction: Unknown.

Status: *Threatened*. Knowledge of hosts unknown.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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18. SMITHS' MARTESIA

Diplothyra smithi Tryon

Phylum: Mollusca
 Class: Bivalvia

Order: Heterodontida
 Family: Pholadidae

Description: Length to 16 millimeters. Shell pear-shaped. Strong callum in adult; light, brittle, inflated; equivalve, umbones prominent. Shell sculptured in anterior triangle with very fine, close-set concentric ridges and radial ribs. Periostracum gray to dull yellow. Siphons short, united, white (Abbott, 1974).

Present Range: Massachusetts to Texas.

Distribution in Virginia: Lower Chesapeake Bay.

Habitat and Mode of Life: Bores in oyster shells.

Reproduction: Unknown.

Status: *Threatened*. Quite rare.

Protective Measures Proposed: None.

Remarks: Seemingly more common before disease destroyed many high-salinity oyster beds.

Author: Marvin L. Wass.

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19. ISOPOD

Paracerceis caudata Say

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Sphaeromidae

Description: Small, rectangular species. Only outer branch of uropods visible. First of two abdominal segments produced as spine. Outer branch of uropods lacking spines. Horizontal sinus across uropod; four teeth, two on either side of uropod (Schultz, 1969).

Present Range: New Jersey to West Indies; 0-46 meters (Schultz, 1969).

Distribution in Virginia: Second most abundant species in eelgrass in 1971 (Marsh, 1973).

Habitat and Mode of Life: Since 1972 found by Robert Orth only once on each side of Chesapeake Bay. Apparently only on eelgrass.

Reproduction: Young out of brood pouches seen from June into September (Marsh, 1973).

Status: *Threatened*. Threatened status caused by freshets, low dissolved oxygen and oil pollution. Local extinction could occur.

Protective Measures Proposed: Surveillance after catastrophes to assess damage.

Remarks: Almost complete disappearance has prevailed for six years.

Author: Marvin L. Wass.

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20. AMPHIPOD

Ampithoe valida Smith

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Ampithoidae

Description: Length to 11 millimeters. First four coxal plates deep, coxa 5 longest. Eye small, round, black. Antenna 1 longest; peduncle short. Male gnathopod 1, segment 5 longer than 6. Gnathopod 2 longer than 1, segment 6 swollen, with rounded median tooth and prominent posterior angle. Uropod 2 shorter than 1 (Bousfield, 1973).

Present Range: Atlantic and Pacific coasts; New Hampshire to Cape Canaveral, Florida (Fox and Bynum, 1975).

Distribution in Virginia: Known only from two specimens (male and female) taken in the Warwick River on fouling plates (Feeley and Wass, 1971).

Habitat and Mode of Life: Usually in shallow water on *Ulva*. Annual, several broods, May-September (Bousfield, 1973).

Reproduction: Unknown.

Status: *Threatened*. Effect of increasing sewage effluent unknown.

Protective Measures Proposed: None. Species apparently common in Maryland portion of Chesapeake Bay.

Author: Marvin L. Wass.

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21. DECAPOD

Macrobrachium ohione Smith

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Palaemonidae

Description: Length: male 68 millimeters, female 102 millimeters. Rostrum high, straight, tip curving up; margin with 9-13 teeth, lower margin with 1 to 3 teeth. Carapace smooth. Antennal scale 2.5 times longer than broad. First legs reach beyond scale. Second legs of adult female stronger than in male; fingers shorter than palm (Williams, 1965).

Present Range: Virginia to Georgia; Mississippi drainage mouth to St. Louis, Missouri and Aransas Bay, Texas.

Distribution in Virginia: In oligohaline zones of the Pamunkey and James Rivers (Hobbs and Massman, 1952).

Habitat and Mode of Life: Presumably it partly burrows into soft mud and feeds on detritus.

Reproduction: Eggs carried by female until hatching occurs.

Status: *Threatened*. In the James River, many must encounter the canal and screens in the Surry Plant. Furthermore, they could be affected by Kepone or other hazardous pollutants.

Protective Measures Proposed: Provide suitable water quality, keep them out of generating plant intakes, and refrain from using them for bait or food.

Remarks: First reported from Virginia in 1952 and Virginia is still the northern limit on the Atlantic coastal plain.

Author: Marvin L. Wass.

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22. DECAPOD

Dissodactylus mellitae Rathbun

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Pinnotheridae

Description: Carapace: Male, length 2.9 millimeters, width 3.5 millimeters; ovigerous female, length 3.3 millimeters, width 4.5 millimeters. Carapace convex, smooth; front concave. Eyes small. Chelipeds short, stout; hand longer than other articles combined. Color light, with few dark mottlings (Williams, 1965).

Present Range: Vineyard Sound, Massachusetts to Charleston, South Carolina and Pensacola, Florida.

Distribution in Virginia: Evidently only a very small area near Kiptopeke, Virginia, commensal with the Keyhole Sand-dollar.

Habitat and Mode of Life: On shallow, sandy bottom.

Reproduction: Unknown; probably May to August.

Status: *Threatened*. Depletion caused by dredging, oil spills, possible sand-mining.

Protective Measures Proposed: None.

Remarks: Possibly occupies one of smallest habitats in Chesapeake Bay.

Author: Marvin L. Wass.

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23. KEYHOLE SAND-DOLLAR

Mellita quinquiesperforata Leske

Phylum: Echinodermata
Class: Echinoida

Order: Clypeasteroidea
Family: Mellitidae

Description: Length to 11 centimeters. Disc very flat, rounded, except at rear. Mouth ventral in center, with radiating grooves. Test pierced by five holes (hence name) (Gosner, 1971).

Present Range: Seems to occur in small numbers in shallow areas along the coast of Chesapeake Bay near Cape Charles. Gosner (1971) believed its northern limit was Chesapeake Bay. It ranges south to the Gulf of Mexico, but no tests have been seen by Wass on the coast from Chesapeake Bay to Cape Hatteras.

Distribution in Virginia: At York Spit Light in 1960; now only near Cape Charles City.

Habitat and Mode of Life: Occurs on fine sand substrates. Feeds by moving currents of fine sand over body. *Dissodactylus mellitae* is a commensal pinnotherid crab associated only with this sand-dollar in Chesapeake Bay.

Reproduction: During summer.

Status: *Threatened*. Decline caused by unknown factors which have restricted its range. Possibly subject to massive dredging in area. Apparent northern limit at upper end of Bay mouth (Gosner, page 573).

Protective Measures Proposed: Not feasible.

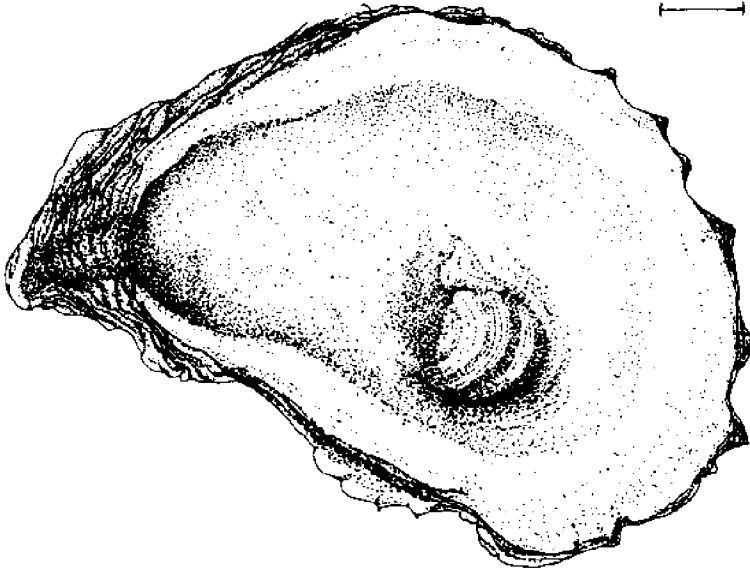
Remarks: Possibly a relict population separated from North Carolinian population.

Author: Marvin L. Wass.

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DEPLETED(3)

1. VIRGINIA OYSTER

Crassostrea virginica GmelinPhylum: Mollusca
Class: BivalviaOrder: Ptereoconchida
Family: Ostreidae

Description: An irregularly-shaped bivalve with a thick shell and tightly-closed valves held shut by one large muscle. Shell broadly oval in ideal conditions; often distorted, bent or elongated in nature. Left valve deeply cupped, thicker than right. Inequilateral, beaks anterior, inconspicuous. Shell formation prolific. This fast-growing mollusk has large areas of gill surface for pumping and filtering plankton from brackish waters (Galtsoff, 1964; Abbott, 1974).

Present Range: New Brunswick to Texas.

Distribution in Virginia: Brackish waters throughout Chesapeake Bay and its tributaries where salinities achieve 10 parts per thousand a few months of the year.

Habitat and Mode of Life: Oysters live intertidally and subtidally wherever hard substrate is available - shell beds, pilings, bridges, piers. Recruitment is irregular but may be intensive, depending on salinity and circulatory regimes. Life-span is long in low salinities where predators and diseases are excluded. In favorable places, oysters setting one on another create reefs. Oyster beds are substrate, food and refuge for a large community of associated and dependent invertebrate species.

Reproduction: Mass spawning in the warm season is followed by 10 to 14 days of planktonic life. Losses from predation and dispersal are very high during this period. Setting occurs on shells and other hard substrates in wide range of salinities (5 to 35 parts per thousand) from 1 July to 1 October in Virginia.

Status: *Depleted.* Oysters were severely depleted from their status when commercial harvesting began about 100 years ago. Although restricted to antiquated gear, continuous harvesting of oysters has resulted in overfishing. Most natural beds in polyhaline waters (20 parts per thousand salinity) are barren. Even where spat setting is adequate, predators prevent survival and effective recruitment. Most oysters are harvested now from private and public beds in low salinity waters (5 to 20 parts per thousand salinity) where both predators and diseases are excluded.

Protective Measures Proposed: Most important is to protect estuarine waters from nutrient and toxic pollutants that upset oyster reproduction and food organisms. Silting, salinity changes and overfishing are additional threats. Avoid introduction of pest and pathogen species with exotic shellfish.

Remarks: A new disease caused by a sporozoan called MSX (*Minchinia nelsoni*) has greatly accentuated depletion of oysters by preventing survival of susceptible seed stocks in high salinity areas. The lower Chesapeake Bay grounds are no longer planted by private oyster growers. Resistant brood stocks have been bred and selected but seed oysters from these must be produced in hatcheries.

Pollution by man is a severe threat to oyster communities in Chesapeake Bay. Kepone contamination has restricted harvesting of oysters in the James River to seed that is replanted in clean waters for cleaning. Chlorine disinfection of sewage threatens to intercept and kill oyster larvae riding the tides as they pass discharging plants. Steadily increasing loads of sewage may destroy oyster populations and most associated organisms by preventing survival of planktonic larvae unless safer methods of nutrient and bacterial control are found.

The failure of oyster fisheries in various parts of the world led to the introduction of exotic species in the hope that the industry could be preserved. This has occurred on the West Coast of North America, Australia and New Zealand, and most recently in France in 1967 - all with the Pacific or Japanese oysters (*Crassostrea gigas*). In each instance, new diseases have broken out in endemic oysters, with catastrophic consequences. In addition, exotic predators and pests have accompanied the oyster imports with far-reaching effects.

Fortunately, the Middle Atlantic Coast is a difficult environment with a continental climate and wide temperature extremes that most exotic species find too strenuous. Few marine exotics are known to occur in Chesapeake Bay but it is unwise to tempt fate. The Portuguese oyster, *Crassostrea angulata*, is virtually gone from the coast of France in less than a decade after a new gill disease appeared, and *Crassostrea gigas* replaced it. Exotic species and their associates are often a severe threat to endemics in disturbed habitats. If they succeed, these exotics often become pests for many years until biotic controls have time to ameliorate their "weedy" tendencies. The southern Atlantic Coast of France is in the "pest" phase with *Crassostrea gigas* now.

There is little danger that *Crassostrea virginica* will become an endangered species. Its wide geographic range and salinity tolerance, including long periods of fresh water in winter and spring when temperatures are low, insure survival. It is also tolerant of many pollutants - heavy metals, pesticides, and bacterial loads. However, genetic diversity could be impaired if oysters were depleted from certain river systems where distinctive physiological and immunological strains are recognized, e.g., the Potomac River population which appears to be a separate race of oysters. These races appear to retain their identity despite much transplanting of seed oysters from other areas.

Author: Jay D. Andrews.

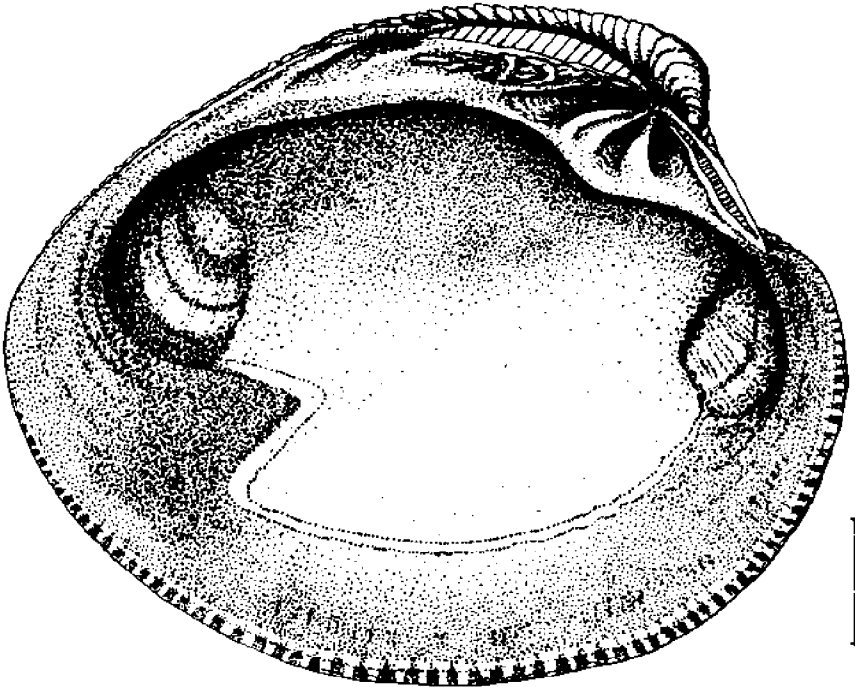
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2. HARD CLAM, QUAHOG

Mercenaria mercenaria Linnaeus

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Veneridae



Description: Maximum length 125 millimeters. Shell subtriangular to ovate, posterior drawn out; heavy, inflated, equivalve, umbones prominent. Lunule conspicuous, heart-shaped. Strong concentric ridges and ribs sculpture valves. Interior flat white or iridescent. Pearls very rare. Siphons short, united (Abbott, 1974).

Present Range: Gulf of St. Lawrence to Gulf of Mexico.

Distribution in Virginia: Lower Chesapeake Bay and lower parts of rivers.

Habitat and Mode of Life: In suitable bottoms above 10 parts per thousand salinity and having sediment soft enough in which to burrow.

Reproduction: Exceedingly poor in Chesapeake Bay; much better in seaside bays of Eastern Shore.

Status: *Depleted*. Increasing scarcity due somewhat to commercial harvesting, but probably due mainly to destruction of small clams by the blue crab.

Protective Measures Proposed: Perhaps most easily cultured clam, but rock aggregate must be added to mud to prevent blue crabs from eating clams.

Author: Dexter S. Haven.

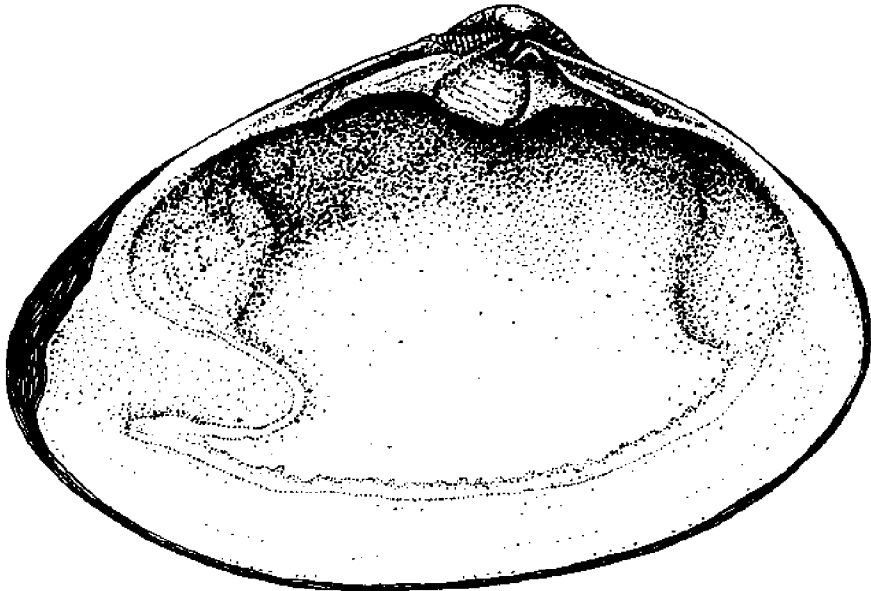
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3. ATLANTIC SURF CLAM

Spisula solidissima Dillwyn

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Mactridae



Description: Length to 180 millimeters. Shell oval; heavy, inflated, equivalve. Sculpture of fine concentric lines. Left valve with three cardinal teeth and two laterals; right valve with two cardinal teeth and four laterals. Shell interior white, smooth. Periostracum shiny, thin, light brown. Shell margin smooth. Siphons short and united (Abbott, 1974).

Present Range: Nova Scotia to South Carolina.

Distribution in Virginia: Taken rarely in Hampton Roads and lower Bay except along shore at Cape Charles and Cape Henry.

Habitat and Mode of Life: Burrows in bottom and extrudes siphons through sand.

Reproduction: Wastage of larvae and young is great. Brood stocks may need to be large for successful recruitment. Predators abundant and may seriously deplete small populations.

Status: *Depleted*. Numbers remain large but fishing was recently restricted to two days a week because of overfishing off Virginia.

Protective Measures Proposed: Limit catch.

Remarks: May come back quickly if successful yearclass occurs. Market and restrictions could portend the future.

Author: Marvin L. Wass.

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SPECIAL CONCERN (68)

1. SPONGE

Mycale cecilia de Laubenfels

Phylum: Porifera

Order: Poecilosclerina

Class: Demospongiae

Family: Ophlitaspongiidae

Description: Flat colonies up to 8 centimeters in diameter forming crusts on shells and calcareous tubes. Color pale yellow to green and tan; texture soft to slimy (Wells, Wells and Gray, 1960).

Present Range: Panama, Hawaii, North Carolina, and Chesapeake Bay.

Distribution in Virginia: Known only from York River.

Habitat and Mode of Life: Lives on stems of eelgrass near bases of grass (Marsh, 1973).

Reproduction: Embryos orange.

Status: *Special Concern*. Died back when eelgrass disappeared during lowered salinities.

Protective Measures Proposed: None.

Remarks: Possibly a new species, subspecies, or variant. Alex Marsh noted different color.

Author: Marvin L. Wass.

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2. RED-FINGER SPONGE

Microciona prolifera (Ellis and Solander)

Phylum: Porifera
 Class: Demospongiae

Order: Poecilosclerina
 Family: Microcionidae

Description: A famous sponge because of its ability to regroup cells put through a fine cloth and form new sponges. This sponge, unlike others, flourishes in colder water, forming tough, ramifying and anastomosing dark red masses up to 2 feet long (Burbanck *In: Brown, 1950*). Most fascinating sponge in the Bay; it shelters many higher animals.

Present Range: North Carolina to New England.

Distribution in Virginia: Over much of Bay to 10 parts per thousand salinity. Now very scarce in York River, none having washed up at VIMS in live condition in the past winter (1977-78).

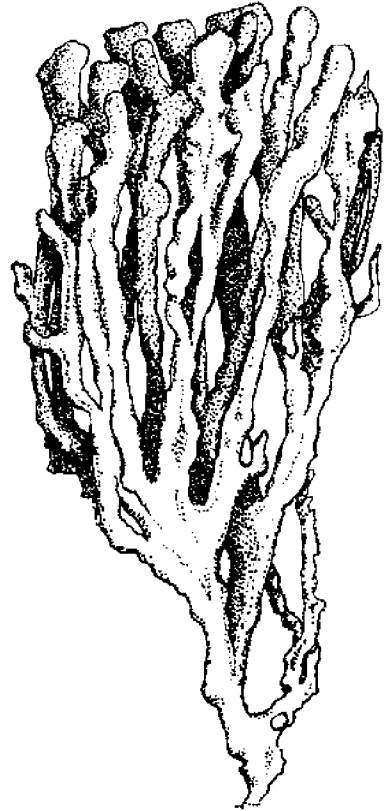
Habitat and Mode of Life: Occurs on pilings, oyster shells and other firm substrates.

Reproduction: By various reproductive devices. H. V. Wilson did cell reaggregation studies on this species.

Status: *Special Concern*. Has continued to decrease since the 1972 storm. Few seen have been in poor condition.

Protective Measures Proposed: None.

Author: Marvin L. Wass.



3. POTATO SPONGE

Craniella laminaris (George and Wilson)

Phylum: Porifera
 Class: Demospongiae

Order: Choristida
 Family: Craniellidae

Description: Colonies begin with conic form, becoming amorphous as they tip. The hard gray structures luxuriate in summer over mud and silty sand, often being partly buried (Wells, Wells and Gray, 1960).

Present Range: From Chesapeake Bay southward.

Distribution in Virginia: Bay and lower rivers above about 20 parts per thousand salinity.

Habitat and Mode of Life: Usually on firmer bottom unless broken loose. Probably grows rapidly. Must filter much water when abundant.

Reproduction: Unknown.

Status: *Special Concern*. Greatly decreased since 1970.

Protective Measures Proposed: None.

Remarks: Once common on VIMS beach in 60's, now found dead in lower York River (few). Jay Andrews found many dead specimens at York Spit in May, 1978.

Author: Marvin L. Wass.

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4. SEA WHIP

Leptogorgia virgulata Lamarck

Phylum: Cnidaria
Class: Anthozoa
Subclass: Alcyonaria

Order: Gorgonacea
Family: Gorgoniidae

Description: Slender, branching, up to 2 feet in length (Gosner, 1971). Occurs in two colors: dark purple in York River, yellow-tan in lower Bay. River specimens more terete (bushy).

Present Range: Chesapeake Bay to northern Gulf of Mexico.

Distribution in Virginia: Lower parts of major rivers and in lower Bay.

Habitat and Mode of Life: Attach by holdfast to solid objects such as oyster shells.

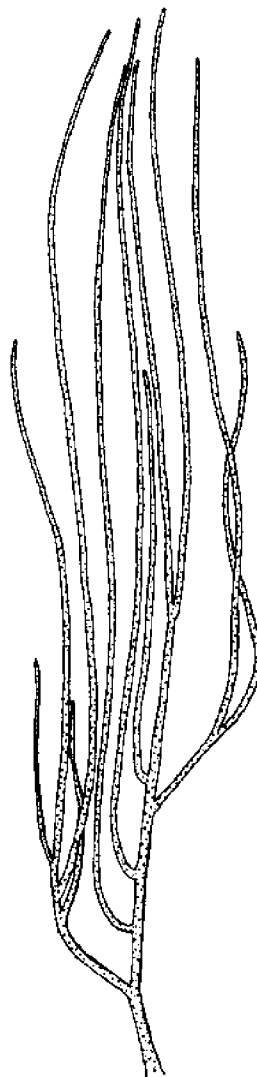
Reproduction: Almost certainly in summer.

Status: *Special Concern*. Not seen in York River since 1972 storm occurred.

Protective Measures Proposed: None.

Remarks: Reasons for lack of return in the York River are unknown.

Author: Marvin L. Wass.



5. SEA ANEMONE

Edwardsia elegans Verrill

Phylum: Cnidaria
 Class: Anthozoa

Order: Actiniaria
 Family: Edwardsiidae

Description: Aura of mystery surrounds this species. Most abundant burrowing anemone, it is vermiform, has 16 tentacles with ragged rust-orange covering on scapus. Tentacular disk delicately beautiful in life (Miner, 1950).

Present Range: Woods Hole to Chesapeake Bay.

Distribution in Virginia: Mesopolyhaline, sandy mud; depths.

Habitat and Mode of Life: Life history never studied.

Reproductions: Unknown.

Status: *Special Concern.* Low salinities and low oxygen followed Tropical Storm Agnes. Other unknown causes had already produced marked declines.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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6. RIBBON-WORM (NEMERTEAN)

Amphiporus ochraceus Verrill

Phylum: Rhynchocoela
 Class: Anopla

Order: Haplonemertini
 Family: Amphiporidae

Description: Body elongate, to 70 millimeters. Inverted V-shaped groove behind head. Worms active, often leech-like. Color ochre. Brain yellow to red. Ocelli 14. Proboscis exceeding body; has herring-bone pattern in retraction (Goodchild *In*: Brown, 1950; McCaul, 1963).

Present Range: Massachusetts to Texas.

Distribution in Virginia: Known from Mumfort Island, York River in Chesapeake Bay.

Habitat and Mode of Life: Common on *Zostera* before Tropical Storm Agnes destroyed the beds.

Reproduction: Mainly in summer.

Status: *Special Concern.* Greatly depleted after loss of eelgrass following 1972 tropical storm.

Protective Measures Proposed: Attempt to reestablish eelgrass.

Author: Marvin L. Wass.

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7. RIBBON-WORM (NEMERTEAN)

Tetrastemma candidum (Muller)

Phylum: Rhynchozoela
Class: Anopla

Order: Haplonemertini
Family: Tetrastemmatidae

Description: Head rounded, slender neck distinct. Body thickened in mid-section, tapering tail pointed. Four ocelli form a square. Body 0.5 by millimeters. Color greenish-brown, with scattered red-brown (McCaul, 1963; Gosner, 1971).

Present Range: Circumpolar; on Atlantic shores, from Norway to South Africa; from Labrador to Florida; Gulf Coast to Louisiana; on Pacific Coast from Alaska to Mexico.

Distribution in Virginia: Frequently collected from eelgrass in the York River by Alex Marsh (1970; 1973).

Habitat and Mode of Life: Frequent on eelgrass.

Reproduction: Unknown.

Status: *Special Concern.* Habitat much regressed.

Protective Measures Proposed: Protect eelgrass.

Author: Marvin L. Wass.

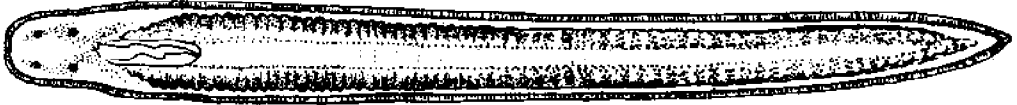
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8. RIBBON WORM (NEMERTEAN)

Tetrastemma elegans Girard

Phylum: Rhynchozoela
Class: Anopla

Order: Haplonemertini
Family: Tetrastemmatidae



Description: Head demarcated by narrow neck; body rounded. Ocelli in square of four. Length usually 0.6 millimeter by 15 millimeters. Outstanding color is pair of brown stripes over length of body. Background cream, may show green eggs laterally (McCaul, 1963).

Present Range: Southern coast of Cape Cod to Chesapeake Bay.

Distribution in Virginia: Second most abundant nemertean at Mumfort Island, Gloucester Point, Virginia.

Habitat and Mode of Life: Found on eelgrass leaves.

Reproduction: Abundant on eelgrass in June; common from April through August.

Status: *Special Concern.* Disappeared from Mumfort Island, York River, after 1972 storm. Recovery of grass has not occurred.

Author: Marvin L. Wass.

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9. RIBBON WORM (NEMERTEAN)

Zygonemertes virescens Verrill

Phylum: Rhynchozoela
 Class: Anopla

Order: Haplonemertini
 Family: Amphiporidae

Description: Very active worm. In moving forward it is rounded in cross-section; when moving backward, worm is short and flattened. Worm 40 by 0.5 millimeters; may contract to 10 by 1.5 millimeters. Three rows of eyes in adults. Color dull olive green, head lighter; dorsum diffusely granulated; posterior two-thirds of body has irregular pigment blotches (McCaul, 1963).

Present Range: Bay of Fundy to Florida, and West Coast.

Distribution in Virginia: In Virginia, reported only from eelgrass. Most abundant nemertean on *Zostera*.

Reproduction: Species found only from mid-April to early October; abundant June through August.

Status: *Special Concern*. Habitat destroyed by low salinity in 1972. No recovery had occurred by 1978.

Author: Marvin L. Wass.

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10. POLYCHAETE

Aglaothamus circinata (Verrill)

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Nephtyidae

Description: Prostonium subpentagonal, anterior margin thin, spatulate; translucent areas near bases of frontal antennae. Tentacular segment enlarged. Proboscis with subterminal papillae in 14 longitudinal rows (Pettibone, 1963).

Present Range: Gulf of St. Lawrence to North Carolina. In depths ranging from 2 to 787 meters.

Distribution in Virginia: Six specimens collected off Cape Charles at depths ranging from 2 to 10 meters.

Habitat and Mode of Life: Collected on bottoms of mud and sand with gravel, rocks and shells.

Reproduction: Unknown.

Status: *Special Concern*. This species is probably at the southern extent of its range near the Chesapeake Bay.

Protective Measures Proposed: None.

Author: Daniel M. Dauer.

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11. POLYCHAETE

Ancistrosyllis jonesi Pettibone

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Pilargiidae

Description: Body long, flattened dorsoventrally, tapered anteriorly; parapodia deeply cut. Lateral antennae shorter than palpophores. Lacking defined eyes. Notopodia enlarged, inflated, conical. Stout hooked notosetae begin on setiger 6. Size about 1 millimeter wide and perhaps 30 millimeters long (Pettibone, 1966).

Present Range: Chesapeake Bay and North Carolina.

Distribution in Virginia: Chesapeake Bay off Rappahannock River, 7 fathoms mud, July 21, 1963; also in York River at Clay Bank and Gloucester Point, M. Wass, D. Boesch. James River oyster bed, one specimen, P. Larsen, 1974.

Habitat and Mode of Life: Intertidal in sand mixed with gravel, mud and shell fragments in North Carolina (Gardner, 1975).

Reproduction: Unknown.

Status: *Special Concern.* Evidently a rare species.

Protective Measures Proposed: None.

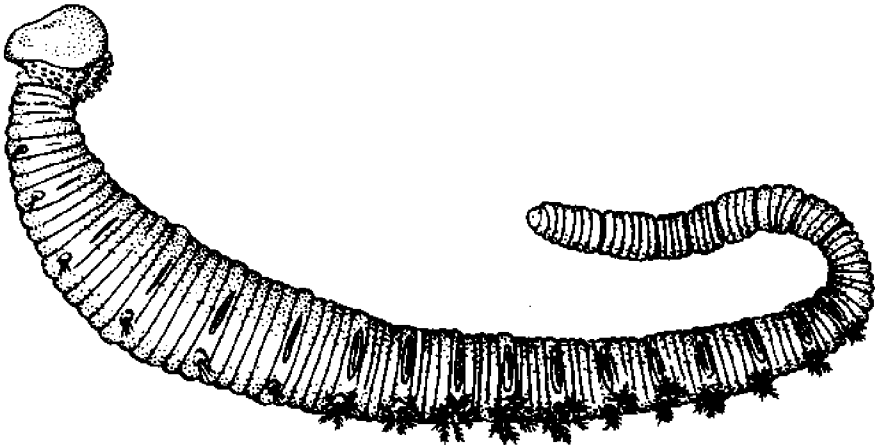
Author: Marvin L. Wass.

12. POLYCHAETE

Arenicola cristata Stimpson

Phylum: Annelida
 Class: Polychaeta

Order: Capitellida
 Family: Arenicolidae



Description: Large dark green worm burrowing into sand and producing large jelly-like masses incorporating eggs. A diatom is common in the jelly mass. Skin of worm annulated; long setae cage head region. Mucus layer envelops sand; skin segments indistinct. Green blood colors skin; reddish gills tufted (Brown, 1950).

Present Range: Cape Cod to Florida.

Distribution in Virginia: Basically in lower Bay at salinities between 10 and 25 parts per thousand.

Habitat and Mode of Life: In finer sands and silts.

Reproduction: Jelly-like egg masses on flats were abundant in early 1960's.

Status: *Special Concern.* None have been seen at VIMS in the 1970's. Dauer collected 10 in Broad Bay of Lynnhaven, indicating a healthy population there.

Protective Measures Proposed: None.

Remarks: Oil spills may have been responsible, but low salinities might also have been detrimental.

Author: Marvin L. Wass.

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13. POLYCHAETE

Brania clavata (Claparede)

Phylum: Annelida
Class: Polychaeta

Order: Phyllodocida
Family: Syllidae

Description: Tiny species; length to 4 millimeters, width to 0.3 millimeter, segments 21-35. Prostomium has two pairs of eyes; lateral pair with large lenses. Eggs and young attach to dorsal body of female on setigers 9-24 and appear crowded, nearly covering dorsum (Pettibone, 1963).

Present Range: Gulf of St. Lawrence to Virginia; Ireland to Tristan da Cunha; Japan Sea and Mexico.

Distribution in Virginia: Gloucester Point, 1964, six per square meter, M. Wass; Mumfort Island, 1968, 13 per gram of *Zostera*, G. A. Marsh (1970, 1973); Chesapeake Bay (Back River), 1970, two specimens, R. Orth; one specimen off Cape Charles, Dan Dauer.

Habitat and Mode of Life: Seems restricted to eelgrass in Chesapeake Bay where it may graze on diatoms.

Reproduction: Mature males and females with eggs appeared on the surface at Woods Hole, July to September.

Status: *Special Concern.* None seen recently.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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14. FRINGED WORM

Cirriformia grandis Verrill

Phylum: Annelida
 Class: Polychaeta

Order: Spionida
 Family: Cirratulidae

Description: Very large, tentaculate worm, 15 centimeters by 6 millimeters. Proboscis unarmed. Body filiform, elongate. Segments eight and nine have two bundles of setae on either side, together with two clusters of long brachial cirri (Miner, 1950; Day, 1973). Clusters are crowded cirri. Color yellow to orange-brown. Cirri very active. *Cirratulus grandis* in Miner (1950).

Present Range: Massachusetts to North Carolina.

Distribution in Virginia: In mesopolyhaline waters of lower rivers.

Habitat and Mode of Life: Lives in soft sediments of river slopes and channels; usually below a depth of 10 feet.

Reproduction: Unknown.

Status: *Special Concern.* Numbers drastically reduced after 1972 storm.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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15. ICE CREAM CONE WORM

Ciatena gouldi Verrill

Phylum: Annelida
 Class: Polychaeta

Order: Terebellida
 Family: Amphictaeidae

Description: One of most aberrant polychaetes in view of sand-grain cone and golden setae forming operculum. Two sets of long, golden setae with about 15 in each set. Worm uses these sharp-pointed setae to dig its burrow (Miner, 1950; Pettibone, 1964).

Present Range: Maine to North Carolina; to 15 fathoms.

Distribution in Virginia: Polyehaline in sandy areas.

Habitat and Mode of Life: Burrows in bottom with head down.

Reproduction: Often very good.

Status: *Special Concern.* Severe decrease occurred about 1964 in the York River and the species has not recovered its former numbers. Dauer found it common off Lynnhaven and Cape Charles (Boesch, Wass and Virnstein, 1976).

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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16. POLYCHAETE

Enoplobranchius sanguineus Verrill

Phylum: Annelida
 Class: Polychaeta

Order: Terebellida
 Family: Terebellidae

Description: An unusual worm looking like a filamentous mop of motile blood red threads, each branch ending in sharp setae. Animal may attain length of 14 inches and tentacles likewise (Miner, 1950; Pettibone, 1964).

Present Range: Gulf of St. Lawrence to Virginia.

Distribution in Virginia: Reported only between eelgrass and lower low water at Gloucester Point. Should occur elsewhere but not reported.

Habitat and Mode of Life: Burrows, sending great numbers of contractile branches through the fine sediment; very difficult to collect an entire worm.

Reproduction: Unknown.

Status: *Special Concern*. Greatly decreased along with eelgrass habitat.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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17. POLYCHAETE

Eumida sanguinea Oersted

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Phyllodocidae

Description: Minute species, about 12 millimeters long, but composed of approximately 65 segments. Two pairs of stout antennae and an unpaired antenna occur. Eyes large, black. Parapodial cirri lanceolate (Pettibone, 1963).

Present Range: Iceland, Norway, Mediterranean Sea, and Gulf of St. Lawrence to Georgia and Gulf of Mexico. West Coast of United States, Galapagos, Japan, Red Sea, Indian Ocean and New Zealand.

Distribution in Virginia: Found to depths of 30 feet in sand in lower Bay at Kiptopeke (scarce), York River (four), and James River.

Habitat and Mode of Life: Intertidal on shells, under rocks, on pilings. Dredged on bottoms of mud, gravel, stones, shells, algae, bryozoans and especially with sandy tunicate, *Amaroucium pellucidum*.

Reproduction: At Woods Hole, numerous small specimens and females with masses of green eggs occurred during summer months.

Status: *Special Concern*. Greatly decreased along with eelgrass habitat.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

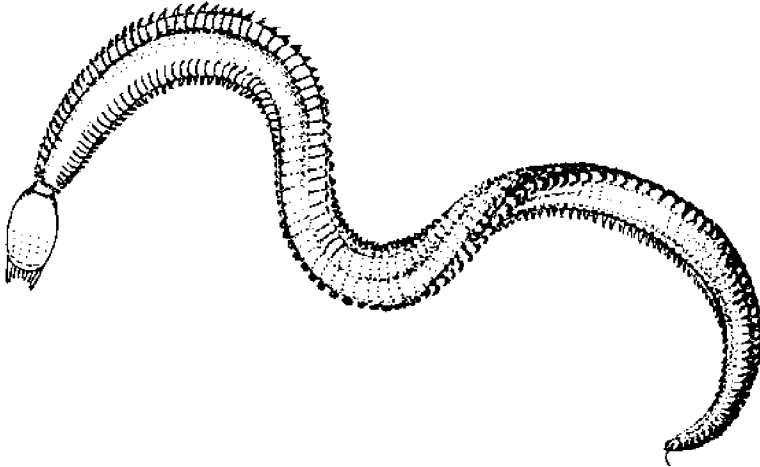
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18. POLYCHAETE

Nephtys incisa Malmgren

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Nephtyidae



Description: Medium size; length to 60 millimeters, width to 4 millimeters. Prostomium arched dorsally, with four antennae. Parapodia with bilobed acicular lobes. Posterior lamella elongate, exceeding acicular lobes. Branchiae cirriform, sickle-shaped (Pettibone, 1963).

Present Range: Greenland, Iceland, Norway, Sweden, North Sea, Baltic Sea, Mediterranean Sea, Gulf of St. Lawrence to Chesapeake Bay, Virginia. Low water to 950 fathoms.

Distribution in Virginia: Chesapeake Bay, mainly at depths of 5 to 15 fathoms.

Habitat and Mode of Life: Found in muddy sand, debris, shells and detritus.

Reproduction: Eggs produced in summer.

Status: *Special Concern.* Population greatly depleted in late 1960's, perhaps due to low dissolved oxygen in summer.

Protective Measures Proposed: None, until cause of great decline can be determined.

Remarks: Was one of most common species at the York River site in early 1960's.

Author: Marvin L. Wass.

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19. POLYCHAETE

Phyllodoce castanea (Marenzeller)

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Phyllodocidae

Description: Length to over 20 millimeters, width 2 millimeters. Tentacular cirri rounded in cross-section. Anterior dorsal cirri ropelike, middle cirri conical. Color yellow to deep red (Gardiner, 1975).

Present Range: Widely distributed in tropical and subtropical oceans. Intertidal to 500 meters.

Distribution in Virginia: Known from a single specimen collected off Cape Charles.

Habitat and Mode of Life: Probably an active carnivore. Collected on pilings, coral, and in fine sand.

Reproduction: Unknown.

Status: *Special Concern.* This species is probably at the northern extent of its geographic distribution.

Protective Measures Proposed: None.

Author: Daniel M. Dauer.

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20. POLYCHAETE

Platynereis dumerilli Audouin and Milne-Edwards

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Nereidae

Description: Length to 75 millimeters, width to 6 millimeters; segments to 90. Body cylindrical, tapered posteriorly. Prostomium suboval. Four eyes quite large. Proboscis with amber jaws, each with 5-13 teeth. Color from iridescent olive green to reddish with violet chromatophores (Pettibone, 1963).

Present Range: Almost cosmopolitan in warm seas.

Distribution in Virginia: Formerly abundant on grass beds to salinities up to 15 parts per thousand.

Habitat and Mode of Life: Population seemed to be mainly on eelgrass. Forms tenacious, transparent tubes on various substrates elsewhere.

Reproduction: By male and female swimmers, form modified epitokes. Males pursue females. Sexual elements emptied into water where fertilization and development occur; or (at Woods Hole) by a "unique copulatory mechanism, as in *Platynereis dumerilli megalops*. Virginia situation unknown. Adults die after spawning.

Status: *Special Concern.* Depleted following Tropical Storm Agnes.

Protective Measures Proposed: Eelgrass must be returned to former habitats.

Author: Marvin L. Wass.

21. POLYCHAETE

Stenostomeringos caeca (Webster and Benedict)

Phylum: Annelida
 Class: Polychaeta

Order: Eunicida
 Family: Dorvilleidae

Description: Length to 8 millimeters, width 0.6 millimeter; segments to 60. Body long, slender, cylindrical, tapered at both ends; flattened ventrally, arched dorsally. Prostomial antennae with 10-15 articles. Color white (Pettibone, 1963, as *Stauronereis*).

Present Range: Gulf of St. Lawrence to Massachusetts, Virginia, North Carolina, Washington, north Japan Sea. Intertidal to 154 meters.

Distribution in Virginia: Two individuals collected off Cape Charles.

Habitat and Mode of Life: Small, carnivorous polychaetes found mainly intertidal to shallow depths. Occur in a wide variety of sediment types.

Reproduction: Unknown.

Status: *Special Concern.* Although few specimens have been collected, it appears that North Carolina represents the extreme southern extent of its distribution.

Protective Measures Proposed: None.

Author: Daniel M. Dauer.

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22. POLYCHAETE

Scoloplos rubra (Webster)

Phylum: Annelida
 Class: Polychaeta

Order: Orbiniida
 Family: Orbiniidae

Description: Length near 70 millimeters, width 1 millimeter. Prostomium acute in front, longer than wide; eyes absent. Thorax broadly oval and much depressed. Branchiae large by sixth segment. Color varies from shades of red to orange with mid-body green (Hartman, 1951).

Present Range: Chesapeake Bay to Florida.

Distribution in Virginia: Six specimens collected near the Narrows of the Lynnhaven complex and two specimens collected off Cape Charles.

Habitat and Mode of Life: Collected on bottoms ranging from fine sands to mixed shell and sand.

Reproduction: Unknown.

Status: *Special Concern.* This species is probably at the northern extent of its geographical range.

Protective Measures Proposed: None.

Author: Daniel M. Dauer.

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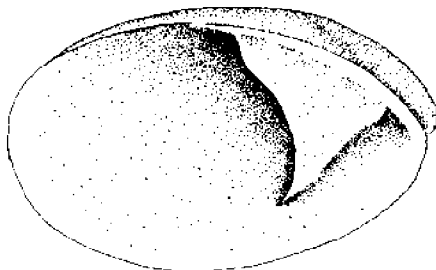
23. CONVEX SLIPPER-SHELL

Crepidula convexa Say

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Calyptraeidae

Description: Length to 13 millimeters long by 5 millimeters high; apex usually overhangs near margin of shell, which is highly arched. Color dull green speckled with varied flecks. Interior mottled with dark brown; diaphragm white with yellow edge (Abbott, 1974).



Present Range: Massachusetts to Bermuda, Florida, Texas and West Indies.

Distribution in Virginia: Lower parts of rivers and adjacent shores and bays, including Eastern Shore.

Habitat and Mode of life: Most abundant on eelgrass, but also on oysters and other substrates in areas with salinities above 10 parts per thousand.

Reproduction: Egg mass composed of a group of egg capsules joined in a sticky mass. During two-week incubation period, egg mass is attached to sticky pad or to propodium. Egg capsules divided into two compartments, totalling about 200 to over 1300 eggs. Average production is three broods per season (Hendler and Franz, 1971).

Status: *Special Concern.* Marsh (1973) found this the most abundant species in his shallowest eelgrass station. His area and many others have not recovered, hence limiting *Crepidula convexa*.

Protective Measures Proposed: Replenish eelgrass.

Remarks: Since *Crepidula convexa* has no larval stage, it will take a long time to repopulate former habitats, especially in eelgrass beds.

Author: Marvin L. Wass.

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24. VARIABLE BITTIUM

Diastoma varium Say

Phylum: Mollusca
Class: Gastropoda

Order: Mesogastropoda
Family: Cerithiidae

Description: Length about 7 millimeters by 2 millimeters. Conical shell with six to eight whorls overlain by spirals and cross-ridges. Aperture rounded; anterior canal a small notch. Operculum with four to five spirals (Abbott, 1974).

Present Range: Maryland to Florida, Texas and Brazil.

Distribution in Virginia: Only where eelgrass is abundant.

Habitat and Mode of Life:

Evidently requires eelgrass substrate to graze on diatoms.

Reproduction: Summer.Status: *Special Concern.*

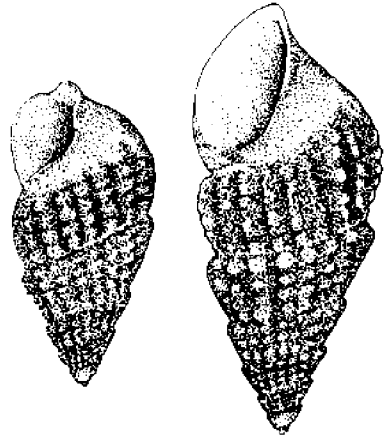
Slowly returning to former areas but still rare in the best grass beds on the Western Shore of the Bay.

Protective Measures Proposed:

Reintroduce *Diastoma* to areas where eelgrass has returned.

Remarks: *Diastoma* was the most abundant species on eelgrass before the 1972 June flood (Marsh, 1973).

Author: Marvin L. Wass.



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25. VERRUCOSE DORIS

Doris verrucosa Linnaeus

Phylum: Mollusca
Class: Gastropoda

Order: Nudibranchia
Family: Dorididae

Description: Adult 20 to 60 millimeters long. Dorsal surface of mantle has "mushroom" papillae. Body oval, lacking projections. Branching branchiae 15, encircling anus. Rhinophores perfoliate. Mantle covers entire body and foot. Eyespots hidden in adult. Color orange-yellow on gray, with two long dark stripes dorsally (Abbott, 1974).

Present Range: Massachusetts to Brazil.

Distribution in Virginia: Deep waters of Bay and mouth of Cherrystone Creek; salinity polyhaline (Vogel, 1977).

Habitat and Mode of Life: Found on sponges, encrusting or free growing; benthic. Active June to January.

Reproduction: Mates and lays eggs in August. Larvae free-swimming.

Status: *Special Concern.* Disappeared from most of Bay after Tropical Storm Agnes; returning slowly to Eastern Shore bayside and western shore.

Protective Measures Proposed: Provide habitats for sponges.

Author: Rosalie M. Vogel.

26. KITTY CAT ELYSIA

Elysia catulus Gould

Phylum: Mollusca
Class: Gastropoda

Order: Nudibranchia
Family: Elysiidae

Description: Adults 3 millimeters long. Parapodia not meeting dorsally. Outline of body catlike. Color dark to light green; head has three white patches, one dorsally and one on either side of head posterior to rolled rhinophores (Abbott, 1974).

Present Range: Nova Scotia to Virginia.

Distribution in Virginia: Shallow waters, lower polyhaline (Vogel, 1977).

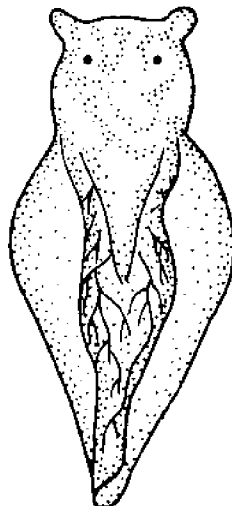
Habitat and Mode of Life: Found in *Zostera* beds on blades. Feeds on *Zostera*.

Reproduction: Not observed in Virginia; suspect mating in Fall.

Status: *Special Concern.* Much depleted. Rare in Virginia; almost eliminated in Chesapeake Bay after Tropical Storm Agnes.

Protective Measures Proposed: Protect eelgrass.

Author: Rosalie M. Vogel.



27. DUSKY STILIGER

Stiliger fuscatus Gould

Phylum: Mollusca
Class: Gastropoda

Order: Sacoglossa
Family: Hermaeidae

Description: Small (3 millimeters), aeolidiform, lacking tentacles, has one pair of rhinophores and dorsal cerata; latter cylindrical, five on a side. Foot lobed anteriorly, tapered posteriorly. Anal opening dorsal. Color rusty to black, white tips on cerata and white strip on rhinophores (Abbott, 1974).

Present Range: New Hampshire to Virginia.

Distribution in Virginia: Lower Bay and Eastern Shore (Vogel, 1977).

Habitat and Mode of Life: Confined to eelgrass, at least in Chesapeake Bay.

Reproduction: Tremendously successful in July and August at Mumfort Island area in York River; is the most abundant species during that time. Disappears during rest of year.

Status: *Special Concern:* Due to eelgrass die-off in 1972 and following warm winters.

Protective Measures Proposed: Reestablish eelgrass in former areas.

Remarks: Marsh (1976) found 4,327 specimens at Mumfort Island in 1970, far exceeding other species in July and August and making this species the third most abundant gastropod in that study.

Author: Rosalie M. Vogel.

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28. BLACK-LINED TRIFORA

Triphora nigrocineta C. B. Adams

Phylum: Mollusca
Class: Gastropoda

Order: Archaeogastropoda
Family: Triphoridae

Description: Long, 7 millimeters, spiral shell has about 15 sinistral whorls marked with three rows of conspicuous tubercles, separated by revolute grooves on each whorl, except first four or five smooth; apical whorls are smooth, except that body whorl has four rows. Color reddish-black to black (Abbott, 1974).

Present Range: Massachusetts to Bermuda and Florida; Texas to Brazil.

Distribution in Virginia: Wherever eelgrass abounds in lower rivers above salinities of 10 parts per thousand and adjacent Bay shores.

Habitat and Mode of Life: Like some other small snails, this species probably grazes on the epiflora of *Zostera*.

Reproduction: Unknown; egg cases probably attached to *Zostera* blades.

Status: *Special Concern*. Low salinity after Tropical Storm Agnes and subsequent "accidents," e.g., oil spills, have precluded return of this and other species in the York River.

Protective Measures Proposed: Probably impossible.

Remarks: *Triphora nigrocineta* is an interesting species worthy of study before it decreases further.

Author: Marvin L. Wass.

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29. PAPER MUSSEL

Amygdalum papyrium (Conrad)

Phylum: Mollusca
Class: Bivalvia

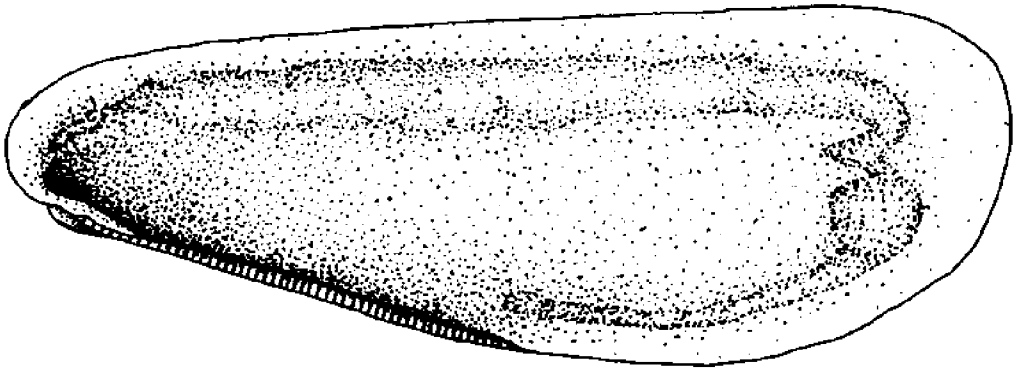
Order: Ptereoconchida
Family: Mytilidae

Description: Shell elongate, 30 millimeters long, smooth, fragile, equivalve; inequilateral, beaks near anterior end, directed forward. Periostracum thin, varnished. Concentric growth lines have fine sculpture. Color iridescent gray to yellow-brown, overlain with reddish brown design (Abbott, 1974).

Present Range: Maryland to Florida and Texas.

Distribution in Virginia: In shallow, sheltered waters on wigeon grass and eelgrass.

Habitat and Mode of Life: Attaches to sea grasses.



Reproduction: Unknown.

Status: *Special Concern.* Suffers from loss of eelgrass, which has not yet recovered.

Protective Measures Proposed: Protect *Ruppia* and *Zostera*.

Author: Marvin L. Wass.

30. COMMON JINGLE SHELL

Anomia simplex Orbigny

Phylum: Mollusca
Class: Bivalvia

Order: Pteronconchida
Family: Anomiidae



Description: Length to 51 millimeters. Shell irregular, near circular, inequivalve; right valve fragile, left strong. Right valve smaller and flatter than convex left valve. Periostracum absent. Color yellow, dull orange or tan. Sculpture raised undulations. Margin jagged. Siphons lacking. Attaches to solid surface (Abbott, 1974).

Present Range: Cape Cod to Bermuda, Florida, Texas and Brazil.

Distribution in Virginia: In lower Chesapeake Bay and lower parts of major rivers.

Habitat and Mode of Life: Attached to oysters and other solid substrates. Color silvery, dull-orange and translucent yellow.

Reproduction: Unknown.

Status: *Special Concern.* Much reduced after passage of Tropical Storm Agnes; apparently far from recovered as yet.

Protective Measures Proposed: None.

Remarks: Shells occasionally used decoratively; prized by children and beachcombers.

Author: Marvin L. Wass.

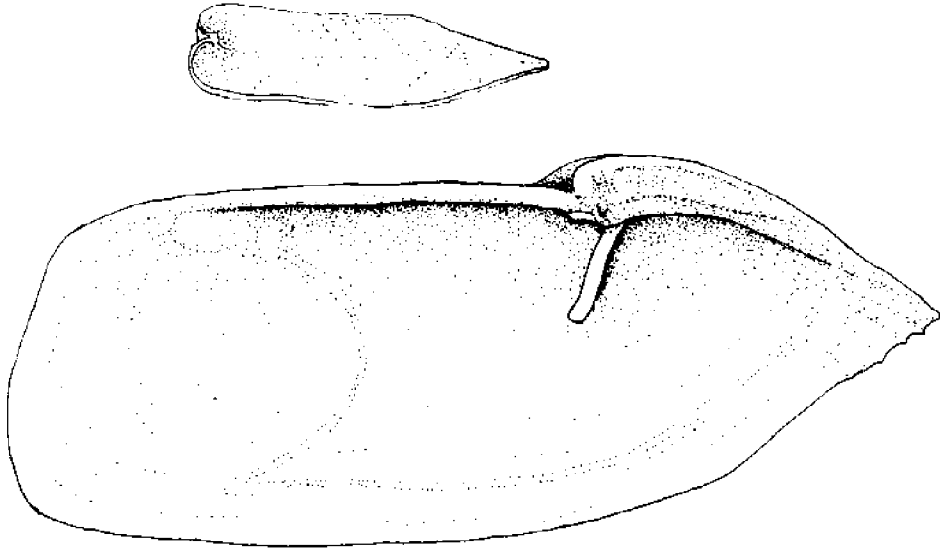
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31. **FALLEN ANGEL WING**

Barnea truncata Say

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Pholadidae



Description: Length to 70 millimeters. Shell rectangular; posterior truncate, anterior pointed, pedal gape wide; thin, fragile, little inflated. Periostracum thin, straw yellow. Sculpture concentric ridges and radiating ribs drawn into small spires where they cross (Abbott, 1974).

Present Range: Salem, Massachusetts to Texas and Brazil; above salinities of 10 parts per thousand.

Distribution in Virginia: Goodwin Island on the York River and Cedar Island.

Habitat and Mode of Life: Burrows into mud, clay and peat (Chanley and Andrews, 1971).

Reproduction: Unknown.

Status: *Special Concern.* Restricted to rather scarce habitats, where it may be quite common.

Protective Measures Proposed: Attempt to save peat and clay banks of the Bay and rivers.

Author: Marvin L. Wass.

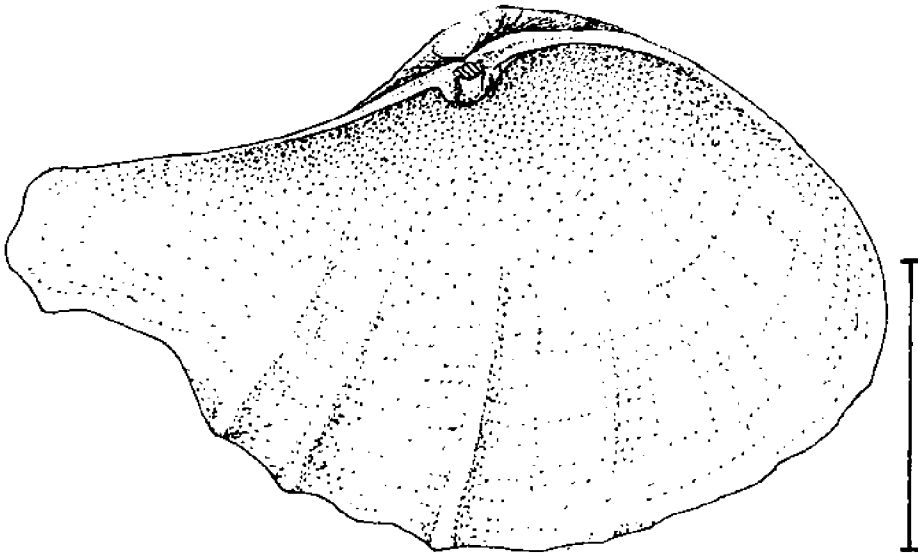
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32. CAROLINA CUSPIDARIA

Cuspidaria glypta (Bush)

Phylum: Mollusca
Class: Bivalvia

Order: Poromyacea
Family: Cuspidariidae



Description: Length to 5 millimeters. Shell subovate, posterior prominent, spout projecting distally, gaping at end. Shell thin, little compressed, inequivalve; left most convex. Sculpture very delicate growth lines, with three prominent radial ribs posteriorly and a fourth near midline. Margin crenulate at ribs. Siphons lacking (Abbott, 1974).

Present Range: Chesapeake Bay to West Indies.

Distribution in Virginia: Lower Chesapeake Bay off Rappahannock River, rare; specimen in York River, 30 feet.

Habitat and Mode of Life: Unknown; presumably uses "handle" to reach substrate surface.

Reproduction: Unknown. Probably quite low.

Status: *Special Concern*. Not seen in 15 years. Northern limit of range.

Protective Measures Proposed: None.

Remarks: Believed by Abbott (1974) to be young of *Cuspidaria costellata*.

Author: Marvin L. Wass.

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33. PONDEROUS ARK

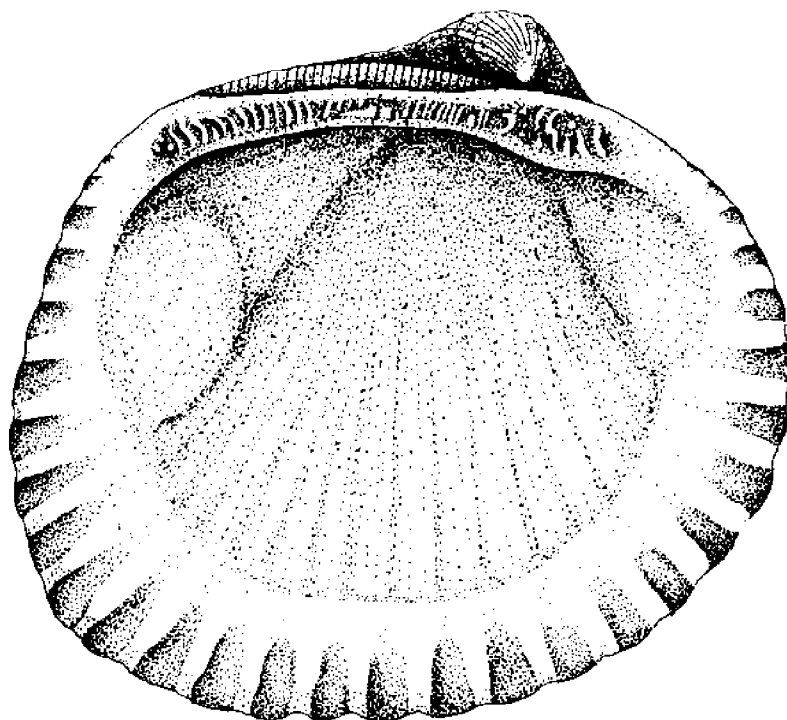
Noetia ponderosa Say

Phylum: Mollusca

Order: Prionodontida

Class: Bivalvia

Family: Arcidae



Description: Length to 65 millimeters. Shell rectangular ovate; heavy, equivalve. Hinge straight, approximately 35 teeth. Adductor scars elevated. Margin scalloped with about 27 ribs. Siphons lacking. Periostracum heavy, dark, worn from beaks. Ligament a wide, black, spear-shaped band (Abbott, 1974).

Present Range: Chesapeake Bay to Florida and Texas; areas above salinities of 15 parts per thousand.

Distribution in Virginia: In polyhaline and euhaline waters, mainly in Eastern Shore bays, to depth of 86 feet at Yorktown bridge.

Habitat and Mode of Life: In fine sand and silt; more common on Eastern Shore.

Reproduction: Unknown.

Status: *Special Concern*. Depleted in lower salinity waters by low salinity and low dissolved oxygen. Not yet returned to all of former areas.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

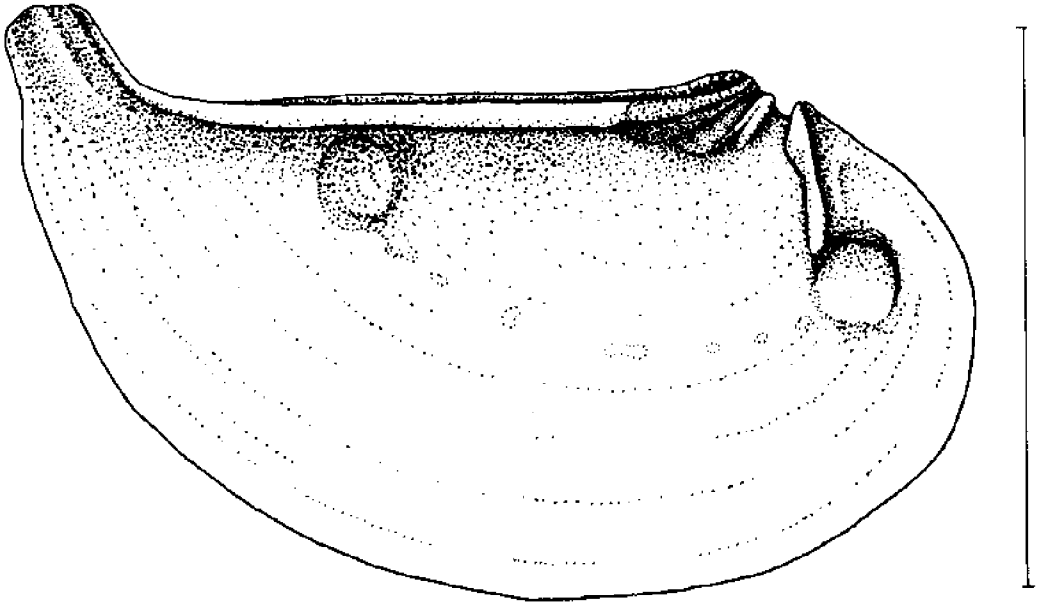
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34. SAY'S PANDORA

Pandora trilineata Say

Phylum: Mollusca
Class: Bivalvia

Order: Pandoracea
Family: Pandoridae



Description: Length to 30 millimeters. Shell crescent-like; strong square ridge along hinge; thin, very compressed, flat; inequivalve; left valve overlapping right. Shell very delicate, color white (Abbott, 1974).

Present Range: Virginia to Florida, Texas, and to a depth of 60 fathoms in the ocean.

Distribution in Virginia: Several specimens taken in 1950's by Andrews at York Spit; off Rappahannock River in Chesapeake Bay, 1963; one off Cape Charles by Dauer, 1978.

Habitat and Mode of Life: Burrows in sand.

Reproduction: Clams hermaphroditic. Eggs large and extruded on mucus strands. Veligers free-swimming about one day before setting (Boss and Merrill, 1965).

Status: *Special Concern*. Very few found; dredging and spoiling imminent along York Spit and Rappahannock Channels.

Protective Measures Proposed: None.

Remarks: A rather small species; perhaps more scarce at northern limit.

Author: Marvin L. Wass.

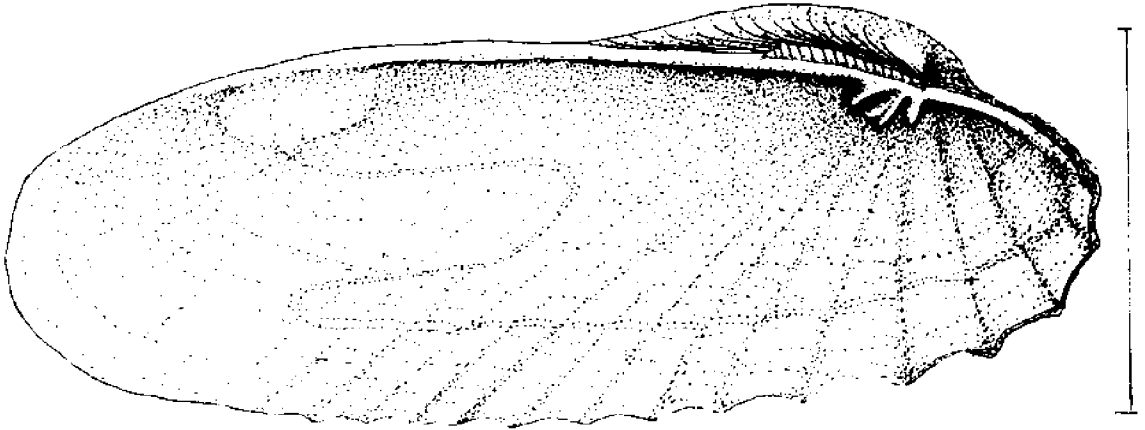
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35. FALSE ANGEL WING

Petricola pholadiformis Lamarck

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Petricolidae



Description: Length to 65 millimeters. Shell elongate-oval; thin, brittle, inflated, equivalve. Ligament a prominent arched band. Lunule ill defined, escutcheon lacking. Sculpture 40 or more radiating ribs. Right valve with two cardinal teeth, left with three. Pallial sinus deep, margin crenulate where ribs reach margin. Color dull white to fawn. Periostracum dark brown (Abbott, 1974).

Present Range: Gulf of St. Lawrence to Texas and Uruguay.

Distribution in Virginia: Common around lower Bay in intertidal peat.

Habitat and Mode of Life: Peat for burrowing is quite scarce and often eroding above salinities of 10 parts per thousand.

Reproduction: Unknown.

Status: *Special Concern*. Due to scarcity of habitats. Formerly abundant in salt water pipe systems in York River. Sporadic in occurrence.

Protective Measures Proposed: Attempt to save eroding peat marshes.

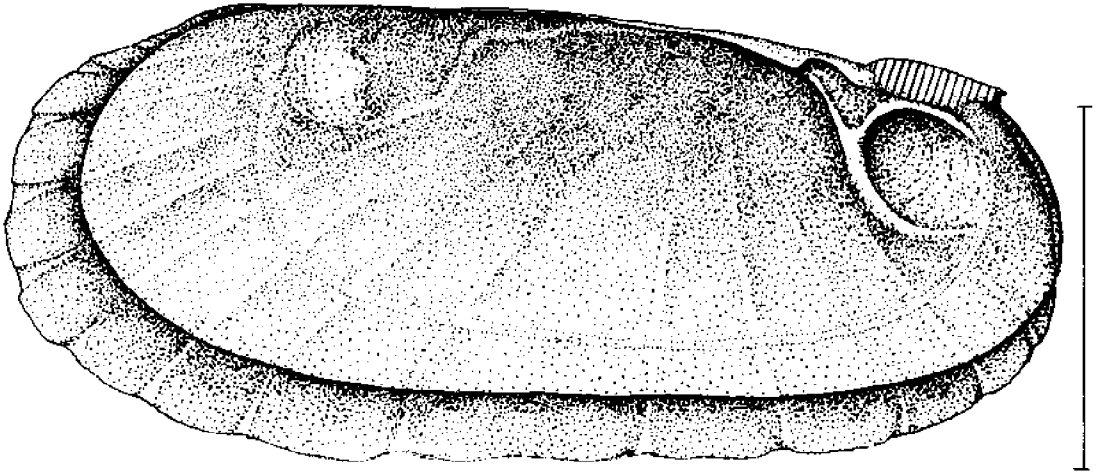
Author: Marvin L. Wass.

36. COMMON ATLANTIC AWNING CLAM

Solemya velum Say

Phylum: Mollusca
 Class: Bivalvia

Order: Protobranchia
 Family: Solemyacidae



Description: Length to 25 millimeters. Shell elongate-ovate, gaping, paper thin, little calcified, moderately inflated; equivalve. Periostracum smooth, shiny, horny, brown: radial markings extend beyond margins as a fringe. Shell interior blue-violet. Margin smooth. Siphons lacking. (Abbott, 1974).

Present Range: Nova Scotia to northern Florida.

Distribution in Virginia: Lower Chesapeake Bay, particularly where *Zostera* beds occur.

Habitat and Mode of Life: Moves about through eelgrass.

Reproduction: Unknown.

Status: *Special Concern.* Seems absent wherever eelgrass has disappeared.

Protective Measures Proposed: Protect eelgrass.

Remarks: Very interesting mollusk. Most primitive Chesapeake bivalve and deserving of all possible protection.

Author: Marvin L. Wass.

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37. OSTRACOD

Cylindroleberis mariae (Baird)

Phylum: Arthropoda
 Class: Crustacea
 Subclass: Ostracoda

Order: Myodocopa
 Family: Cylindroleberidae

Description: Large species, length 2 millimeters. Valves elliptical, notched in front. Body shiny, rather compressed (Miner, 1950).

Present Range: Massachusetts to Virginia.

Distribution in Virginia: Mesopolyhaline; apparently only abundant in eelgrass beds.

Habitat and Mode of Life: Shallow burrower in fine sand.

Reproduction: Unknown.

Status: *Special Concern*. Reduced, especially where lower salinities reduced eelgrass beds.

Protective Measures Proposed: None.

Remarks: Up-to-date sampling needed.

Author: Marvin L. Wass.

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38. OSTRACOD

Sarsiella texana Kornicker and Wise

Phylum: Arthropoda
 Class: Crustacea
 Subclass: Ostracoda

Order: Myodocopa
 Family: Sarsiellidae

Description: Length to 1.33 millimeters. Carapace of adult female oval, lacking sinus; a pointed area on ventral margin one-third distance from posterior end. Narrow, little-raised rim borders carapace, which lacks ornaments. Carapace compressed dorsally; thinning towards ventral end, posteriorly. Furca of adults with five claws.

Present Range: Virginia to Texas.

Distribution in Virginia: Poorly known; probably mainly polyhaline.

Habitat and Mode of Life: Evidently same as *Sarsiella zostericola*; congeneric habitat differences unknown.

Reproduction: Summer.

Status: *Special Concern*. Population usually about 10% of *Sarsiella zostericola*.

Protective Measures Proposed: None.

Remarks: Studies needed.

Author: Marvin L. Wass.

39. OSTRACOD

Sarsiella zostericola Cushman

Phylum: Arthropoda
 Class: Crustacea
 Subclass: Ostracoda

Order: Mydocopa
 Family: Sarsiellidae

Description: Adult female laterally oval, with point on ventral margin near posterior end; lacking anterior sinus. Slight rim borders carapace. Surface has puncta and three raised ribs radiating from hub near center. Adult male carapace has prominent anterior rostrum (Miner, 1950).

Present Range: At least Virginia to Texas.

Distribution in Virginia: Lower York River.

Habitat and Mode of Life: Associated with eelgrass beds, but abundant in deeper waters in early 1960's.

Reproduction: Unknown.

Status: *Special Concern*. Depleted by loss of eelgrass beds in some areas and possibly by low dissolved oxygen levels in deeper water.

Protective Measures Proposed: None.

Remarks: Annual sampling should be done.

Author: Marvin L. Wass.

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40. OSTRACOD

Loxoconcha impressa (Baird)

Phylum: Arthropoda
 Class: Crustacea
 Subclass: Ostracoda

Order: Podocopa
 Family: Loxoconchidae

Description: Tiny species. Shell narrowed posteriorly and notched at upper posterior angle. Ventral margin has flattened border. Shell evenly punctate (Miner, 1950).

Present Range: Vineyard Sound to Chesapeake Bay.

Distribution in Virginia: In Rappahannock and York Rivers (Elliott *et al.*, 1966).

Habitat and Mode of Life: Apparently confined to *Zostera* and *Ruppia* beds.

Reproduction: Summer.

Status: *Special Concern*. Due to eelgrass setback.

Protective Measures Proposed: Protect eelgrass.

Author: Marvin L. Wass.

41. OPOSSUM SHRIMP

Mysidopsis bigelowi (Tattersall)Phylum: Arthropoda
Class: CrustaceaOrder: Mysidacea
Family: Mysidae

Description: Length 7.5 millimeters. Carapace has blunt point between eyes. Eyes of medium size, occupying less than half of whole eye. Antennal scale with setae present on inner and outer margins. Telson armed with many spines. Antennal scale approximately five times as long as telson; latter cleft (Wigley *In*: Smith, 1964).

Present Range: Virginia; shallows to about 200 feet offshore (Gosner, 1971).

Distribution in Virginia: Mobjack Bay and York River (Mumfort Island); also at Wachapreague, Virginia (Van Engel, 1972).

Habitat and Mode of Life: Common on eelgrass in deeper beds before 1972 (Marsh, 1973).

Reproduction: Unknown.

Status: *Special Concern*. Due to depletion of eelgrass.

Protective Measures Proposed: Protect eelgrass.

Author: Marvin L. Wass.

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42. CUMACEAN

Cyclopsis varians CalmanPhylum: Arthropoda
Class: CrustaceaOrder: Cumacea
Family: Bodotriidae

Description: Length of female 3 millimeters, male smaller. Cephalothorax well rounded above. Carapace compressed, height more than half length. Rostrum short. Abdomen long, slender. Separation of thorax and abdomen indistinct (Wigley *In*: Smith, 1964).

Present Range: Southern New England to Virginia.

Distribution in Virginia: York River (Clay Bank), three in eelgrass bed, Robert Orth; Elizabeth River, rare, Michael Richardson.

Habitat and Mode of Life: Burrows in grass beds and possibly in other substrates.

Reproduction: Unknown.

Status: *Special Concern*. Obviously quite rare in Chesapeake Bay.

Protective Measures Proposed: None.

Remarks: Possibly tied to grass beds.

Author: Marvin L. Wass.

43. ISOPOD

Edotea triloba Say

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Idoteidae

Description: Length about 7 millimeters. Body ovate. Thoracic segments appear scalloped. First antennae shorter. Head wide, anterior margin has two broad points before the eyes. Telson has large, round hump in center (Schultz, 1969).

Present Range: Maine to Virginia.

Distribution in Virginia: Widely distributed; perhaps most abundant in eelgrass beds. Orth found 540 per square meter in a *Zostera* bed. Wass found 600 per square meter in Tangier Sound at 87 feet (27 meters).

Habitat and Mode of Life: Lives at all depths where detritus or grassbeds occur above salinities of 10 parts per thousand.

Reproduction: Females brood young in pouch.

Status: *Special Concern*. Usually abundant in eelgrass beds when these flourish. Now depleted by lack of grass beds and possibly by low dissolved oxygen and, in shallows, by oil residue.

Protective Measures Proposed: None feasible, except grass restoration, which promises to be difficult.

Remarks: Not in danger, but quite reduced.

Author: Marvin L. Wass.

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44. ISOPOD

Erichsonella attenuata Harger

Phylum: Arthropoda
Class: Crustacea

Order: Isopoda
Family: Idoteidae

Description: Length 12 millimeters. Body elongate. Uropods ventral, forming chamber enclosing pleopods. Sides of head entire; eyes lateral. Pleotelson forming near triangular point, with minute tubercle on either side (Schultz, 1969).

Present Range: Connecticut to North Carolina.

Distribution in Virginia: Shallows of lower ends of rivers and along stable shores.

Habitat and Mode of Life: Clinging to eelgrass, where it probably feeds on microalgae. Ranked fifth in total numbers of fauna on eelgrass.

Reproduction: Females ovigerous April to November; retained in marsupium until about 2 millimeters long; 35-40 young carried in marsupium.

Status: *Special Concern*. Obviously tied to eelgrass. If true, this species must have one of the shortest ranges on the Atlantic coast. Now greatly reduced by eelgrass die-off.

Protective Measures Proposed: Possibly replanting eelgrass if winters stay cool.

Remarks: Once was the fifth most abundant species on eelgrass (Marsh, 1973).

Author: Marvin L. Wass.

45. ISOPOD

Idotea balthica Pallis

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Idoteidae

Description: Length near 35 millimeters. Abdomen over one-third longer than body, divided into two short and one long segment. Telson with three teeth, central two largest. Female much smaller (Schultz, 1969).

Present Range: Gulf of St. Lawrence to Rio de Janeiro; also in eastern Atlantic and Mediterranean.

Distribution in Virginia: Apparently only on eelgrass (Marsh, 1973).

Habitat and Mode of Life: Swims among grass and moves along stems. Probably feeds on diatoms.

Reproduction: Unknown.

Status: *Special Concern*. Obviously associated mainly with eelgrass in Virginia. Hence now greatly depleted.

Protective Measures Proposed: Foster eelgrass by planting.

Remarks: Rather unique in habits and range; less common than *Erichsonella attenuata*.

Author: Marvin L. Wass.

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46. RAPID ISOPOD

Ligia exotica Roux

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Ligidae

Description: Large littoral isopod, about 35 millimeters long. Body somewhat tear-drop shaped. Antennae long, divergent. Carapace consisting of at least 11 segments. Long slender legs capable of great speed on any firm surface. Runs much like a cockroach.

Present Range: Unknown. Possibly from Delaware Bay and at least to Gulf Coast of Florida; also occurs in Japan.

Distribution in Virginia: On old pilings and breakwaters wherever salinity is above about 15 parts per thousand.

Habitat and Mode of Life: Lives in crevices in shade, where wave splash is frequent. Does both oral and anal drinking (Parry, 1953). Large water needs must be deadly when oil covers surfaces.

Reproduction: Unknown.

Status: *Special Concern*. Once very abundant at VIMS. Only juveniles seen recently. Great decrease obviously due to increasing massive oil spills in York River. Situation seems normal elsewhere in Virginia.

Protective Measures Proposed: Cease oil spills and leaks.

Remarks: Perhaps amateur naturalists needed to keep surveillance on this and other intertidal species.

Author: Marvin L. Wass.

47. AMPHIPOD

Acanthohaustorius intermedius Bousfield

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Haustoriidae

Description: Length 4.5 millimeters. Body broad, rostrum acute, side plates acuminate rearward, plate with spinous process. Gnathopod 1 simple, segment 5 greatly enlarged; telson wide, deeply notched (Bousfield, 1973).

Present Range: East side of Cape Cod Bay and Georges Bank south to Cape Kennedy.

Distribution in Virginia: Lower Bay, upper polyhaline and euhaline.

Habitat and Mode of Life: Burrowing in fine sand to depth of 40 meters.

Reproduction: Females ovigerous May-September.

Status: *Special Concern*. Occurs in oligohaline areas subject, in some cases, to habitat loss by dredging, low oxygen and industrial effluents.

Protective Measures Proposed: Definitive survey and occasional subsequent surveillance.

Remarks: May be significant part of food chains in low salinity marshes.

Author: Marvin L. Wass.

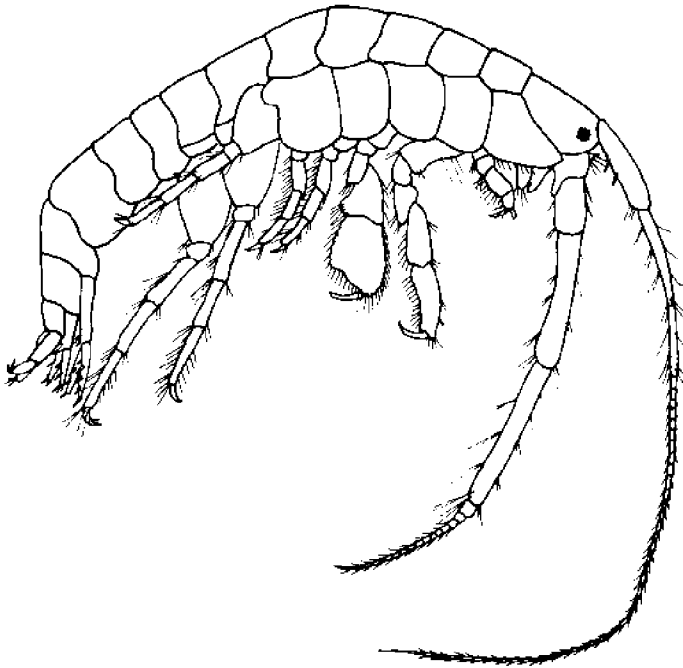
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48. AMPHIPOD

Ampithoe longimana Smith

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Ampithoidae



Description: Length 10 millimeters. Eye rather large, round, black. Antennae 1 and 2 almost equal to length of body; peduncles long. Antenna 2 has bristled, setose whorls. Male gnathopod has segments 5 and 6 elongate; segments 5 and 6 in female are short, stout. Gnathopod 2, segments 5 and 6 heavier than gnathopod 1. Telson short, apex rounded (Bousfield, 1973).

Present Range: Florida to southern Maine.

Distribution in Virginia: Most common on eelgrass at salinity below 13 parts per thousand (Feeley and Wass, 1971).

Habitat and Mode of Life: Makes nests on algae and eelgrass (*Zostera*) (Marsh, 1970).

Reproduction: Females ovigerous May-September.

Status: *Special Concern*. Depleted due to die-back of eelgrass in 1972. Recovery very slow.

Protective Measures Proposed: Replanting of eelgrass.

Remarks: Food for fish and larger invertebrates.

Author: Marvin L. Wass.

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49. AMPHIPOD

Cerapus tubularis Say

Phylum: Arthropoda

Order: Amphipoda

Class: Crustacea

Family: Corophiidae

Description: Tiny species, length to 4.5 millimeters. Antenna 1 and 2 short, flagellum has three segments. Antenna 1, peduncular segment 1, very broad, forming tube plug. Uropod 1, peduncle with soft ciliated lobes; outer ramus with up to 18 bordering cusps. Uropod 2 with cusps and a spine (Bousfield, 1973).

Present Range: Cape Cod to eastern Florida, to depths of over 100 feet (Bousfield, 1973). Salinity 15 to 21 parts per thousand.

Distribution in Virginia: In silt-clay sediments at depths of 15 to 30 feet.

Habitat and Mode of Life: In flexible, portable tube having a rectangular cross-section.

Reproduction: Females ovigerous June-September.

Status: *Special Concern*. Depleted since 1965, seemingly due to low dissolved oxygen in York River (Boesch, Wass and Virnstein, 1976).

Protective Measures Proposed: Possible control of sources of biological oxygen demand (BOD) and heated water.

Remarks: Depletion known certainly in York River.

Author: Marvin L. Wass.

50. AMPHIPOD

Colomastix halichondriae Bousfield

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Colomastigidae

Description: Minute species, length 2-3 millimeters. Head and rostrum short, acute. Eye round, red. Gnathopod 1 slender, long, 4-6 setae at end. Gnathopod, segment 5 short, deep; segment 6 rather powerful, with palmar tooth and large hinge tooth. Telson with apex subtruncate (Bousfield, 1973).

Present Range: Cape Cod to Chesapeake Bay and Georgia; possibly Gulf Coast (Bousfield, 1973).

Distribution in Virginia: Commensal in only two sponges; salinity above 15 parts per thousand.

Habitat and Mode of Life: Food unknown; lives in sun sponge, *Halichondria bowerbanki* and in *Haliclona permollis*; winter habitat unknown. Marsh (1970) found 110 specimens on *Zostera* in *Haliclona*.

Reproduction: Unknown.

Status: *Special Concern*. Depleted by die-back of *Zostera* and by low salinity. Possibly also by oil spills.

Protective Measures Proposed: Mainly reestablishing *Zostera* to former areas.

Author: Marvin L. Wass.

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51. AMPHIPOD

Cymadusa compta Smith

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Ampithoidae

Description: Length 7-11 millimeters in male, 12-15 millimeters in female. Body arched at junction of thorax and abdomen. First antenna exceeds second; flagellum very long. First and second gnathopods of male strong, near equal, covered with plumose setae (Bousfield, 1973).

Present Range: Central Main to Gulf Coast (Bousfield, 1973).

Distribution in Virginia: Formerly abundant in lower rivers, 15 to 23 parts per thousand salinity (Feeley and Wass, 1971).

Habitat and Mode of Life: Only abundant on eelgrass, where it forms tubes. Annual; several broods May-September (Bousfield, 1973).

Reproduction: Unknown.

Status: *Special Concern*. Depleted severely due to eelgrass regression.

Protective Measures Proposed: Some replanting of eelgrass.

Author: Marvin L. Wass.

52. AMPHIPOD

Rudilemboidea nageli Bousfield

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Aoridae

Description: Minute species, length 3 millimeters. Body slender, coxal plates shallow. Head short; anterior lobe prominent, acute; eye basal. Gnathopods 1 and 2 slender in female; in male weakly subchelate, palm short, exceeded by dactyl, segment 5 swollen (Bousfield, 1973).

Present Range: Cape Cod to Georgia; eastern Gulf of Mexico (Bousfield, 1973).

Distribution in Virginia: Thus far known only from eelgrass in York River.

Habitat and Mode of Life: Apparently confined to eelgrass or, farther south, other marine grasses.

Reproduction: Females ovigerous from May to August.

Status: *Special Concern*. Depleted in eelgrass die-back in 1972 and in following wet years and warm winters.

Protective Measures Proposed: Replenishment of eelgrass.

Remarks: One of several species common on eelgrass in favorable years.

Author: Marvin L. Wass.

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53. BIG-CLAWED SNAPPING SHRIMP

Alpheus heterochaelis Say

Phylum: Arthropoda
 Class: Crustacea

Order: Decapoda
 Family: Alpheidae

Description: Length of male 40 millimeters, female 50 millimeters. Rostrum carinate to base of eyestalks. Carapace over one-half length of abdomen. Eyes small, under carapace. Antennae little longer than body. First legs strongly chelate, very unequal. Larger chela strongly chelate, very unequal. Abdomen compressed, smooth. Color dark translucent green, with purple on carapace sides; chelipeds marked with white. Walking legs pale red, tips of uropods blue with narrow border of orange. Outer blade with red patch above blue and a narrow white border (Williams, 1963).

Present Range: Chesapeake Bay to Sao Paulo, Brazil.

Distribution in Virginia: Seems to have been reported only from Gloucester Point in oyster trays.

Habitat and Mode of Life: In shell piles, etc.

Reproduction: Probably during July and August.

Status: *Special Concern*. Evidently scarce, taxonomy of larvae confused (Sandifer, 1972).

Protective Measures Proposed: Provide "artificial reefs."

Remarks: At northern limit of range.

Author: Marvin L. Wass.

54. GREEN SNAPPING SHRIMP

Alpheus normanni Kingsley

Phylum: Arthropoda
 Class: Crustacea

Order: Decapoda
 Family: Alpheidae

Description: Male 26 millimeters, ovigerous female 16 millimeters. Carapace two-thirds length of abdomen, little compressed. Rostrum extending back to base of eyestalks. Eyes under ocular hoods. Antennae little longer than body. Chelae unequal; larger broad, flattened. Smaller chela one-half as wide, three-quarters as long. Telson with two pairs of dorsal spines. Color gray or dull green; large chela dark green, usually banded with yellow-brown. Large chela with two pale bands; finger black, dactyl reddish (Williams, 1965).

Present Range: Chesapeake Bay to Bermuda, West Indies, and Sabine, Texas.

Distribution in Virginia: Polyhaline. Gloucester Point, York River Channel, Cherrystone Creek and James River.

Habitat and Mode of Life: Requires hiding places such as oyster shells, rocks and cans.

Reproduction: Larvae all from surface samples in August, except one in September (Sandifer, 1972).

Status: *Special Concern*. Northern limit of range; apparently rare. None reported since 1965.

Protective Measures Proposed: Artifacts needed in which to hide.

Remarks: Oyster-shell dredging, creosoted piling and oil spills may be inimical.

Author: Marvin L. Wass.

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55. EELGRASS SHRIMP

Hippolyte pleuracantha Stimpson

Phylum: Arthropoda
 Class: Crustacea

Order: Decapoda
 Family: Hippolytidae

Description: Small shrimp. Length 12 to 18 millimeters. Body smooth; plumose hair-tufts on carapace. Rostrum stout at base, thin and decurved distally. Eyes large. Antennal scale exceeding rostrum. Legs 3-5 long. Abdomen strongly bent at segment 3; dactyls with series of combs on inner border (Williams, 1965).

Present Range: New Jersey to Galveston, Texas; Bermuda.

Distribution in Virginia: Occurs wherever eelgrass grows in Chesapeake Bay.

Habitat and Mode of Life: Tied to eelgrass; not known from *Ruppia*.

Reproduction: Summer months.

Status: *Special Concern*. Perhaps entirely dependent on eelgrass beds, which are now at a low point.

Protective Measures Proposed: Eelgrass replenishment.

Author: Marvin L. Wass.

56. LONG-WRISTED HERMIT

Pagurus longicarpus Say

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Paguridae

Description: Carapace length: male 10 millimeters, female 11 millimeters. Shield broad as long. Rostrum obsolete. Eyestalks stout, cornea dilated. Antennal peduncles exceeding eyes by one-third of last article. Right cheliped larger and longer than left. Left cheliped smaller, hairier. Walking legs iridescent; posterior carapace light green (Williams, 1965).

Present Range: Nova Scotia to northern Florida; Sanibel Island to Texas coast.

Distribution in Virginia: Mouth of Potomac River to depth of 53 meters on continental shelf.

Habitat and Mode of Life: Migrates to deeper water in winter; returns to shallows in summer. Feeds on algae and detritus.

Reproduction: Ovigerous March to October (Roberts, 1971).

Status: *Special Concern*. This formerly abundant hermit crab was not seen at Gloucester Point in 1977. A 200,000 gallon oil spill occurred on June 26, 1977. However, larvae of this species reached Gloucester Point in August 1978 -- a hopeful sign.

Protective Measures Proposed: Perhaps cessation of oil spills and attention to biological oxygen demand (BOD) sources.

Remarks: This tragedy should not have happened to such a valuable species for research and classroom interest.

Author: Marvin L. Wass.

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57. WEBSTER'S SCALEY-TUBE

Lepidopa websteri Benedict

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Albuneidae

Description: Carapace length 12 millimeters. Carapace as broad as long, front has setose fringe. Eyestalks oval, lamellate. Antennules exceeding eyestalks, flagella nearly three times as long as carapace. First legs have broad flat articles; fifth legs greatly reduced. Uropods small (Williams, 1965).

Present Range: Previously known from Drum Inlet and Beaufort Inlet, North Carolina (south to) Petit Bois, Mississippi. Larvae, and now an adult, known from mouth of Chesapeake Bay.

Distribution in Virginia: A single female was taken by trawl at 7 meters on sandy bottom off Fishermans Island by Old Dominion University Research Vessel *Holton* 26 January 1976.

Habitat and Mode of Life: Burrows in sand beaches in Carolinian zone; probably in deeper water on Virginia coast.

Reproduction: Larvae reported by Sandifer (1972) from the mouth of Chesapeake Bay and along the Eastern Shore. Goy (1976) found larvae in Bay mouth in July and August.

Status: *Special Concern.* Probably at northern end of range. Should occur in outer beach sands.

Protective Measures Proposed: None feasible, lacking more knowledge of the habitat.

Author: Anthony J. Provenzano.

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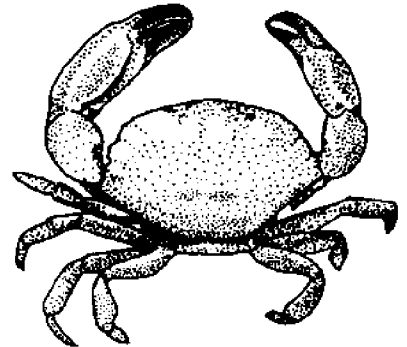
58. FLAT MUD CRAB

Eurypanopeus depressus Smith

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Xanthidae

Description: Length 14 millimeters, width 20 millimeters. Carapace transversely oval, flattened posteriorly. Four anterolateral teeth. Chelipeds unequal; larger heavy, inflated, dactyl strongly curved. Unusual blood-red spot occurs on third maxilliped (Williams, 1965).



Present Range: Chesapeake Bay south along Atlantic and Gulf Coasts. Not common in Delaware Bay (?).

Distribution in Virginia: Formerly widely distributed in Chesapeake Bay in salinities above 12 to 15 parts per thousand (summer breeding temperatures); population now much depressed by sacculinid parasite *Loxothylacus panopaei*, a parasitic barnacle (Van Engel *et al.*, 1966; Ryan, 1956).

Habitat and Mode of Life: Scavenger on oyster beds, shelly and rocky shores, pilings, and in eelgrass beds. More abundant in shallow waters (less than 20 feet in depth).

Reproduction: Females with egg "sponges" common throughout warm season prior to 1964; specimens now scarce and more frequently exhibit externa of sacculinid parasite. Severe depression of reproduction in past 14 years.

Status: *Special Concern.* Formerly the most abundant of five species of mud crabs in Chesapeake Bay, now fourth in abundance. Habitats not changed appreciably although oyster populations, which support major crab populations, are much reduced in high salinities where crabs live. A sporozoan disease, *Minchinia nelsoni*, caused disastrous oyster mortalities beginning in 1959. Gulf of Mexico oysters imported to replace lost supplies were the source of the sacculinid invasion. No recuperation of crab population has occurred.

Protective Measures Proposed: None considered feasible.

Remarks: The mud crab *Neopanope texana sayi* increased rapidly in abundance with competition removed. It now replaces *Eurypanopeus depressus* as a major scavenger on oyster beds, etc.

Author: Jay D. Andrews.

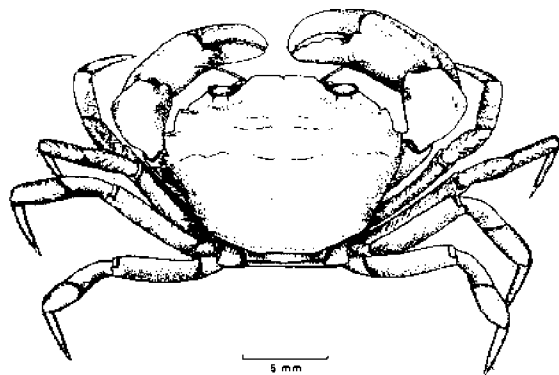
59. HARRIS' MUD CRAB

Rhithropanopeus harrisi Gould

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Xanthidae

Description: Length 15 millimeters, width 19 millimeters. Carapace subsquadrate, three-quarters as long as wide. Chelipeds unequal. Major chela with short solid finger and strongly curved dactyl. Minor chela with longer immovable finger and long dactyl. Walking legs long, somewhat hairy. Color brown above, paler below; fingers light (Williams, 1965).

Present Range:

New Brunswick, Canada to Veracruz, Mexico and northeast Brazil.

Distribution in Virginia: Throughout lower salinity waters of Chesapeake Bay, mostly in tributaries to Bay (Ryan, 1956; Van Engel, 1966). Common on oyster beds.

Habitat and Mode of Life: Subtidal mud crab living in lower breeding salinities than other mud crabs (about 10 to 18 parts per thousand during summer).

Reproduction: Breeds in warm season without competition in its primary habitats on oyster beds. Withstands freshets well. It fills a niche that other xanthid scavengers cannot utilize.

Status: *Special Concern.* Formerly common on oyster beds. Populations now fluctuate with salinities due to parasitization by sacculinid *Loxothylaeus panopaei*. *Rhithropanopeus harrisi* tolerates lower salinities than parasite; hence, in wet years crab populations rebound only to be decimated in dry years by the sacculinid. Species not apparently endangered after 14 years of extreme fluctuations of populations.

Protective Measures Proposed: None considered feasible.

Remarks: This species is important in a salinity zone where most other scavengers are excluded.

Author: Jay D. Andrews.

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60. SCANNING PINNIXA

Pinnixa retinens Rathbun

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Pinnotheridae

Description: Male length 4 millimeters, width 7 millimeters; ovigerous female length 6 millimeters, width 12 millimeters. Carapace sloping down to margins.

Chelipeds small, long as first leg; fingers slender, not gaping. Third leg stout. Telson wider than long (Williams, 1965).

Present Range: Found only in Chesapeake Bay, Alligator Harbor, Florida and Aransas, Texas.

Distribution in Virginia: Type from Poplar Island, Maryland, 20 fathoms, soft bottom (Rathbun, 1918). Recent specimens from York and James River (Hampton) and off Rappahannock River.

Habitat and Mode of Life: Commensal host unknown. No larvae taken by Sandifer in plankton tows.

Reproduction: Unknown.

Status: *Special Concern*. Lack of knowledge of life history and evident paucity over entire Carolinian Province.

Protective Measures Proposed: None possible.

Remarks: Seems to prefer deeper areas and estuaries or coastal bays.

Author: Marvin L. Wass.

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61. MUSSEL CRAB

Pinnotheres maculatus Say

Phylum: Arthropoda
Class: Crustacea

Order: Decapoda
Family: Pinnotheridae

Description: Mature female: Size circular, diameter near 14 millimeters. Front of carapace little advanced. Orbits small, eyes round. Chelipeds and fingers stout. Walking legs slender, hairy. Abdomen large. Color dull brown. Mature male: Carapace flat, one-half as wide as female. Color is a striking pattern of white bare spots on dark background. Young females resemble males (Rathbun, 1918; Williams, 1965).

Present Range: Off Martha's Vineyard, Massachusetts to Mar del Plata, Argentina (Williams, 1965).

Distribution in Virginia: Polyhaline. Off mouth of Potomac River; New Point Comfort.

Habitat and Mode of Life: Commensal in several bivalves and in *Chaetopterus* tubes; possibly more abundant when bay scallops were in the Bay. Apparently never found in Eastern Shore seaside bays (Sandifer, 1972).

Reproduction: Unknown.

Status: *Special Concern*. Seemingly much decreased in recent decades, possibly due to demise of bay scallops and advent of winter dredging for crabs in the lower Bay.

Protective Measures Proposed: None feasible.

Remarks: Unlikely to increase due to dredging and decrease of shellfish.

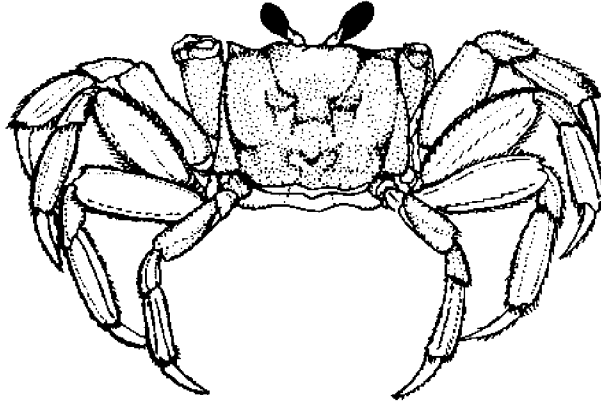
Author: Marvin L. Wass.

62. GHOST CRAB

Ocypode quadrata

Phylum: Arthropoda
 Class: Crustacea

Order: Decapoda
 Family: Ocypodidae



Description: Carapace - length 44 millimeters, width 50 millimeters. Carapace squarish, with H-shaped depression in center. Front and side margins raised, beaded. Orbits and eyestalks large, club-shaped. Chelipeds well-developed, rough, serrulate above. Large hand with vertical stridulating ridge of tubercles (Williams, 1965).

Present Range: Block Island, Rhode Island to Santa Catarina, Brazil.

Distribution in Virginia: Once reached York County (Dexter Haven); now generally rare from Ocean View to lower Virginia Beach, except at Cape Henry. Occurs on all Eastern Shore outer beaches.

Habitat and Mode of Life: Burrows in sand beaches above normal high-tide line. Races to tide line to catch sand-fiddlers and to feed on carrion.

Reproduction: Egg deposition occurs from May to July.

Status: *Special Concern*. Likely to become increasingly endangered on southeastern beaches of Virginia. If present, very scarce in Ocean View-Virginia Beach area.

Protective Measures Proposed: Promote attitude of appreciation. Explain usefulness of ghost crabs as scavengers.

Remarks: Probably most interesting denizen of ocean beaches. Also probably performs useful function by mixing sands of different grain sizes.

Author: Marvin L. Wass.

63. HARTMAN'S ECHIURID

Thallasema hartmani Fisher

Phylum: Echiurida

Order: Echiuroidea
Family: Thallasemidae

Description: Length 40 millimeters, proboscis 8 millimeters. Two inconspicuous nephridia. Segment of intestine between end of foregut and start of siphon very long, exceeding extended specimen. Skin papillae numerous, elongate. Setae with hook not sharply bent. Lower lip of mouth formed by flange of proboscis. Color in life reddish (Fisher, 1947).

Present Range: Lower Chesapeake Bay and North Carolina.

Distribution in Virginia: Lower York River below Clay Bank at depths below 10 feet; off Rappahannock Spit, depth about 75 feet, by *Fish Hawk* in 1920.

Habitat and Mode of Life: Burrows in bottom, but most taken in trawls.

Reproduction: Unknown.

Status: *Special Concern*. Probably more rare in Virginia than in North Carolina (Porter and McCrary, 1977).

Protective Measures Proposed: Prevent pollution.

Remarks: Commensal clam (Jenner and McCrary, 1970) found in Virginia only once, near Parramore Island, but not with host.

Author: Marvin L. Wass.

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64. COLORLESS SYNAPTA

Leptosynapta tenuis AyresPhylum: Echinodermata
Class: HolothuroideaOrder: Apodida
Family: Synaptidae

Description: Length to 14 centimeters, diameter 10 millimeters. Flexible, translucent species, banded lengthwise by five bands seen through body wall. Tentacles 12, branched. Calcareous anchors occur beneath skin. Stomach usually filled with foreign material (Miner, 1950).

Present Range: New England to North Carolina.

Distribution in Virginia: Lower Bay to 15 parts per thousand salinity.

Habitat and Mode of Life: Most abundant in shallow fine sand beaches, as at Gloucester Point.

Reproduction: Spring of the year, when they come out of the substrate and swarm.

Status: *Special Concern*. Apparently absent from Gloucester Point following passage of Tropical Storm Agnes. However, recent oil spills may be more detrimental.

Protective Measures Proposed: None feasible at this late date, except possible control of oil spills.

Remarks: Life history poorly known.

Author: Marvin L. Wass.

65. FIVE-PARTED SEA CUCUMBER

Pentamera pulcherrima (Ayres)

Phylum: Echinodermata
 Class: Holothuroidea

Order: Dendrochirota
 Family: Phylloporidae

Description: Small species, length to 5 centimeters. Tentacles 10, much branched. Five ambulacral tracts with two double rows of tube feet. Flat, calcareous tables (plates) in integument (Miner, 1950; Gosner, 1971).

Present Range: Vineyard Haven, Massachusetts to South Carolina.

Distribution in Virginia: Formerly abundant on old oyster beds in the lower York River and Mobjack Bay; also Hampton Roads.

Habitat and Mode of Life: Creeps over bottom by use of tube-feet; requires shell or other firm substrates.

Reproduction: Unknown.

Status: *Special Concern*. Apparently now absent from York River.

Protective Measures Proposed: None seem feasible, but conservation of shell beds is important.

Author: Marvin L. Wass.

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66. PLATE-FINGERED CUCUMBER

Sclerodactyla briareus (Lesueur)

Phylum: Echinodermata
 Class: Holothuroidea

Order: Dendrochirota
 Family: Sclerodactylidae

Description: Length to 10 centimeters. Body elongate; able to form ovoid shape. Tentacles 10, tree-like. Tube feet scattered over surface. Color dull brown to black (Miner, 1950; see *Thyone briareus* in Reid *In*: Brown, 1950).

Present Range: Vineyard Sound to Gulf of Mexico.

Distribution in Virginia: Eastern Shore bayside creeks; formerly lower York River to Wormley Rock.

Habitat and Mode of Life: In deeper water, but not on anaerobic fine silt.

Reproduction: Sexes separate; filaments emit sex products into a chamber connected to a genital duct which conducts eggs or sperm cells to genital ducts.

Status: *Special Concern*. Now very rare in York River; formerly common.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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67. SCHLOSSER'S BOTRYLLUS

Botryllus schlosseri Pallas

Phylum: Chordata
 Class: Ascidiacea

Order: Pleurogona
 Family: Styelidae

Description: Mass up to 10 centimeters wide, usually much less. Surface smooth, fleshy. Zooids arranged in small round groups. Color much varied, from olive-green to purple with lighter lines edging zooids (Van Name, 1945).

Present Range: Very wide distribution on both sides of Atlantic.

Distribution in Virginia: Comes and goes with salinity changes. Probably also affected by oil spills.

Habitat and Mode of Life: Sets and grows on pilings and eelgrass. Common in summer with favorable sites and salinity. A pest at Gloucester Point on oyster trays and eelgrass in mid-1960's (dry period).

Reproduction: Increases in warm months by larvae and growth of colonies.

Status: *Special Concern*. Now apparently absent from lower York River.

Protective Measures Proposed: None feasible; species likely abundant elsewhere.

Author: Marvin L. Wass.

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68. GREEN PEROPHORA

Perophora viridis Verrill

Phylum: Chordata
 Class: Ascidiacea

Order: Enterogona
 Family: Perophoridae

Description: Zooids 2-4 millimeters in diameter. Forms slender stolons creeping like carpet grass over rocks and pilings. Zooids ovoid; colorless to bright green. Individual transparent, making observation of reversing heartbeat easily seen (Van Name, 1945).

Present Range: Cape Cod to Gulf of Mexico; Bermuda and West Indies.

Distribution in Virginia: Polyhaline. Occurs in lower Bay and lower parts of rivers. Common on oyster trays at Gloucester Point prior to low salinity of 1971-74.

Habitat and Mode of Life: On solid structures. Filters food from ambient water.

Reproduction: By larvae in summer.

Status: *Special Concern*. Depleted by lowered salinity and possibly oil spills.

Protective Measures Proposed: Probably none feasible.

Remarks: Very rare now in lower York River. Useful for classroom purposes when alive.

Author: Marvin L. Wass.

STATUS UNDETERMINED (31)

1. POTATO SPONGE

Craniella erania (Muller)

Phylum: Porifera
 Class: Demospongiae

Order: Choristida
 Family: Craniellidae

Description: Colonies consist of upright, circular masses up to 5 centimeters high and attaching to solid substrates. Many individuals tend to occur at a site. Colonies are hard with color gray-green to tan (Wells, Wells, and Gray, 1960).

Present Range: North Carolina coast at least to Chesapeake Bay.

Distribution in Virginia: Off Indian Creek, Kilmarnock, Virginia, probably to mouth of Bay.

Habitat and Mode of Life: On hard sand bottom; loosely colonial.

Reproduction: Unknown.

Status: *Undetermined*. Apparently rare on western shore of Bay. Unknown from eastern shore of Bay.

Protective Measures Proposed: None.

Remarks: Interesting classroom animal, if it were not so rare.

Author: Marvin L. Wass.

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2. DERSTED'S RIBBON-WORM

Derstedia dorsalis (Abildgaard)

Phylum: Rhynchocoela
 Class: Anopla

Order: Haplonemertini
 Family: Prosorochnidae

Description: Body cylindrical, both ends sharp-pointed. Length 10 millimeters, width 2 millimeters. Four ocelli form a square. Color variable but with distinct pigment patches forming diffuse circling bands. Background ochre, pigment color dark brown (McCaul, 1963; Gosner, 1971).

Present Range: North coast of Europe to Spain; Atlantic Coast, Nova Scotia to Florida and Mexico.

Distribution in Virginia: York River on eelgrass; also from sandy mud at 20 meters in mid-Chesapeake Bay.

Habitat and Mode of Life: Evidently adaptable to various habitats.

Reproduction: Unknown.

Status: *Undetermined*. Reason for scarcity unknown.

Remarks: Further studies using fine screens needed.

Author: Marvin L. Wass.

3. "WHITE NEMERTEAN"

Phylum: Rhynchocoela
Class: Anopla

Order: Unknown
Family: Unknown

Description: Slender, white; about 15 times as long as wide. Small species.

Present Range: Known only from Virginia in oligomesohaline sites, but certainly must be found in other mid-Atlantic estuaries.

Distribution in Virginia: As above.

Habitat and Mode of Life: Occurs in fine sediments.

Reproduction: Unknown.

Status: *Undetermined*. Relatively scarce.

Protective Measures Proposed: None.

Remarks: There seem to be no systematists working on rhynchocoels in North America.

Author: Marvin L. Wass.

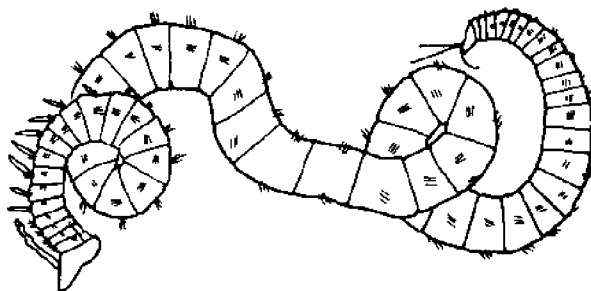
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4. POLYCHAETE

Aricidea wassi Pettibone

Phylum: Annelida
Class: Polychaeta

Order: Orbiniida
Family: Paraonidae



Description: Body elongate, slender, threadlike, wide anteriorly, tapering posteriorly. Branchiae begin on setiger 4; 9 to 18 on longer worm. Notopodia and neuropodia have thick bundles of setae in several rows. Length to 30 millimeters, width to 0.5 millimeter, segments to 200 (Pettibone, 1965).

Present Range: Chesapeake Bay, Virginia, off Eastern Shore.

Distribution in Virginia: As above.

Habitat and Mode of Life: Occurred in mud and sand with some shells.

Reproduction: Unknown.

Status: *Undetermined*. Not seen in Virginia waters since described. Two individuals collected off Cape Charles in 1978.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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5. POLYCHAETE

Autolytus prolifer O. F. Muller

Phylum: Annelida
Class: Polychaeta

Order: Phyllodocida
Family: Syllidae

Description: Stem form to 20 millimeters; segments to 70; nuchal epaulettes inconspicuous. Body pale yellow to peach colored (Pettibone, 1965). Sex buds produced in unisexual chains of two to eight and proliferated after setigers 32-38 (range 19-65).

Present Range: Gulf of St. Lawrence to Georgia; low water to 30 fathoms.

Distribution in Virginia: Barren Island and Bay mouth, *vide* Marian Pettibone.

Habitat and Mode of Life: In low water among algae and sessile animals on rocks and in sediment.

Reproduction: Two to eight sexual buds formed in unisexual chains. Parapodia enlarge with sex products; 5 to 10 ovigerous segments proliferate from a few cells which enlarge.

Status: *Undetermined*. Not found by VIMS personnel.

Protective Measures Proposed: None.

Remarks: Usually found among sessile organisms where fouling occurs.

Author: Marvin L. Wass.

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6. SCALE WORM

Harmothoe acanellae Verrill

Phylum: Annelida
Class: Polychaeta

Order: Phyllodocida
Family: Polynoidae

Description: Elytra 15 pairs, easily loses scales. Large worm, up to 90 millimeters long and 25 millimeters wide. Prostomium with four large eyes. Notosetae few; neurosetae has long spinous areas and bare hooked tips. Proboscis large, dark purple (Pettibone, 1963).

Present Range: Off Nova Scotia, Grand Banks, Massachusetts, Rhode Island and North Carolina from 23 to 1230 fathoms.

Distribution in Virginia: In Chesapeake Bay, coral association must have been with *Leptogorgia*.

Habitat and Mode of Life: Associates with horny coral and sea pens.

Reproduction: Unknown.

Status: *Undetermined*.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

7. SCALE WORM

Lepidonotus squamatus Linne

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Polynoidae

Description: Length to 50 millimeters but much less in Virginia. Elytra much varied in color: mottled amber, reddish and greenish (Pettibone, 1963).

Present Range: One of most abundant polynoids in northern hemisphere.

Distribution in Virginia: Not found in Chesapeake Bay. One specimen found at Rogues Island, Hog Island Bay, on seaside of Eastern Shore, May 23, 1960 by Sewell Hopkins, determined by Marian H. Pettibone.

Habitat and Mode of Life: Slow-moving polynoid that clings to stones and lives in crevices between sessile animals; also on man-made structures. Rolls up like pill bug when disturbed. Scales not easily lost.

Reproduction: Breeding at Woods Hole from mid-April to end of May.

Status: *Undetermined*.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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8. POLYCHAETE

Marphysa sanguinea (Montagu)

Phylum: Annelida
 Class: Polychaeta

Order: Eunicida
 Family: Eunicidae

Description: Long worm; up to 600 millimeters (24 inches) long by 11 millimeters wide. Front segments narrow, cylindrical, then much flattened, tapering posteriorly; fragile. Branchia begin on setiger 20. Color striking, yellow-orange, red-brown, pinkish gray, with brilliant opalescent iridescence; branchiae bright red; acicula black (Pettibone, 1963).

Present Range: Virginian Province, littoral to 91 meters.

Distribution in Virginia: Only three specimens found on western side of Bay; more numerous on eastern side.

Habitat and Mode of Life: Evidently usually in sand; also in *Zostera* bed at Chincoteague.

Reproduction: Unknown.

Status: *Undetermined*.

Protective Measures Proposed: None.

Remarks: Fairly large; quite colorful in life. More sampling in sand bottoms needed.

Author: Marvin L. Wass.

9. POLYCHAETE

Microphthalmus szeletkowi Meczniow

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Hesionidae

Description: Tiny worm; segments to 40; 6 millimeters long, 0.5 millimeter wide. Notosetae simple, curved, lyrate. Body brown-pigmented dorsally and ventrally; transverse and lengthwise bands occur (Pettibone, 1963).

Present Range: Ireland, North Sea, Cape Cod, northern Japan Sea.

Distribution in Virginia: One found at Piney Point at mouth of Potomac River by Virnstein in 1975.

Habitat and Mode of Life: Found in shallow water over sand and muddy water.

Reproduction: Eggs laid in "oval, sticky mucous mass" (Rasmussen, 1956).

Status: *Undetermined*.

Protective Measures Proposed: None.

Remarks: More searching with meiofaunal collecting techniques is needed.

Author: Marvin L. Wass.

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10. POLYCHAETE

Notocirrus spiniferus Moore

Phylum: Annelida
 Class: Polychaeta

Order: Eunicida
 Family: Arabellidae

Description: Length to over 110 millimeters, width 4 millimeters; segments over 220. Prostomium subconical, with four eyes on posterior border. Parapodia small; notopodia distinct. Proboscis has dark mandibles (Pettibone, 1963). Parasitic in *Diopatra*.

Present Range: Massachusetts to North Carolina.

Distribution in Virginia: Found in Hampton Roads by D. F. Boesch in 1969; only two specimens.

Habitat and Mode of Life: Parasitic in *Diopatra cuprea*, but not reported by C. Mangum in her study of *Diopatra*. More than 50 have been found parasitizing one *Diopatra*.

Reproduction: Unknown.

Status: *Undetermined*. Not found as parasite in Chesapeake Bay.

Protective Measures Proposed: None.

Remarks: Niche likely small in Chesapeake Bay.

Author: Marvin L. Wass.

11. POLYCHAETE

Proceraea cornuta Agassiz

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Syllidae

Description: Stem form length to 18 millimeters, width 0.7 millimeter; segments to 78. Nuchal epaulettes indistinct; body flesh-colored; bases of parapodia forming faint lateral brownish bands. Female and male with pre-natatory, natatory and postnatatory setigers in varying numbers (Miner, 1950; Pettibone, 1963).

Present Range: New England to Virginia.

Distribution in Virginia: Taken off New Point Comfort in January, 1921 (Cowles, 1930).

Habitat and Mode of Life: On seaweed and shells.

Reproduction: Unknown.

Status: *Undetermined*. Never found again in the Bay, a hiatus of 57 years, until Dauer took one off Lynnhaven Roads in 1977.

Protective Measures Proposed: None.

Remarks: May be extirpated from earlier sites.

Author: Marvin L. Wass.

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12. POLYCHAETE

Sthenelais limicola (Ehlers)

Phylum: Annelida
 Class: Polychaeta

Order: Phyllodocida
 Family: Sigalionidae

Description: Length to 100 millimeters, width to 4 millimeters, segments to 200 or more. Elytra translucent, colorless (Pettibone, 1963).

Present Range: Gulf of St. Lawrence to North Carolina, Norway to Mediterranean and South Africa.

Distribution in Virginia: Oyster ground at Wachapreague, Eastern Shore.

Habitat and Mode of Life: Apparently occurs on both mud and sand bottoms near the coast. Food of bottom fish in Massachusetts.

Reproduction: Unknown.

Status: *Undetermined*. Only one found.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

13. BERMUDA SAND-SHORE WORM

Pontodrilus bermudensis Beddard

Phylum: Oligochaeta
 Class: Clitellata

Order: Haplotaxida
 Family: Tubificidae

Description: Mature worms to 72 millimeters long by 3 millimeters diameter. Small spermathecal pores located on lateral-most setae of ventral bundles. Dorsal setae of posterior segments in regular ranks. Transverse genital marks on ventral surface between segments 19 and 20 (Cook and Brinkhurst, 1973).

Present Range: Chesapeake Bay and Bermuda, probably in most Carolinian Province estuaries at salinities above 10 parts per thousand.

Distribution in Virginia: Cape Charles and Gloucester Point.

Habitat and Mode of Life: Burrows in beach sand where wave action is moderate. Probably polyeuhaline.

Reproduction: Unknown.

Status: *Undetermined*. May be threatened by oil spills. Population densities unknown.

Protective Measures Proposed: Control oil spills.

Remarks: Census needed.

Author: Marvin L. Wass.

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14. BEAUTIFUL LITTLE CAECUM

Caecum pulchellum Stimpson

Phylum: Mollusca
 Class: Gastropoda

Order: Mesogastropoda
 Family: Caecidae

Description: Minute curved snail with 20-30 circular ribs; length about 2 millimeters (Abbott, 1974).

Present Range: New Hampshire to Brazil.

Distribution in Virginia: Found only at one place, off Rappahannock River in hard sand, depth 30 feet.

Habitat and Mode of Life: Food unknown, probably plankton. Obviously prefers sand.

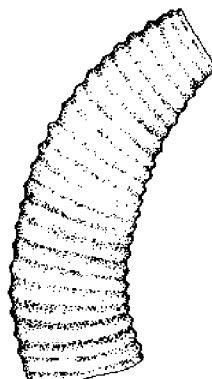
Reproduction: Protect sand areas if investigations show species to be scarce.

Status: *Undetermined*. Lack of specimens may be due to too large screen sizes.

Protective Measures Proposed: None.

Remarks: Smaller screens should used often to collect meiofauna.

Author: Marvin L. Wass.



15. ERCOLANIAN NUDIBRANCH

Ercolania sp.

Phylum: Mollusca
Class: Gastropoda

Order: Sacoglossa
Family: Hermaeidae

Description: Adult 3 millimeters; aeolidiform; rhinophores cylindrical, lacking oral tentacles. Cerata single, eight on each side of dorsum, with orange digestive-gland diverticulae in each. Dorsum with black spots (Abbott, 1974).

Present Range: Mouth of Rappahannock River, two specimens taken - one in 1971, a second in 1972 (Vogel, 1977).

Distribution in Virginia: As above.

Habitat and Mode of Life: Unknown.

Reproduction: Unknown.

Status: *Undetermined.*

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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16. TENELLIAN NUDIBRANCH

Tenellia sp.

Phylum: Mollusca
Class: Gastropoda

Order: Nudibranchia
Family: Cuthonidae

Description: Small, 3 to 5 millimeters. Head small, rounded; body longer, oval. Rhinophores simple cylinders. Cerata clumped on either side of dorsum. Eyes behind rhinophores. Foot narrow, less than one-third of body width. Tail short, broad and pointed. Adult high as wide. Dorsum has dark melanophores (Abbott, 1974).

Present Range: Cherrystone Creek and Wachapreague Channel, Virginia (Vogel, 1977).

Distribution in Virginia: As above.

Habitat and Mode of Life: Feeds on hydroids.

Reproduction: Approximately 20-50 eggs in one egg mass.

Status: *Undetermined.* Due to undescribed status and lack of knowledge of range.

Protective Measures Proposed: Protect water quality in the area.

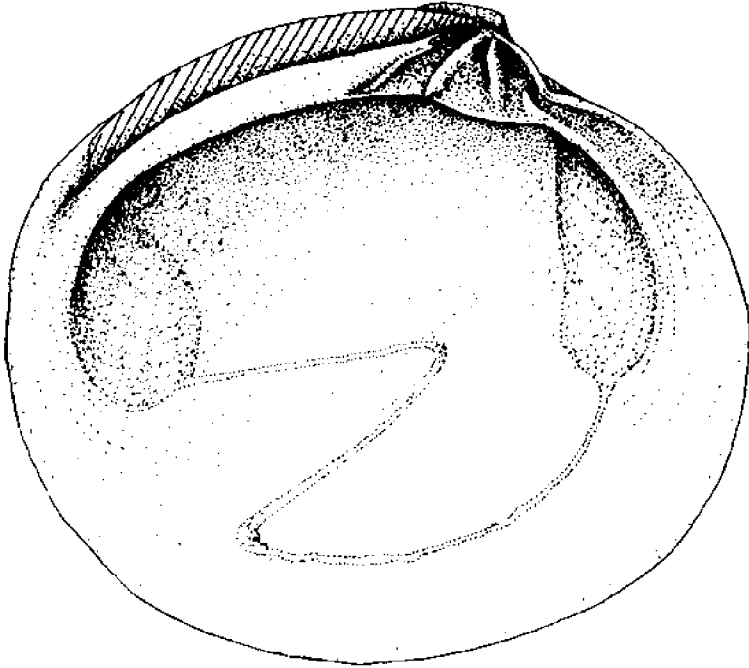
Author: Marvin L. Wass.

17. DISK DOSINIA

Dosinia discus Reeve

Phylum: Mollusca
 Class: Bivalvia

Order: Heterodontida
 Family: Veneridae



Description: Length to 90 millimeters. Shell subcircular, rather fragile, compressed; beaks anterior to midline. Escutcheon narrow, weak. Sculpture fine, concentric ridges. Shell white (Abbott, 1974).

Present Range: Virginia to Florida, Texas and the Bahamas.

Distribution in Virginia: Taken once near Sarah's Creek, near Gloucester Point. A few others from lower Bay.

Habitat and Mode of Life: Burrows deeply into sand-silt bottoms. Ploughs through bottoms in submerged position.

Reproduction: Unknown.

Status: *Undetermined*. Some likely disturbed by dredging in lower Bay.

Protective Measures Proposed: None.

Remarks: Not commercially harvestable.

Author: Marvin L. Wass.

18. WEDGE-SHAPED MARTESIA

Martesia cuneiformis Say

Phylum: Mollusca
 Class: Bivalvia

Order: Heterodontida
 Family: Pholadidae

Description: Wedge clam approximately 16 millimeters long. Transverse groove passes straight from umbo to shell margin, dividing shell; anterior area resembles rasp. Anterior rounded and inflated; valves having rasping effect. Siphons protrude through gaping ends. Umbones and shell plates form boring tool (Abbott, 1974).

Present Range: Virginia to Texas and Brazil.

Distribution in Virginia: Very rare in lower Bay.

Habitat and Mode of Life: Burrows in driftwood.

Reproduction: Unknown.

Status: *Undetermined*. Probably becoming even more scarce due to flotsam differences in Bay, with more petroleum-derived products, plywood, and treated lumber being jettisoned and less unadulterated wood put overboard.

Protective Measures Proposed: None.

Remarks: Probably decreased with the onset of the oil era.

Author: Marvin L. Wass.

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19. ATLANTIC FLAT LEPTON

Mysella planulata (Stimpson)

Phylum: Mollusca
 Class: Bivalvia

Order: Heterodontida
 Family: Montacutidae

Description: Length 5 millimeters. Shell oval; fragile, compressed, equivalve, posterior beaks almost touching. Sculpture of fine lines. Cardinal teeth lacking. Two prominent laterals in each valve. Siphons lacking (Abbott, 1974).

Present Range: Nova Scotia to Texas and West Indies.

Distribution in Virginia: Chesapeake Bay off Rappahannock River.

Habitat and Mode of Life: Reported attached to buoys, eelgrass, and pilings.

Reproduction: Unknown.

Status: *Undetermined*. Found only once in Chesapeake Bay. Taken in benthic grab.

Protective Measures Proposed: None.

Remarks: Commensal host, if any, seems not to be known.

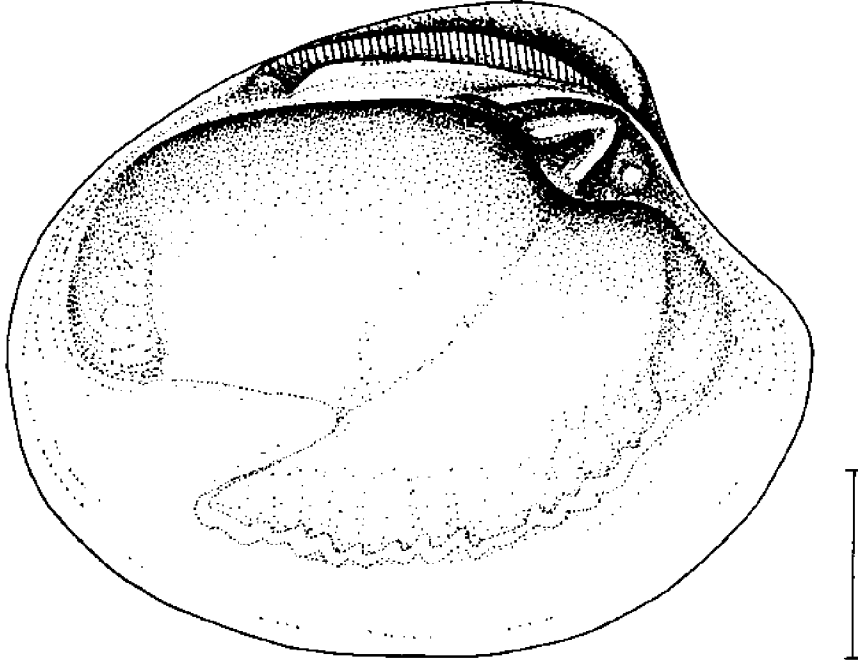
Author: Marvin L. Wass.

20. MORRHUA VENUS

Pitar morrhuanus Linsley

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontidae
Family: Veneridae



Description: Length to 50 millimeters. Shell subovate; heavy, thick, inflated; equivalve, umbones anterior. Lunule spade-shaped, sculpture heavy growth lines. Each valve has three cardinal teeth. Pallial line wide, corrugated; sinus deep, triangulate. Margin smooth. Siphons united. Periostracum rust to gray-brown (Abbott, 1974).

Present Range: Gulf of St. Lawrence to North Carolina.

Distribution in Virginia: Lower York River, one specimen; Eastern Shore, oceanic, in seaside bays.

Habitat and Mode of Life: Burrows in bottom.

Reproduction: Unknown.

Status: *Undetermined*. Perhaps far south of optimal habitat. Offshore shelf species.

Protective Measures Proposed: None.

Remarks: Never more than one found at a time.

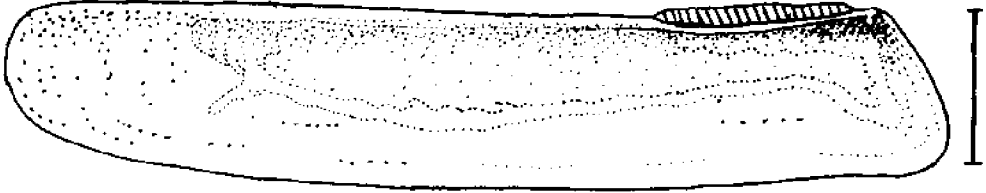
Author: Marvin L. Wass.

21. GREEN JACKKNIFE CLAM

Solen viridis Say

Phylum: Mollusca
Class: Bivalvia

Order: Heterodontida
Family: Solenidae



Description: Length to 53 millimeters. Shell elongate-rectangular, upper and lower margins straight, both ends truncate and gaping; thin, fragile, compressed; equivalve. Periostracum thin, shiny, pale green, gray or brown. Shell interior white (Abbott, 1974).

Present Range: Rhode Island to Florida and the Gulf States.

Distribution in Virginia: Never taken in Chesapeake Bay. Found in patches only off Cedar Island in shallow sand.

Habitat and Mode of Life: Burrows like other jackknife or razor clams.

Reproduction: Unknown.

Status: *Undetermined*. Optimal habitats must be investigated.

Protective Measures Proposed: None.

Remarks: Could be plentiful in places, but none have been found in recent years.

Author: Marvin L. Wass.

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22. CLADOCERAN

Ilyocryptus sordidus (Lieven)

Phylum: Arthropoda
Class: Crustacea

Order: Cladocera
Suborder: Cladocera
Family: Daphnidae

Description: Length of male to 1 millimeter. Post-abdomen has margin where anus opens. Long spines occur on periphery. Color normally red but often opaque with debris (Edmondson, 1959).

Present Range: Widely distributed, but uncommon.

Distribution in Virginia: Known only from Pamunkey River (Van Engel, 1972).

Habitat and Mode of Life: Planktonic, with resting stages. In weeds on muddy bottoms.

Reproduction: Unknown.

Status: *Undetermined*. Obviously rare.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

23. CLADOCERAN

Simocephalus exspinosus (Koch)

Phylum: Arthropoda
 Class: Crustacea

Order: Cladocera
 Suborder: Cladocera
 Family: Daphnidae

Description: Length to 3 millimeters in female, 1.3 millimeters in male. Eye large, elongate. Post-abdomen narrowed toward apex; up to 12 anal spines (Edmondson, 1959).

Present Range: Ranging over most of continent, but uncommon.

Distribution in Virginia: Taken only in Pamunkey River, 15 miles above West Point (Van Engel, 1972).

Habitat and Mode of Life: Planktonic.

Reproduction: Unknown.

Status: *Undetermined*. Rare; taken only in June.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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24. MANTIS SHRIMP

Squilla empusa Say

Phylum: Arthropoda
 Class: Crustacea

Order: Stomatopoda
 Family: Squillidae

Description: Length to approximately 14 centimeters. Carapace membranous with median ridge and groove complex. Posterior border has three lobes. Eyes on narrow stalks forming a V. Maxillipeds form raptorial claws able to hold prey securely. Caudal appendages also armed. Color pale or yellow green; tail rose-mottled and black. Eyes bright emerald green (Miner, 1950).

Present Range: Cape Cod to Florida and northern Gulf of Mexico.

Distribution in Virginia: Lower bay and up rivers to about 15 parts per thousand salinity.

Habitat and Mode of Life: Burrows into suitable bottom; in mud in the Cape Cod area (Miner, 1950).

Reproduction: Eggs hatched in burrows.

Status: *Undetermined*. Likely intolerant to low dissolved-oxygen levels and certain oil fractions. Rarely taken in benthic grabs.

Protective Measures Proposed: None.

Remarks: Population may be assessed by numbers found in striped bass stomachs.

Author: Marvin L. Wass.

25. OPOSSUM SHRIMP

Heteromysis formosa (S. I. Smith)

Phylum: Arthropoda
 Class: Crustacea

Order: Mysidacea
 Family: Mysidae

Description: General form rather robust. Carapace short and broad dorsally. Abdomen not tapered posteriorly. Antennular peduncle strong and well-developed, reaching distal end of antennal scale. Males semi-translucent, colorless. Females greenish-yellow; caudal appendages rose, joints violet (Lochhead *In*: Brown, 1950).

Present Range: Canada to Chesapeake Bay.

Distribution in Virginia: Cedar Island (M. Roberts); Hampton Roads (D. F. Boesch).

Habitat and Mode of Life: Lives in dead intact bivalve shells, such as *Maetra* and *Spisula*.

Reproduction: Unknown.

Status: *Undetermined*. Apparently quite scarce.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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26. ISOPOD

Chiridotea abmyra Bowman

Phylum: Arthropoda
 Class: Crustacea

Order: Isopoda
 Family: Idoteidae

Description: Sides of head creased, eyes dorsal, body broad, telson pointed; sides curved; second antenna longer than third. Single spine back of terminal claw on finger of first large gnathopod. Uropods ventral, invisible dorsally, turned inwards to form cover enclosing pleopods (Schultz, 1969).

Present Range: Cape Cod to Georgia.

Distribution in Virginia: West Point and lower Pamunkey River.

Habitat and Mode of Life: Unknown. Taken in plankton.

Reproduction: Unknown.

Status: *Undetermined*.

Protective Measures Proposed: None.

Remarks: Not taken in other rivers.

Author: Marvin L. Wass.

27. AMPHIPOD

Corophium aquafusum Heard and Sikora

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Corophiidae

Description: Medium-sized species (length 4-7 millimeters), heavily setose; urosome fully segmented. Rostrum lacking in male, present in female. Both sexes have two strong teeth on distoventral margin of segment 4. Single spine on segment 1 of antenna 1 in female; lacking in male (Heard and Sikora, 1972).

Present Range: Chesapeake Bay to Georgia.

Distribution in Virginia: Mattaponi River; probably also in other oligohaline waters. Robert Diaz.

Habitat and Mode of Life: Tube-dwelling amphipod living in oligohaline marshes. Eaten by white catfish and mummichogs.

Reproduction: Females ovigerous June to September.

Status: *Undetermined*. Probably threatened in some places by industrial and domestic effluents.

Protective Measures Proposed: Help keep oligohaline waters free of toxic pollutants and low dissolved oxygen values.

Remarks: Should be sought in all oligohaline areas. Perhaps extinct in Hampton Roads area.

Author: Marvin L. Wass.

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28. AMPHIPOD

Idunella sp.

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Liljeborgiidae

Description: Body smooth, sexual differences strong. Head has short rostrum, small eyes. Gnathopod large, subchelate. Seventh pereopod longest and heaviest. Telson large, deeply cleft (Bousfield, 1973).

Present Range: Chesapeake Bay and North Carolina (Fox and Bynum, 1975).

Distribution in Virginia: York River, Gloucester Point; Hog Island Bay, Eastern Shore (Feeley and Wass, 1971).

Habitat and Mode of Life: Commensal in burrows of the polychaete *Amphitrite ornata* and the mud shrimp *Upogebia affinis*.

Reproduction: Most likely from May to September.

Status: *Undetermined*. Remains undescribed and poorly known as to habits and commensal hosts.

Protective Measures Proposed: Valid description and further studies needed.

Remarks: Should extend to Florida; possibly to Gulf Coast.

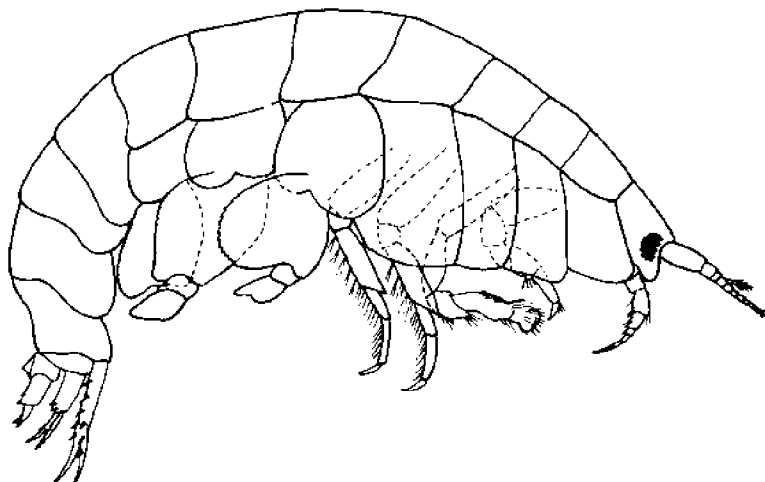
Author: Marvin L. Wass.

29. AMPHIPOD

Lysianassa alba (Holmes)

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Lysianassidae



Description: Length 8-10 millimeters. Antennae short. Eye kidney-shaped, smallish. Body surface smooth. Coxal plates deep; coxa 5 large. Antenna 1, peduncle 2 longer than 3. Gnathopod 1 simple, pereopod 7 longest. Telson wide as long; rounded (Bousfield, 1973).

Present Range: Cape Cod to northern Florida; eastern Gulf of Mexico.

Distribution in Virginia: Polyhaline; apparently only abundant in eelgrass beds. York River - Chesapeake Bay (Feeley and Wass, 1971).

Habitat and Mode of Life: Burrower in mud-sand substrates.

Reproduction: May-September.

Status: *Undetermined*.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

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30. AMPHIPOD

Microprotopus raneyi Wigley

Phylum: Arthropoda
 Class: Crustacea

Order: Amphipoda
 Family: Isaeidae

Description: Tiny species, 2-4 millimeters. Antennae 1 & 2 subequal. Gnathopod 1 subchelate. Gnathopod 2 very large; segment 6 subovate. Segment 5 with plumose setae. Uropods 1 and 2 exceeding 3. Ramus of uropod 3 slender, lacking lateral spines, but has 2 apical spines (Bousfield, 1973).

Present Range: Cape Cod Bay, Vineyard Sound and Buzzards Bay to north Florida and Gulf of Mexico (Lowry, 1972).

Distribution in Virginia: Abundant at Wachapreague Inlet. Not seen elsewhere in Virginia.

Habitat and Mode of Life: Builds tubes in sandy substrates.

Reproduction: Females ovigerous May to September.

Status: *Undetermined*. Probably at all inlets on outer beaches along Eastern Shore.

Protective Measures Proposed: None likely needed.

Remarks: Further surveys of psammofauna needed on outer beaches.

Author: Marvin L. Wass.

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31. AMPHIPOD

Parapleustes aestuarius Watling
and Maurer

Phylum: Arthropoda

Order: Amphipoda

Class: Crustacea

Family: Pleustidae

Description: Length of male 3 to 4 millimeters, female 3.5 to 6 millimeters. Gnathopods strong, body dorsally smooth. Antenna 1 as long as first 5 pereonites; posterior lobe on fifth article of gnathopods; three spine clusters delimit gnathopod palms (Watling and Maurer, 1973).

Present Range: Delaware Bay to Georgia.

Distribution in Virginia: Known only from York River (Feeley and Wass, 1971).

Habitat and Mode of Life: Lives among hydroids and ectoprocts. Mesopolyhaline.

Reproduction: Unknown.

Status: *Undetermined*.

Protective Measures Proposed: None

Author: Marvin L. Wass.

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RECENTLY EXTINCT OR EXTIRPATED (5)

1. COMMON AMERICAN AUGER

Terebra discocuta Say

Phylum: Mollusca
 Class: Gastropoda

Order: Neogastropoda
 Family: Terebridae

Description: Small slender auger; elongate spire tapers to fine point. Shell has 15 whorls sculpted with spiral grooves and vertical ribs. Aperture small (Abbott, 1974).

Present Range: Maryland to Florida, Texas and the West Indies; Brazil; California to Panama.

Distribution in Virginia: Formerly to York Spit in lower Chesapeake Bay when Willis Hewatt found a shell two decades ago.

Habitat and Mode of Life: Creeps over sand bottoms and drills bivalves.

Reproduction: Unknown.

Status: *Extirpated* in Virginia waters as far as we can discern. No shells found on Virginia coast beaches recently.

Protective Measures Proposed: None.

Remarks: No probable reason for extirpation, except possibly colder weather or loss of food sources.

Author: Marvin L. Wass.

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2. CAROLINA MARSH CLAM

Polymesoda caroliniana Bosc

Phylum: Mollusca
 Class: Bivalvia

Order: Heterodontida
 Family: Cycladidae

Description: Length to 48 millimeters. Shell triangulate; strong, inflated, equivalve; beaks ahead of midline, facing forward. Sculpture concentric undulating lines; growth lines clear. Both valves with three cardinal teeth. Left valve with 21 large, knoblike laterals, one anterior, one posterior. Pallial line narrow. Margin smooth. External ligament dark brown. Shell interior white to iridescent purple (Abbott, 1974).

Present Range: Lavaca Bay, Texas through Gulf of Mexico and north along western Atlantic Coast to James River, Virginia.

Distribution in Virginia: Jamestown Island to Mulberry Island in James River (Andrews and Cook, 1951). Presumed to be endemic.



Habitat and Mode of Life: Low intertidal zone in marshes, grassy shores and ripraps where protection from wave action is provided (Andrews and Cook, 1951). Usually an abundance of detritus and organic matter in niches. Siphons short, hence is a presumed filter feeder on plankton and organic particles. Shells formerly common on shores.

Reproduction: Unknown.

Status: *Extirpated*. Not found for 10 to 15 years in James River.

Protective Measures Proposed: Marshes are polluted by industry and military bases along this stretch of river. Much of shoreline is in Jamestown area of National Historical Park where swimmers and picnickers frequent eroding shore and collect molluscs. Riprap on military bases is most probable future habitat of this species. Effect of Kepone unknown.

Remarks: Scarce or extinct in Virginia. Except riprap niche, habitat limited in area and subject to man-induced deterioration and destruction.

Author: Jay D. Andrews.

3. DECAPOD

Ogyrides alphaerostris Kingsley

Phylum: Arthropoda
 Class: Crustacea

Order: Decapoda
 Family: Alpheidae

Description: Length 27 millimeters. Rostrum depressed, tipped with setae. Eyestalks long. First legs scarcely reach antennal scale. Second legs exceed antennal scale by full chela length; fingers pointed. Uropods with exopods falciform, curvature greatest distally (Williams, 1965).

Present Range: Eastern Shore of Virginia to St. Simons Island, Georgia; Alligator Harbor, Florida to Horn Island, Mississippi.

Distribution in Virginia: Taken on seaside of Northampton County in 1879 and never collected in Virginia again.

Habitat and Mode of Life: Euhaline.

Reproduction: Likely in July.

Status: *Extirpated*. Possibly because of cooler water since late 1800's or because of loss of eelgrass.

Protective Measures Proposed: None realistic.

Author: Marvin L. Wass.

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4. LITTLE SPINY BRITTLE-STAR

Ophiothrix angulata Say

Phylum: Echinodermata
 Class: Ophiuroidea

Order: Ophiurida
 Family: Ophiothricidae

Description: Disc 10 millimeters, anus 6 centimeters. Top disc covered with sharp spines, except for radial shields. Arms with two to six slender, blunt spines. Arm segments much broader than long. Thorn-tipped scale on each segment of arm from base to tip. Almost every color occurs (Miner, 1950).

Present Range: Chesapeake Bay to Rio de Janeiro.

Distribution in Virginia: Tangier Sound, 2 to 13 fathoms (Koeler, 1914); lower mid-Chesapeake Bay, J. Whitcomb.

Habitat and Mode of Life: Moves over bottom to feed.

Reproduction: Unknown.

Status: *Extirpated*. Not seen since 1958. Miner (1950) reported it common from Chesapeake Bay south.

Protective Measures Proposed: None.

Author: Marvin L. Wass.

5. SEA SQUIRT

Ecteinascidia turbinata Herdman

Phylum: Chordata
 Class: Ascidiacea

Order: Enterogona
 Family: Perophoridae

Description: Colony to 15 centimeters in favorable areas where they form around grass stems and mangrove roots in Florida. Zooids about 20 millimeters long. Test thicker at ends of body. Branchial sac long, barrel-shaped, with about 27 to 30 rows of small stigmata. Test transparent, colorless. Living zooids yellow, pinkish orange, or bright orange (Van Name, 1945).

Present Range: Chesapeake Bay (?) to Bermuda, Gulf of Mexico and West Indies.

Distribution in Virginia: If existing, at mouth of York River (Calder, Thornborough and Lowry, 1966).

Habitat and Mode of Life: Attaches to stable substrates, feeds on plankton.

Reproduction: Breeds August to September.

Status: *Extirpated.*

Protective Measures Proposed: None needed.

Remarks: Must have arrived in Chesapeake Bay through shipping. Ideal for classroom use.

Author: Marvin L. Wass.

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FRESHWATER AND MARINE FISHES¹

Robert E. Jenkins

Introduction

Robert E. Jenkins and John A. Musick

The current list of freshwater fishes known from Virginia stands at 206 species, including 10 that are diadromous and 4 others ranked as freshwater-estuarine. Eight of the freshwater and one of the freshwater-estuarine species were introduced to the state. Several additional strictly freshwater fishes are expected to be discovered. The Virginia freshwater ichthyofauna is relatively rich in species compared with most other states. For example, Maryland and Delaware together have 99 species (Lee *et al.*, 1976), West Virginia 151 (Denoncourt *et al.*, 1975), Kentucky 201 (Clay, 1975), and North Carolina 195 (Menhinick *et al.*, 1974). Some of these totals reflect our adjustments for diadromous and estuarine fishes. The other adjacent state, Tennessee has a much richer freshwater fauna than Virginia.

The high number of freshwater species in Virginia relates to habitat diversity within, and major ecological differences between, the five physiographic provinces (Hoffman, 1969) drained within the state. Also involved are prehistoric evolutionary factors such as geographic isolation and speciation following penetration by fish stocks of drainage divides via stream captures and other drainage modifications (Ross, 1969; 1972a; Lachner and Jenkins, 1971; Jenkins *et al.*, 1972). The fauna basically are adapted to running water, with most species preferring clear, clean water and a bottom not heavily silted. There are only two natural lakes in Virginia, at altitudinal extremes -- Mountain Lake in Giles County and Lake Drummond, the latter in Dismal Swamp.

Of the 197 native freshwater species, 3 are considered herein as *Endangered*, 6 *Threatened*, and 25 are so restricted in distribution and/or so rare in Virginia that they are listed as of *Special Concern*. The total of 34 represents 17% of the native freshwater fish fauna. Additionally, one of the 197 species is completely *Extinct*, another is *Extirpated* from the state, and a third has one of its subspecies *Extirpated* from the state. Five other species are of *Undetermined Status*, and at least one of these probably is *Extirpated*.

The freshwater ichthyofauna as a whole are impacted by a number of factors adverse to survival of fishes. Major factors include excessive turbidity and silt loads, domestic and chemical pollution, channel modification, disruption of natural temperature regimen, reduction of instream flow, impoundment, and competitive species interactions (in one case following introduction of a non-native fish species). Often it is difficult to identify the specific factor(s) that have reduced or extirpated populations, as did P. W. Smith (1971) for Illinois fishes, and Trautman and Gartman (1974) in Ohio. Some of the problems, particularly siltation, are widespread, chronic and/or continual. Specific perturbatory factors are noted

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in the accounts for many species. For some species only one life stage, or reproduction, may be affected, whereas with other species effects may be general and even cumulative throughout the life cycle. In any case, the results may be the same - reduction or elimination of populations.

Virginia's marine and estuarine fish fauna is characterized by its dynamic nature. Most elements of the fauna are migratory. All are highly mobile. Most are widespread coastally and occur in their preferred habitats in many localities within Virginia and other states. Musick (1972) annotated 208 species of marine and estuarine fishes within Virginia's coastal fish fauna, including 174 marine, 24 estuarine, and 10 diadromous (9 anadromous, 1 catadromous) species. Fourteen (10 diadromous and 4 estuarine) species are shared with the freshwater faunal list. Of the 174 marine species, 59 are regular summer visitors and 93 occur rarely or sporadically during the summer. During the winter only 6 marine fishes are regular visitors and 16 occur rarely or sporadically. All of the 24 species of estuarine fishes are resident. These along with 3 anadromous, 1 catadromous, and 2 marine species remain in shallow coastal habitats in Virginia during the entire year.

From the foregoing it appears that there are many species which may occur rarely and/or seasonally in Virginia's coastal waters. It would be ridiculous to include most of these on a list of endangered species for the state because they are extralimital for the most part, and are able to visit Virginia occasionally because of their mobility and the inherent accessibility of the marine environment. We recognize only three species of marine or estuarine inhabitants for inclusion within the list of Virginia threatened and endangered biota. These are two anadromous fishes, the shortnose sturgeon (*Acipenser brevirostrum*) as *Endangered*, Atlantic sturgeon (*Acipenser oxyrinchus*) as *Threatened*, and an estuarine fish, the marsh killifish (*Fundulus confluentis*) as of *Special Concern*. The two sturgeons are included in totals and the percentage of freshwater fishes; the killifish is excluded from the most recent freshwater faunal list.

Some of the problems that beset certain marine and estuarine fishes are dredging, thermal pollution, chemical pollution including oil spills and spraying for insects, alteration of marshes to drier habitats, and overfishing of commercially important species.

Data Sources and Acknowledgments

Although some significant areas of the Old Dominion remain to be explored ichthyologically, its waters generally have been well surveyed qualitatively -- the result of more than a century of accumulated efforts. Quantitative studies have been made of several streams and estuaries. Hildebrand and Schroeder (1928) and Musick (1972) documented, including extensive references, results of collections of marine and estuarine fishes. The locations of some 4100 freshwater and estuarine collections are shown in Jenkins *et al.* (1976) and about 1300 additional recent freshwater collections are encompassed in the present report. Some of the earlier history of Virginia freshwater ichthyology is noted in Jenkins *et al.* (1976). Unfortunately, few collections were made prior to 1940. The most significant forays were in 1867 by Cope (1868), in 1888 by Jordan (1889), and in 1937 and 1938 by Schultz (1939). Many elements of the fauna probably were declining during that period. From 1940, starting with extensive efforts by E. C. Raney and his students, a good, wide data base was established and it has been synthesized by the first author. Jenkins *et al.* (1972: particularly page 57) cited extensive distributional literature not directly treated herein.

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Abbreviations used herein:

CU-Cornell University
USNM-National Museum of Natural History
VIMS-Virginia Institute of Marine Science
VPI&SU-Virginia Polytechnic Institute and State University
SL-standard length
FL-fork length
TL-total length

In this report we have attempted to use the following terms in a consistent sense, as defined (in part, Jenkins *et al.*, 1972):

System - a main channel and its tributaries forming a subdivision of a drainage.

Drainage - an interconnected major group of streams or systems entering an Atlantic estuary (*e.g.*, James River drainage) or the Ohio River (such as the Tennessee River drainage).

Stream size:

Creek - watercourse which averages up to about 10 meters in width.

Stream (when used in strict sense herein) - average between 10 and 60 meters in width.

River - usually greater than 60 meters average width.

Previous Lists and Concepts of Status Categories

Seven freshwater species (roughhead shiner, bigeye jumprock, rustyside sucker, yellowfin madtom, orangefin madtom, blotchside logperch, and Roanoke logperch) were regarded as *Rare* in Virginia (and nationally) by Jenkins (*In: Miller, 1972*). The sense of the *Rare* category was roughly synonymous with that of *Threatened* as used herein and federally. In 1974, seven species (as above, except roughhead shiner and bigeye jumprock deleted due to new information; duskytail darter and sharphead darter added - the sharphead just discovered in Virginia) were listed as *Endangered* in Virginia (Anonymous, 1974b). Actually, the *Threatened* category, to which most of the species were then assigned by Jenkins, was merged with *Endangered* by the editor of that paper.

One of the most important events regarding recognition of species in jeopardy was the workshop sponsored by the Southeastern Division of The Wildlife Society that was held in September 1974 in Tallahassee, Florida. The sessions treating southeastern freshwater fishes were chaired by C. R. Gilbert and had vast input from some 15 southeastern ichthyologists in attendance who were thoroughly familiar with the fish fauna of their state of residence and other states. Hence, each species could be considered validly on a southeastern regional and national basis. All but one of the freshwater fishes regarded herein as *Endangered* or *Threatened* were recommended for enlistment on a national basis under one of these categories. The categories essentially were as defined and currently used for federal status.

The Committee on Fishes for the present work encountered some difficulty with application on a state level of certain categories used herein. For all species we considered total distribution and abundance extralimital to Virginia. Although we feel that the large majority of species are properly ranked with regard to state political boundaries, some species listed as both *Special Concern* and "peripheral" in the table and accounts may actually merit *Threatened* or *Endangered* status with respect to the Virginia population only. Good examples are the four species listed from the Peedee River drainage, which drains only a very small portion of Virginia, the pearl dace and slimy sculpin of the Potomac-Shenandoah River drainage, the sand shiner on the state line in the New River drainage, and some of the Tennessee River drainage fishes. Eighteen of the 26 fishes listed as *Special Concern* are considered peripheral. None of the populations of the *Endangered* or *Threatened* species are considered peripheral (Table 1).

The lack of comprehensive knowledge of distribution and abundance of freshwater fishes in Virginia during settlement and later historical periods hampers our thinking of ecological tolerances, present status, and projected future success of species. A number of species, for example the orangefin madtom and Roanoke logperch in the Roanoke drainage and the spotfin chub and yellowfin madtom of the Tennessee drainage, have been known since their discovery to occupy only a single small portion of, and/or have disjunctive ranges within, the physiographic province sections of drainages that include their preferred habitat. For some species we can document recent depletion or extirpation of populations caused by man, but for many it is not clear whether disjunction has been of long term and due to natural factors, or of recent origin relating to man-caused changes. We suspect that many cases of apparent but undocumented extirpation arose from a widespread increase in turbidity and siltation, particularly during the 1800's, associated with settlement and deforestation. Among the numerous nonpoint factors causing stream degradation, turbidity and siltation probably have been the most widely destructive to native aquatic life. One may conclude that many or all extant populations of numerous species given status herein are existing in marginal habitat conditions, are barely surviving, and that only a slight decline in stream quality could cause their extirpation. If this is true, then the status of many species could be downgraded from *Special Concern* to *Threatened* or *Endangered*.

Fishes and other aquatic organisms have preferred habitats and ecological niches, described by parameters such as type and availability of food, stream gradient, current velocity, bottom type, water temperature and chemistry, depth, cover and other factors. Many, and in some watersheds all, of these factors vary with distance from the shoreline in standing or lentic waters such as ponds and lakes, and from source springs in running or lotic waters, effecting specific zonal distribution patterns of the biota. Hence, most species of fishes of running water may be classified as small creek, or stream, or riverine forms, regardless of the specific (often unidentified) factor(s) that establish and enforce the zonal patterns. Linear or longitudinal zonation patterns have been discussed broadly by Hynes (1970) and were determined for the fishes of several Virginia streams (Burton and Odum, 1945; Jenkins and Freeman, 1972; Jenkins and Burkhead, 1973; Hambrick, 1973; Masnik, 1974; Stauffer *et al.*, 1975). Jenkins *et al.* (1972) ranked central eastern United States freshwater fishes according to their habitation of creeks, streams, or rivers (and with respect to gradient).

Recognition of linear zonation is important with regard to environmental problems. The large majority of the species listed herein prefer or are restricted to moderate and large size streams and rivers, even though the fishes may be small in size. Larger streams and rivers generally are more developed and adversely impacted from point and nonpoint sources than small streams because they provide sufficient water supply for population centers and industry. Although a moderate to relatively large number of records exist for some riverine species listed herein, the records are concentrated in or confined to a few main channels -- for some species only one or two rivers. If sufficiently stressed at one upstream point, populations inhabiting a considerable length of river could be extirpated. Some of the records of typically riverine species are from the lower sections of major tributaries, suggesting a source for natural restocking of the main river after fish kills. However, tributary populations of some riverine fishes actually may be unstable, reliant upon recruitment from the main river, and insignificant to recovery of the river fauna to its former diversity. In fact, tributary populations may die out with demise of the river population (for a possible example, see account of Tippecanoe darter). Rapid recovery in the river of more tolerant or fecund species may preclude, by competitive interaction, reestablishment of sensitive or less fecund forms.

Although larger streams have greater capacity to dilute pollution, a general rule seems to exist in upland and montane regions of Virginia concerning many sensitive species: the larger the size of streams to which they are restricted or that they prefer (and the fewer the number of streams or "threads of life" they occupy), the greater is the jeopardy in which the species is placed. Partial resolution of this apparent enigma may relate to greater depositional tendencies in larger streams, which course through larger valleys, have moderate to low gradients in Virginia, and hence are generally subject to greater rates of siltation than smaller, higher gradient, dominantly erosional tributaries on slopes. We therefore think that amounts of pollution, siltation, and stream size preferences all are interrelated with degree of environmental stress on species.

We are also concerned with attrition in quality of small streams. While there are many more small than large streams in Virginia, and deterioration of small streams often is a more localized and perhaps alleviable problem, redispersal of extirpated headwater species via larger channels may be impeded or prevented by natural ecological barriers and by other factors such as dams and pollution.

TABLE 1

List of fish species whose Virginia population(s) is recommended for one of the following status categories: Endangered (E), Threatened (T), Special Concern (SC), Extinct or Extirpated (X). Peripheral (P) is appended for certain species of Special Concern whose Virginia population currently is not critical to the overall survival of the species.

FAMILY: ACIPENSERIDAE		
E	<i>Acipenser brevirostrum</i> , Shortnose sturgeon	Anadromous
T	<i>Acipenser oxyrinchus</i> , Atlantic sturgeon	Anadromous
FAMILY: POLYODONTIDAE		
SC(P)	<i>Polyodon spathula</i> , Paddlefish	Clinch
FAMILY: CYPRINIDAE		
SC(P)	<i>Hybopsis hysinotus</i> , Highback chub	Peedee
SC(P)	<i>Hybopsis labrosa</i> , Thicklip chub	Peedee
E	<i>Hybopsis monacha</i> , Spotfin chub	N Holston
SC(P)	<i>Notropis ariommus</i> , Popeye shiner	N Holston, Clinch, Powell
SC(P)	<i>Notropis atherinoides</i> , Emerald shiner	Clinch, Powell
SC	<i>Notropis semperasper</i> , Roughhead shiner	James
SC(P)	<i>Notropis stramineus</i> , Sand shiner	New
SC(P)	<i>Notropis whipplei</i> , Steelcolor shiner	Clinch
SC(P)	<i>Phenacobius crassilabrum</i> , Fatlips minnow	S Holston
SC(P)	<i>Semotilus margarita</i> , Pearl dace	Potomac
FAMILY: CATOSTOMIDAE		
X	<i>Lagochila lacera</i> , Harelip sucker	N Holston
SC(P)	<i>Moxostoma carinatum</i> , River redhorse	S & Mid Holston, Clinch, Powell
SC	<i>Moxostoma hamiltoni</i> , Rustyside sucker	Dan
SC(P)	<i>Moxostoma robustum</i> , Smallfin redhorse	Peedee
FAMILY: ICTALURIDAE		
T	<i>Noturus flavipinnis</i> , Yellowfin madtom	N Holston, Clinch
T	<i>Noturus gilberti</i> , Orange-fin madtom	James, Roanoke, Dan
FAMILY: CYPRINODONTIDAE		
SC(P)	<i>Fundulus confluentis</i> , Marsh killifish	Estuarine
FAMILY: ATHERINIDAE		
SC(P)	<i>Labidesthes sicculus</i> , Brook silverside	Clinch, Powell
FAMILY: PERCOPSIDAE		
X	<i>Percopsis omiscomaycus</i> , Trout-perch	Potomac
FAMILY: COTTIDAE		
SC(P)	<i>Cottus cognatus</i> , Slimy sculpin	Potomac
FAMILY: CENTRARCHIDAE		
SC	<i>Ambloplites cavifrons</i> , Roanoke bass	Chowan, Dan, Roanoke
SC	<i>Emmeacanthus chaetodon</i> , Black-banded sunfish	Chowan

(continued)

FAMILY: PERCIDAE

E	<i>Etheostoma acuticeps</i> , Sharphead darter	S Holston
SC(P)	<i>Etheostoma caeruleum</i> , Bluebreast darter	N Holston, Clinch
SC(P)	<i>Etheostoma chlorbranchium</i> , Greenfin darter	S Holston
SC(P)	<i>Etheostoma jessiae</i> , Blueside darter	N Holston
T	<i>Etheostoma tippecanoe</i> , Tippecanoe darter	Clinch
T	<i>Etheostoma species</i> , Duskytail darter	Clinch
SC	<i>Percina aurantiaca</i> , Tangerine darter	N Holston, Clinch, Powell
SC	<i>Percina burtoni</i> , Blotchside logperch	N Holston, Clinch
X	<i>Percina caprodes semifasciata</i> , Northern logperch	Potomac
SC	<i>Percina copelandi</i> , Channel darter	Clinch, Powell
SC(P)	<i>Percina crassa</i> , Piedmont darter	Peedee
SC	<i>Percina macrocephala</i> , Longhead darter	Mid & N Holston, Clinch
T	<i>Percina rex</i> , Roanoke logperch	Chowan, Roanoke, Dan

Critical Watersheds and Habitats

The following is a consideration of specific streams, stream systems, or habitat types that collectively sustain all freshwater species recommended herein for status of *Endangered* and *Threatened* and for most species listed as *Special Concern*. Hence, the watersheds merit particular attention regarding conservation of Virginia's fish fauna (Figure 1; Table 2). Federal designation of some of the streams as Critical Habitat is noted.

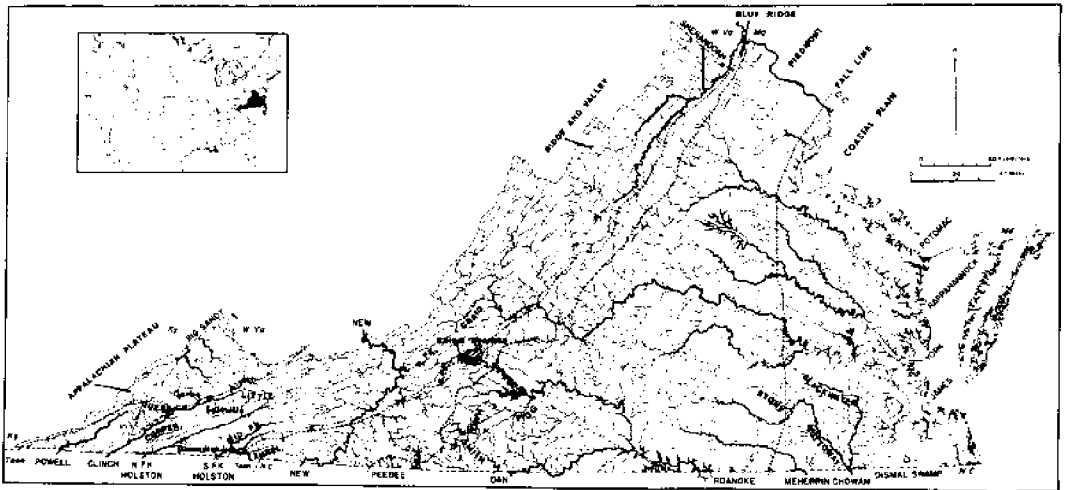


Figure 1. Principal streams, rivers, physiographic provinces and certain towns and cities

TABLE 2

Summary of critical drainages or subdivisions supporting jeopardized surviving populations of fish species in Virginia. Sequence of listing of watercourses is first on the Atlantic slope from north to south, then in Ohio River basin from east to west and then south to north (clockwise).

	Status of Species in Virginia			Total
	<i>Endangered</i>	<i>Threatened</i>	<i>Special Concern</i>	
Potomac-Shenandoah River drainage	-	-	2	2
Upper James River drainage	-	1*	1	2
Blackwater River, Chowan River system	-	-	1	1
Stony Creek, Nottoway River system	-	1	1	2
Upper Roanoke River system**	-	2	1	3
Town Creek, Dan River system	-	1	1	2
Upper Dan River system, Patrick County	-	1	1	2
Peedee River drainage	-	-	4	4
New River drainage	-	-	1	1
South Fork Holston River	1	-	2	3
Laurel Creek, South Fork Holston system	-	-	2	2
Middle Fork Holston River	-	-	2	2
North Fork Holston River	1	-	6	7
Clinch River***	-	1	11	12
Copper Creek, Clinch River system	-	3	6	9
Powell River	-	-	6	6
Anadromous	1	1	-	2
Estuarine	-	-	1	1

*refers to *Noturus gilberti*, possibly introduced.

**section above Leesville Dam.

***excludes two species of Clinch system in Virginia known to be surviving only in Copper Creek.

Fall Line

This is a roughly north-south oriented belt or zone of varying width, approximately 10-30 kilometers in Virginia, through which Atlantic slope streams have increased gradient in their descent from the gently undulating outer Piedmont onto the relatively flat Coastal Plain. The increments in gradient vary from high in the Potomac River (1.9 meters per kilometer or 10 feet per mile, through 28 kilometers or 17 miles, from Chain Bridge in Washington, D.C. to the mouth of Seneca Creek) to moderate in the Nottoway and Meherrin Rivers of the Chowan system (one meter per kilometer, Jenkins *et al.*, 1975). In the more northern drainages of Virginia, the Fall Line is characterized by frequent falls, cascades or rocky rapids, whereas in the Chowan major falls are absent, although riffles become more frequent and the substrate firmer than in the adjacent provinces.

The Fall Line passages of our rivers and smaller waterways are scenic and provide unique habitats for development of diverse fish faunas. For some anadromous species they provide spawning habitat. For many year-round resident fish populations they comprise ecotonal habitats supporting both Piedmont and Coastal Plain species, and often with an admixture of disjunct populations of characteristically montane and upper Piedmont forms, *e.g.*, the Roanoke logperch, *Percina rex*, in the Chowan system (Jenkins *et al.*, 1975).

Some of Virginia's larger cities have been built in or near the Fall Line -- Washington, D.C. and suburbs, Fredericksburg on the Rappahannock, and Richmond on the James. This relates to a large supply of fresh water and blockage by the Fall Line of major shipping. Industrial and domestic pollution associated with such population centers have led to degradation of adjacent riverine and estuarine habitats, reducing fish populations and recreational and other human uses of the rivers. Dam construction in some of these centers may have further reduced spawning habitat available to the two species of sturgeon, *Acipenser*, recommended for status herein, as well as that of other anadromous species such as shads and river herrings, *Alosa*.

Spring Runs of Potomac-Shenandoah Drainage

The larger cold springs and spring runs associated with limestone in the Potomac-Shenandoah Valley provide habitat for two Pleistocene glacial relicts, both of which reach their southern range limit therein -- pearl dace, *Semotilus margarita*, and slimy sculpin, *Cottus cognatus*. Most of these streams have suffered greatly, mainly by siltation from farm drainage and clearance of bank vegetation which also effected increasing temperature. One of the currently healthier streams, Mossy Creek in Augusta County, still supports both species and is only one of the two Virginia streams known to do so. It once had a probably native population of brook trout, but most of it has been heavily silted. It is now being developed into a specially regulated brown trout fishery (Schuder, 1977).

Upper Roanoke River Drainage

The Roanoke drainage of Virginia and North Carolina contains more fish species and has a greater number (6) of fish species or subspecies native and unique to a single drainage than any other drainage on the Atlantic slope of the United States (Jenkins *et al.*, 1972). The upper portion of the drainage, in the mountains and upper Piedmont of the Roanoke proper and Dan River systems, contains a major portion of the total Roanoke ichthyofauna, including all six forms endemic to the drainage.

The longest mileage of stream harboring more than one species recommended for status is Roanoke River and its North and South Forks in Roanoke and Montgomery counties, totalling some 88 kilometers (55 miles) starting in Roanoke River at the Tinker Creek mouth in the eastern sector of Roanoke. Some 62 kilometers (39 miles) remain with subtraction of the lower 26 kilometers of the river from eastern Roanoke

up to about the western limit of Salem. This lower section has been heavily stressed for many years (see *Percina rex* account), and the most sensitive species are absent or rare therein.

From Salem upstream the watershed harbors the apparently healthiest population of Roanoke logperch, *Percina rex*, and one of the most successful populations of orangefin madtom, *Noturus gilberti*. Action currently is underway at the federal level for designation of both species as *Threatened* and of the upper Roanoke as *Critical Habitat*. The section also contained one of the few known populations of Roanoke bass, *Ambloplites cavifrons*, until its demise in the 1950's, apparently owing to competitive exclusion by the introduced rock bass, *Ambloplites rupestris*. Additionally, the section supports virtually all other native species characteristic of the rich upper Roanoke fauna. Many elements of the fauna are jeopardized in the populous upper basin by effects of increasing urbanization, industrialization, and some of the proposals for flood control by channel modifications and dams.

Another upper Roanoke stream particularly worthy of mention is Town Creek, a major tributary of Smith River, Dan River system, Franklin and Henry counties. The Roanoke logperch and Roanoke bass were discovered in lower Town Creek in 1977, and its total fish fauna was found to be diverse. Maintenance of the apparently good water quality of the stream would protect the fauna. Town Creek is the largest tributary of the cold tailwater section of Smith River below Philpott Dam. This section of the Smith contains the finest larger stream trout fishery in Virginia, but it depends in good part on clean water from Town Creek.

Stony Creek, Lower Roanoke Drainage

This tributary of Nottoway River, Chowan River system, Dinwiddie and Sussex counties, sustains an isolated population of Roanoke logperch and additionally has the Roanoke bass. Much of the stream is considerably silted, although some stretches of firm gravel substrate occur in its lower half. A sewage treatment plant being located at the town of Stony Creek, about 1 kilometer above the mouth, may discharge wastes sufficiently chlorinated to distress the fauna. We note that the peculiar cutlips minnow, *Exoglossum maxilllingua*, is nearly restricted in the Roanoke drainage to the upper Pigg River, Town Creek, and lower Stony Creek. These four waters also comprise all verified areas of occurrence of the Roanoke logperch. *Exoglossum maxilllingua* is more widespread and often common in Atlantic slope drainages farther northward, but in the Roanoke it serves as an indicator of relatively good stream conditions, as do the three other above-mentioned Roanoke species.

South Fork Holston River System

This major branch of the Tennessee River drainage in Virginia has most of its tributaries arising in the Blue Ridge province. The main channel, although in the Ridge and Valley province, resembles moderately high gradient, cool Blue Ridge streams, and hence differs faunistically from the other major Tennessee drainage tributaries in the Virginia Ridge and Valley. The critical section of the South Holston system is the lower portion in Washington County above South Holston Reservoir. The main South Fork contains the sharphead darter, *Etheostoma acuticeps*, recommended for *Endangered* status, and the fatlips minnow, *Phenacobius crassilabrum*, of *Special Concern*. Entering the South Fork a few kilometers above the single known *Etheostoma acuticeps* locality is its largest tributary, Laurel (or Whitetop Laurel) Creek. This stream contains clean, good trout water in its middle and upper reaches, but the lower section has been stressed by various effluents from the town of Damascus, and adverse effects have been detected in the South Fork below Laurel Creek. The only Virginia stream housing *Phenacobius crassilabrum*, besides the South Fork, is Laurel Creek, the record site being just above Damascus. Another species of

Special Concern, the greenfin darter, *Etheostoma chlorobranchium*, is known in the state from a single locality in Laurel Creek at a few kilometers above Damascus. Improvement of water quality in Laurel Creek would enhance the survival of those three species in Virginia; the effluent problems are being addressed (see *Etheostoma acuticeps* account).

North Fork Holston, Clinch and Powell Rivers

The fish fauna of the Tennessee River drainage probably is the richest of all North American drainage faunas (Jenkins *et al.*, 1972), and that of the Holston and Clinch-Powell systems (in part, Ross and Carico, 1963; Masnik, 1974) is among the most speciose within the drainage. The group composed of the North Fork Holston, Clinch and Powell rivers, all typical Ridge and Valley watercourses, has the largest number of surviving fish species (16) recommended for status. Additionally, the extinct harlip sucker occupied the North Fork and probably the Clinch and Powell. A number of other species have a distribution and/or abundance nearly as limited as that of some of the species listed as *Special Concern*. The Middle Fork Holston, a South Fork tributary, contains 2 of the 16 species (river redhorse, longhead darter). Only 1 of the 16 (river redhorse) also inhabits the South Fork Holston in Virginia. This is a partial expression of certain natural ichthyofaunal differences among the five main Tennessee River tributaries.

The North Fork Holston has been chronically stressed for many years by chemical effluents from industry in Saltville at the Smyth-Washington county line. This probably has been a major factor in the enlistment herein of eight main channel species: spotfin chub (*Threatened* nationally), popeye shiner, bluebreast darter, tangerine darter, blotchside logperch, longhead darter, the extinct harelip sucker, and the extirpated and nationally *Threatened* yellowfin madtom. The other North Fork species listed, blueside darter, is a tributary form.

The main industrial plant on the North Fork Holston ceased operation in 1972, but chemical contents of abandoned settling lagoons are subject to erosion and seepage into the river, and the rate of recovery of the river has been slow (Hill *et al.*, 1975). Based on the report by Hill *et al.* (1975), subsequent study by biologists of the Tennessee Valley Authority, and our collections and snorkeling observations, the fish species richness in the Washington County section is significantly lower than that in Smyth County above Saltville and below Washington County, in Scott County, and in Tennessee (see accounts of North Fork species, particularly spotfin chub). The spotfin chub and yellowfin madtom have not reappeared above Saltville, possibly due to siltation, and the river redhorse is unknown to have occurred recently in the lower river, perhaps because of pollution in the main Holston River from the highly industrial Kingsport, Tennessee area.

The North Fork Holston has been designated as Critical Habitat relative to the spotfin chub from its mouth in Tennessee through Scott and Washington counties to the Washington-Smyth county line (Federal Register 1977, Vol. 42, No. 8, p. 2514).

The Clinch River and its largest tributary, Powell River, have the most speciose fish fauna in Virginia. The fauna above Norris Reservoir, Tennessee, was documented by Masnik (1974). Of the 20 Tennessee drainage species recommended for status, 14 are known from the Clinch system of Virginia and 2 additional (spotfin chub, harelip sucker) probably occurred there. The ashy darter, *Etheostoma cinereum*, of *Undetermined Status*, also is known from Clinch River. Nearly all 15 Clinch system species are riverine or large stream fishes. Six were found to be confined to the main channel of the Clinch, and in some cases Powell River: paddlefish, emerald shiner, steelcolor shiner, brook silverside, ashy darter, and channel darter. Seven inhabit only the main channel and lower section of one, two or three larger tributaries: popeye shiner, river redhorse, bluebreast darter, Tippecanoe darter, tangerine darter, blotchside logperch, longhead darter. The other two

species, yellowfin madtom and duskytail darter, are known in Virginia from only one of the larger tributaries, but both inhabit(ed) large rivers in Tennessee.

The Clinch and Powell have long been stressed by the coal industry, operating in tributary watersheds within the edge of the Appalachian Plateau. Principal problems appear to be siltation from mine sites and readily suspendable coal particles from washing operations (summary in Masnik, 1974); acid wastes may also be involved. Although attempts are being made to reduce these hazards to aquatic life, mining continues at a high rate.

Fish kills in Clinch River due to major chemical spills from a power plant in Carbo, Russell County, have taken a heavy toll. The widely publicized alkaline spill in 1967 had drastic effects from Carbo through Scott County, dissipating in Tennessee. An acid spill in 1970 had effects in Russell County. For details of these and other fish kills, see Crossman *et al.* (1973); Masnik (1974); Jenkins (1975c); McLeod and Moore (1978); Raleigh *et al.* (1978); and the account herein of the Tippecanoe darter. Raleigh *et al.* (1978) found that general recovery of fish populations following kills in the Clinch was relatively rapid, but noted a slight decrease in number of species. The records of many of the species treated herein are concentrated just above the Carbo power plant and near the Tennessee line, suggesting that the rare riverine species generally recover relatively slowly. Certain species, such as the ashy darter, may have been extirpated.

Critical Habitat has been designated (Federal Register 1977, Vol. 42, No. 8, p. 2514-2515): Clinch River from Norris Reservoir, Tennessee, upstream through Russell County; Powell River from Norris Reservoir up to the Lee-Wise county line, Virginia. Designation was made in reference to the nationally *Threatened* yellowfin madtom, slender chub, *Hybopsis cahnii* (known only in Tennessee but possibly at least formerly of occurrence in Virginia), and certain molluscs, and it protects a large number of other aquatic forms in jeopardy.

Copper Creek

More fish species (69) have been found in this major Clinch River tributary in Scott and Russell counties than in any other except Powell River (Jenkins and Burkhead, 1973). It contains the only Virginia population of the undescribed duskytail darter which merits *Threatened* status nationally, and the only extant Virginia population of the nationally *Threatened* yellowfin madtom. Additionally, it houses the following seven, mostly of *Special Concern*: popeye shiner, river redhorse, Tippecanoe darter (*Threatened*, possibly *Extirpated*), bluebreast darter, tangerine darter, blotchside logperch, longhead darter.

Copper Creek is in fairly good condition but we doubt that it is much better than some other streams of similar geology in the upper Tennessee. It has some moderately silted sections in agricultural areas. Its species richness probably relates partly to location in a limestone (not coal-bearing) valley in the Ridge and Valley Province, diverse habitats, and size (medium, 98 kilometers, 61 miles in length); additionally, it has been intensively collected. The two other largest Clinch-Powell system tributaries in Virginia are Guest and Little rivers. The former drains largely through the Appalachian Plateau and is subject to the effects of coal mining; it has not been well collected, but the collections suggest the fauna is smaller than that of Copper Creek. Little River, in the Ridge and Valley at the head of Clinch River, has a rich fauna including some species listed herein; when its lower section is sampled intensively, it may be found to have a fauna essentially similar to that of lower Copper Creek.

Copper Creek has been designated as Critical Habitat (Federal Register 1977, Vol. 42, No. 8, p. 2515) relative to the yellowfin madtom.

SPECIES ACCOUNTS

ENDANGERED (3)

Tennessee River Drainage (2)

1. SPOTFIN CHUB

Hybopsis monacha (Cope)

Phylum: Chordata
Class: Osteichthyes

Order: Cypriniformes
Family: Cyprinidae

Description: Body elongate; eyes small, laterally placed; mouth inferior, medial part of upper lip expanded anteriorly; one pair of minute terminal labial barbels or, occasionally, barbels absent; teeth 4-4; anal fin rays 8;



scales moderate to somewhat small, 52-62 along lateral line; caudal spot large and with anterior portion larger than posterior part; posterior part of dorsal fin with dark area or moderate amount of melanophores in membranes; body lacks blotches and speckling. Color in life: juveniles, adult females and non-breeding males olive above, sides largely silvery, lower parts white; large nuptial males have brilliant turquoise-royal blue on upper parts of body, and all fins tipped with satiny white. Small species, adults about 55-77 millimeters SL (Jenkins, 1975a; Jenkins and Burkhead, manuscript).
Illustration: Eddy, 1969.

Present Range: Endemic to Tennessee River drainage. Known from 12 tributary systems, persisting in only three: North Fork Holston River, Tennessee and Virginia; Little Tennessee River, North Carolina; Emory River, Tennessee. Occupies Ridge and Valley province in Virginia, Blue Ridge or uplands elsewhere.

Distribution in Virginia: North Fork Holston River, Scott County, at three shoals (and in the short segment of the North Fork in Tennessee; total 41 kilometers). Formerly from the North Fork above and in the vicinity of Saltville, Smyth County (Figure 2).

Habitat and Mode of Life: Medium to large, typically clear, warm, freely flowing streams. Apparently restricted in North Fork Holston to areas of moderate to rapid flow over major bars and beds of unsilted small gravel (most substrate particles of 2 centimeters and smaller in size). Generally rare. Found among rubble and boulders in other streams. Feeds benthically, and perhaps in midwater, on small immature insects. Apparently largely a sight feeder (Reno, 1969; Jenkins and Burkhead, manuscript); feeds diurnally but may also feed at night.

Reproduction: Spawning probably occurs in June, possibly beginning in May and extending to July. Reproductive behavior unknown. Does not breed until third or fourth year of life; probably spawns only one or two years before death. Fecundity normal for cyprinids of its size and body form; total mature ova 589 and 791 in females of 72 millimeters and 77 millimeters SL, respectively.

Number in Captivity: None.

Status: *Endangered* in Virginia. *Threatened* nationally (Federal Register, 1977), *Endangered* in North Carolina (Bailey, 1977) and Tennessee, *Extirpated* in Alabama (Ramsey, 1976) and Georgia. Disappeared in some streams due to impoundment, siltation, pollution, and/or rotenone renovation, but reasons for demise in others are unknown. Probably declined in North Fork Holston due to chemical pollution from Saltville and siltation (Hill *et al.*, 1975), and possibly by intensive collecting on localized gravel bars. Critical Habitat designated in North Fork Holston: junction with South Fork in Tennessee through Scott and Washington counties, Virginia.

Protective Measures Proposed: Enforcement of law regarding Critical Habitat and practice of soil conservation to reduce siltation.

Remarks: The blue-bodied, white-finned nuptial male is a strikingly beautiful fish. The species is of considerable significance in determination of phylogenetic interrelationships among some major groups of American cyprinid fishes. It has vanished from most of its range and appears to be extinction-prone.

Author: Robert E. Jenkins.

* * * * *

2. SHARPHEAD DARTER

Etheostoma acuticeps Bailey

Phylum: Chordata
Class: Osteichthyes

Order: Perciformes
Family: Percidae

Description:

Snout acute, body compressed; lateral line complete, with 54-65 scales; head, breast and nape scaleless; branchiostegal membranes narrowly conjoined; lateral body in adults with 12-16



oblique dark bars. Color in life subdued, olive to greenish dorsally and laterally; body lacks red spots in life and pale spots in preservative; fins lack dark margin; subocular spots, streaks or bar faint or absent; breast may have greenish-blue tint and some fins may have yellow or orange wash. Adults range between 40-60 millimeters SL. Illustrations: Bailey, 1959.

Present Range: Endemic to upper Tennessee River drainage. South Fork Holston River, Virginia (and formerly Tennessee); Nolichucky River, Tennessee, and its major tributary in North Carolina, the Toe River system (Bailey, 1959); Zorach and Raney, 1967; Jenkins and Burkhead, 1975b; Saylor and Etnier, 1976). Occupies Ridge and Valley and Blue Ridge provinces.

Distribution in Virginia: Known from three specimens taken during 1972 from a single riffle in South Fork Holston, Washington County, at river kilometer 119.7, along Route 711 between the junction of Routes 710-711 and the junction of Routes 711-810. Sections above and below the riffle have been well surveyed (Figure 2).

Habitat and Mode of Life: Medium to large, cool to warm streams where it occupies runs and riffles with clean gravel to boulder substrate. Consumes immature insects, apparently diurnally (Jenkins and Burkhead, 1975b).

Reproduction: Behavior unknown. Spawning probably begins in June; mature specimens are 2 and 3 years old. Fecundity data (Jenkins and Burkhead, 1975b) inadequate for determination of reproductive potential.

Number in Captivity: Unknown, but has been kept in aquaria (N. M. Burkhead, pers. comm.).

Status: *Endangered* in Virginia. Considered *Endangered* nationally at 1974 workshop sponsored by The Wildlife Society. Revised to *Threatened* nationally (but not under legislation currently) due to recent discovery of Nolichucky population. The known site of occurrence in Virginia is only about 1.7 kilometers upstream from the head of South Holston Reservoir; the species undoubtedly would not survive in reservoir conditions. It may be locked into this section because of decreasing stream size upstream. Additionally, the nearby and largest South Fork Holston tributary in Virginia, Laureal Creek (entering at 6.3 kilometers above the collection site), has been chronically stressed by domestic and industrial (particularly American Cyanamid Corp.) pollution recovery zone. However, an agreement recently signed between American Cyanamid, the Environmental Protection Agency and the State of Virginia (Water Control Board) will lead to the start of construction in 1978 of an effluent treatment facility (Durwood Willis, Virginia Water Control Board, pers. comm.) In 1977, operation of a sewage treatment plant began in Damascus, but adjustment of waste chlorination has been a problem (Sylvester Taylor, Virginia Water Control Board, pers. comm.). Although water quality apparently is being upgraded, the Virginia population probably will remain in jeopardy. The population apparently is small and probably competing with other members of the subgenus *Nothonotus* that are more numerous and widespread in the South Fork Holston. Abandoned manganese mines in the upper South Fork Holston watershed (references in Jenkins and Burkhead, 1975b) cause considerable siltation in that area, but their effect on the section inhabited by *Etheostoma acuticeps* is unknown.

Protective Measures Proposed: Implementation of industrial effluent treatment; chlorinate wastes at only low levels, or dechlorinate wastes; reduce siltation rates in watershed; designation of species as *Threatened* nationally, and listing of South Fork Holston in Virginia as Critical Habitat.

Author: Robert E. Jenkins.

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Diadromous (1)

3. SHORTNOSE STURGEON

Acipenser brevirostrum Lesueur

Phylum: Chordata
Class: Osteichthyes

Order: Acipenseriformes
Family: Acipenseridae

Description: A small dark sturgeon which may be distinguished from its sympatric congener *Acipenser oxyrinchus* by its smaller lateral dermal shields, wider mouth (less than three fifths width of bony interorbit), a single row of dermal shields between the pelvic and anal fins, and its darkly pigmented intestine. Further diagnostic characters and illustrations may be found in

Gorham and McAllister (1974) and Vladykov and Greeley (1963). The figures purported to be *Acipenser brevirostrum* in Goode (1884), Jordan and Evermann (1900) and Hildebrand and Schroeder (1928) actually are based on an adult *Acipenser oxyrinchus*.

Present Range: Drainages of the Atlantic coast of North America from the St. Johns River, Putnam County, Florida, north to the St. John River, southern New Brunswick, Canada (Gorham and McAllister, 1974). Reproducing populations apparently are present in the St. John River, New Brunswick; Kennebec River, Maine; Connecticut River, Massachusetts; Hudson River, New York; Delaware River; Altamaha River, Georgia (Hoff, 1965; Gorham and McAllister, 1974; Kinnear, in litt.) and perhaps other rivers as well.

Distribution in Virginia: Known from a single specimen, the skin of which is deposited in the Smithsonian Institution (USNM 26273). Musick recently examined and confirmed the identification of this specimen which was collected from the Potomac River by J. W. Milner on 19 March 1876. The specimen has been the basis for reports of *Acipenser brevirostrum* from the Potomac River by Uhler and Lugger (1876), Smith and Bean (1899), Hildebrand and Schroeder (1928), Vladykov and Greeley (1964) and Musick (1972).

Habitat and Mode of Life: An anadromous species, *Acipenser brevirostrum* also may reside in some rivers or estuarine systems all year (Boyle, 1969; Gorham and McAllister, 1974), unlike its congener, *Acipenser oxyrinchus*, which, upon approaching maturity, migrates to the sea in the winter. The smallest known specimen (USNM 64330) is 185 millimeters FL and was collected from Salmon Creek, North Carolina. The largest specimen (1194 millimeters FL) was caught in Kennebascasis Bay. This specimen weighed 10.1 kilograms, but another shorter specimen from the same locality weighed 13.8 kilograms, and specimens as heavy as 18 kilograms are reported by commercial fishermen. Length-weight relationships have been reported by Gorham and McAllister (1974). These authors have also summarized information on age and growth and report that *Acipenser brevirostrum* attains an age of at least 27 years. Feeding upon the bottom, *Acipenser brevirostrum* has been reported to consume sludgeworms, chironomid larvae and small crustaceans (Vladykov and Greeley, 1964).

Reproduction: Male *Acipenser brevirostrum* have been reported to mature at about 52 centimeters TL at 5 years of age, and females at about 56 centimeters TL at 6 years (Vladykov and Greeley, 1964). Spawning begins as early as April in the Delaware and Hudson rivers (Hoff, 1965; Vladykov and Greeley, 1964) but is later (June to August) to the north in the St. John River, New Brunswick (Gorham and McAllister, 1974). Hoff (1965) has reported this species spawning about 30 kilometers above the Fall Line in a rocky area at the base of a falls in the Delaware River. McAtee and Weed (1915) indicated that this species and *Acipenser oxyrinchus* ascended the Potomac River to Little Falls, in the Fall Line zone, Washington, D.C., but no farther. All recent records of viable populations (cited above) are from large rivers. It is possible that *Acipenser brevirostrum* requires large rivers with access to rocky substrates for spawning. Such habitats are accessible only in and above the Fall Line zone in those rivers located south of the terminal glacial moraine (from the Delaware River south). Construction of dams on rivers (such as the James, Rappahannock and Susquehanna) in this area could have extirpated *Acipenser brevirostrum* by preventing it from reaching major sections of required spawning habitats.

Number in Captivity: Unknown.

Status: *Endangered* in Virginia. This species is classified as *Endangered* on the U.S. Endangered Species List (Federal Register, Vol. 32, 11 March 1967). It is already protected by Virginia laws Relating to Fisheries of Tidal Waters section 28.1-49.1 (Anonymous, 1974a).

The question exists whether *Acipenser brevirostrum* was ever a member of the Virginia fish fauna. The existence of one specimen collected more than 100 years ago is certainly not good evidence that a viable population (either resident or migratory) ever occurred in the state. Conversely, the species was first discovered and described from the Delaware River estuary, the nearest large estuarine system to the north of the Chesapeake, and apparently the species still spawns there. In addition, viable populations presently exist in river systems to the south of the Chesapeake. Therefore, it is possible that *Acipenser brevirostrum* may have spawned in Virginia's larger rivers at one time or at least may have occurred in Virginia's near-shore waters as a migratory component of populations which spawned elsewhere. As in other Atlantic coast rivers *Acipenser brevirostrum* probably has been *Extirpated* in Virginia because of dam construction and pollution.

Protective Measures Proposed: If *Acipenser brevirostrum* still occurs in Virginia, it should be taken occasionally by the spring gillnet fishery for shad or in spring poundnet catches. The Virginia Institute of Marine Science monitors these fisheries as part of its continuing study of anadromous fishes (supported by the National Marine Fisheries Service). Research has begun on the occurrence and species composition of sturgeons taken incidentally by the alosine fisheries. Through the auspices of the National Marine Fisheries Service the Shortnose Sturgeon Recovery Team is currently attempting to compile and assess all available information on *Acipenser brevirostrum*. Following this compilation the team will make recommendations for re-establishment of the species. Among their options may be fish culture (artificial) fertilization and transplantation of eggs). Such techniques for other species of sturgeons were investigated many years ago (Ryder, 1890). Fish culture of *Acipenser brevirostrum* should be more successful than that of *Acipenser oxyrinchus* because *Acipenser brevirostrum* is much smaller and easier to handle and modern culture techniques utilizing hormones may be used to produce and maintain fish in spawning condition.

Author: John A. Musick.

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THREATENED (6)

Roanoke and James River Drainages (2)

1. ORANGEFIN MADTOM

Noturus gilberti Jordan and Evermann

Phylum: Chordata
 Class: Osteichthyes

Order: Siluriformes
 Family: Ictaluridae



Description: Body somewhat robust to rather elongate; head depressed, eyes small; eight barbels; pectoral and dorsal fins short, each with a short spine. Coloration of body and head olive or brown above, pale below, lacking spots and blotches; fins lack dark margin and usually have yellowish wash in undarkened areas; caudal fin particularly diagnostic, mostly dusky to dark, with an obvious pale margin that widens at upper tip of the fin, forming a moderately large and somewhat triangular area that is yellow to orange in life and pale in preservative. Moderate size madtom catfish, adults ranging between 60-85 millimeters SL (Taylor, 1969; Jenkins, 1977b). Illustration: Taylor, 1969.

Present Range: Restricted to upper Roanoke River drainage, Virginia, North Carolina, and Craig Creek system of upper James River drainage, Virginia; Ridge and Valley and upper Piedmont provinces. Total range about 130 stream kilometers.

Distribution in Virginia: Roanoke drainage, four widely separated populations: (1) Upper Roanoke River from Salem into lower North Fork and through upper South Fork into lower Bottom Creek, Roanoke and Montgomery counties; (2) Big Chestnut Creek, a Pigg River tributary, Franklin County, at lower Route 718 bridge (Hambrick, 1973); (3) North Fork of South Mayo River, Patrick County, 3.2 kilometers northwest of Stuart; (4) Dan River, Patrick County, at Route 103 bridge (and in North Carolina down to area of Danbury, Menhinick *et al.* 1974, and pers. comm., 1978; Bailey, 1977). James drainage, about 18 kilometers of Craig Creek centered approximately at Newcastle and approximately the lower 1 kilometer of Johns Creek, a Craig tributary at Newcastle, Craig County. James drainage population possibly established by recent introduction by bait fisherman (Figure 2).

Habitat and Mode of Life: Medium to large, cool to warm streams of moderate gradient and with swifter sections having little or, occasionally, moderate amounts of silt. Juveniles and adults were found exclusively in runs and riffles of gravel, rubble and boulder during all seasons. Young probably tend to occupy slower currents. Mostly nocturnal. Feeds apparently fairly unselectively on immature benthic insects; may be a taste feeder. Generally uncommon or rare.

Reproduction: Spawns apparently in late April and May, possibly early June in cooler section of Dan River. Fecundity very low, about 35-65 ova. Length-frequency data, although inconclusive, suggest males and females mature by second spring after the year of hatching (age-group 2); no age-group 1 specimens were found, and none were apparently older. The smallest specimens studied, 32-33 millimeters SL, were taken in August and September.

Number in Captivity: None, but has been kept in aquaria.

Status: *Threatened* in Virginia. Currently under federal review for *Threatened* status nationally. Upper Roanoke population under increasing stress from urbanization, industry and agriculture (see *Percina rex* account). No recent record for Roanoke River in City of Roanoke, where known in late 1800's. Rare in Salem. Big Chestnut Creek population small, in marginal habitat. No recent record for Mayo River system, where one specimen was taken in 1952. Dan River population probably persisted due to upstream impoundments serving as silt sedimentation basins. Craig Creek population known since 1951 and may be introduced, but no clear evidence of spread found in 1970's; proposal to impound lower Craig Creek and another to designate it as a Virginia Scenic River are forestalled.

Protective Measures Proposed: Designation as *Threatened* nationally and in Virginia; avoid channel modification; possible dams should be dry dams or permanent impoundment should have multiple levelwater release to retain natural temperature regimen in tailwaters; silt control.

Remarks: A poorly known, geographically relict species with no close relative.

Author: Robert E. Jenkins.

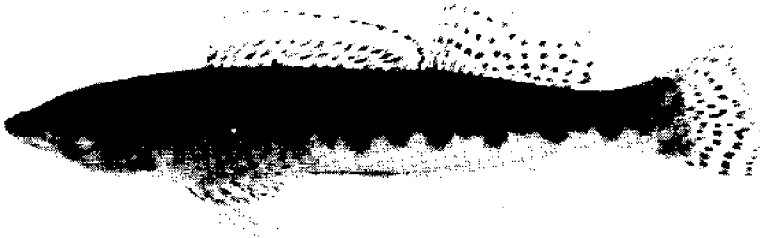
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2. ROANOKE LOGPERCH

Percina rex Jordan and Evermann

Phylum: Chordata
Class: Osteichthyes

Order: Perciformes
Family: Percidae



Description: Body elongate, cylindrical to slightly compressed; snout moderate to elongate, conic or slightly upturned at tip, and tip is distinctly forward of upper jaw; lateral line complete, scales small, numbering 83-90 in lateral line; nape, cheek and opercle fully scaled or nearly so; mid-ventral scales on belly of male markedly enlarged, spinous. Coloration: back dark to greenish, sides greenish to yellowish, belly white or with yellowish wash. Lateral bars on body prominent, blackish, often slightly disconnected from dark dorsal

marks, or confined to mid-lateral areas as oval blotches; upper sides and back with dark scrawlings; subocular bar, caudal spot and prepectoral spots or blotch well developed; first dorsal fin with black margin and a submarginal, longitudinal, yellowish to red-orange band; second dorsal and caudal fins darkly speckled. Large darter, adults ranging between 80-117 millimeters SL. Illustration: Anonymous, 1974b.

Present Range: Known only from Roanoke River drainage, Virginia; in all three major subdivisions of the drainage, as five widely separated populations: (1) Upper Roanoke, Roanoke and Montgomery counties, from City of Roanoke into lower North Fork and middle South Fork of Roanoke River; (2) Pigg River, Franklin County, just below dam located just above Business Route 220 bridge in Rocky Mount; (3) Middle Roanoke (Staunton) River, Campbell County, within a few kilometers above Brookneal (but the reports of "logperch" by fishery biologists remain unverified by preserved specimen); (4) Town Creek, Henry County, approximately 0.4 kilometer above mouth; and (5) Stony Creek, Sussex and Dinwiddie counties, and lower section of Sappony Creek, its main tributary (Jenkins, 1977a). Occupies Ridge and Valley and Piedmont provinces, and, in Stony Creek, the Fall Line (Figure 3).

Distribution in Virginia: As stated above.

Habitat and Mode of Life: Medium to large, warm, usually clear streams and rivers of moderate gradient with moderately to unsilted substrates varying from gravel to boulder. Within such streams larger juveniles and adults occupy all habitats except over deep silt. At least most of the few young known were captured in pools and slow runs, often over sand. Apparently feeds fairly unselectively on largely immature aquatic insects, occasionally on molluscs. A visual feeder; food frequently sought by overturning stones with snout. Usually exists in low population density, as determined by snorkeling and collecting.

Reproduction: Spawns in June, possibly starting in late May; behavior unknown. All females mature when of age-group 4 (5th year of life); some apparently mature 1 or 2 years earlier; oldest specimen is of age-group 5. Youngest known, 32 millimeters SL, taken 9 July.

Status: *Threatened* in Virginia. Currently under federal review for *Threatened* status nationally. Largest known population, in upper Roanoke, under increasing stress from urbanization, industry and, in upper basin, agriculture; the segments of this population in City of Roanoke and lower Mason Creek had been at very low levels during early 1970's, and may have been extirpated due to chemical spills in 1975 and 1976. Adverse impacts on upper Roanoke River were discussed by: Jackson and Henderson, 1942; McGauhey and Eich, 1942; Cairns *et al.*, 1971; Jenkins and Freeman, 1972; Sherrard and Hoyle, 1977; and Jenkins, 1977a. Recently, flood control structures and/or channel modifications have been proposed for this part of the basin. The Pigg River population is known from a single site. It survived the severe 1975 chemical spill which entered the Pigg immediately below the capture site, but the putative segment of the population extending some 20 kilometers downstream may be extirpated currently. The population of extreme lower Stony Creek is threatened by chlorination from the proposed sewage treatment plant of the Town of Stony Creek. The middle Roanoke (Staunton) River population has been favored by recent designation of a 10-mile section as a Virginia Scenic River.

Protective Measures Proposed: Designation as *Threatened* nationally and in Virginia; avoid channel modification; possible dams should be dry dams or permanent impoundment should have multiple level water release to retain natural temperature regimen in tailwaters; silt control on agricultural lands and roadsides.

Remarks: A large, handsome darter, with fascinating feeding behavior of stone flipping. It is a geographic relict with respect to its closest relatives in the subgenus *Percina*, notably the blotchside logperch, *Percina burtoni*. It is one of the better biological indicators of moderate to good upland stream conditions in the Roanoke drainage, in which it has been widely extirpated; the species is now fractionated into five widely separated populations.

Author: Robert E. Jenkins.

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Tennessee River Drainage (3)

3. YELLOWFIN MADTOM

Noturus flavipinnis Taylor

Phylum: Chordata
Class: Osteichthyes

Order: Siluriformes
Family: Ictaluridae



Description: Madtom catfish of moderate proportions, head depressed, eyes large, eight barbels; pectoral spine long, with serrae highly developed. Coloration of back and sides mottled or flecked with dark; four prominent dark saddles -- across back at dorsal fin base, between dorsal and adipose fins, over adipose fin, and from top to bottom in area of procurrent caudal rays and caudal peduncle; back, within dark area just anterior to dorsal fin, with two separate or largely fused pale spots. Dorsal and caudal fins with pale margin and dark band or mottling medially to submarginally. In life, darker areas olive to dark brown, pale body areas and fins with yellowish tinge. Reaches 100 millimeters SL. (Taylor, 1969; Taylor *et al.*, 1971). Illustration: Taylor *et al.* (1971).

Present Range: Known only from upper Tennessee River drainage, in five streams: Copper Creek and North Fork Holston River, Virginia; Hines Creek (lower Clinch River tributary) and Powell River, Tennessee; Chickamauga Creek, Georgia. Ridge and Valley province. All except the Copper Creek and possibly the Powell River populations are extirpated.

Distribution in Virginia: Copper Creek, Scott County, from mouth in Clinch River upstream into Russell County; total about 78 stream kilometers although range may be discontinuous (Figure 3).

Habitat and Mode of Life: Small to large warm streams with moderate gradient and usually clear water with little siltation. Inhabits pools and backwaters, rarely runs. Nocturnally active and then sometimes distant from cover; during daylight under banks or closely associated with other cover types in stream margin shallows and deeper pools. Feeds on moderate variety of immature benthic insects. Probably a taste feeder primarily.

Reproduction: Scant data suggest late spring and possibly early summer as spawning period; fecundity between 100-300 ova. Smallest gravid female 65 millimeters SL, age unknown; longevity probably 4-5 years. Smallest known specimens, 24-29 millimeters SL, taken in September and October.

Number in Captivity: None.

Status: *Threatened* in Virginia. *Threatened* nationally (Federal Register, 1977). *Endangered* in Tennessee. Thought to be extinct (Taylor, 1969) until discovery in Powell River in 1968 and Copper Creek in 1969. Possibly extirpated from Powell River and unknown from the other three localities since late 1800's. One of the latter, the only other known in Virginia, is North Fork Holston River, Smyth County, where specimens were taken just above Saltville (Jordan, 1889; reported as *Noturus miurus*). The entire North Fork from Saltville downstream has been chronically stressed by chemical pollution (in part, Hill *et al.*, 1975). Above Saltville the river is in fair condition, but the species has not been seen in any of the many recent collections from there. Status of Copper Creek population is unclear. Taylor *et al.* (1971) thought it was fairly common in the lower part of the creek, but more recent and intensive day and night collecting suggests that generally it is uncommon or rare in lower and upper Copper Creek (Jenkins and Burkhead, manuscript; Jenkins, 1975b).

Protective Measures Proposed: Copper Creek into its headwaters and Powell River, Lee County, Virginia (and in Tennessee) have been designated as Critical Habitat for *Noturus flavipinnis* (Federal Register, 1977). Local residents should be made aware of the designations and the designations should be enforced. Copper Creek could benefit from better silt control in agricultural areas along parts of the stream.

Remarks: Probably a phyletic link between the *furiosus* and *miurus* species -- groups of subgenus *Rabida* (Taylor *et al.*, 1971).

Author: Robert E. Jenkins.

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4. TIPPECANOE DARTER

Etheostoma tippecanoe Jordan and Evermann

Phylum: Chordata
Class: Osteichthyes

Order: Perciformes
Family: Percidae



Description: One of the smallest darter species, reaching 35 millimeters SL; body compressed; snout moderately sharp; lateral line incomplete, with 44-52 scales in lateral series, 13-17 unpored. Coloration: males dusky mottled or with 4-11 blue to black bars on sides; ground color of sides pale yellow to orange, breast pale to blue; first dorsal fin golden olive to blackish with a marginal golden band; caudal fin with central bluish to dusky area surrounded by gold. Females subdued in color, appear generally mottled with olive-brown on body, may have a faint golden overcast and a few faint dusky bars (Zorach, 1969). Illustrations: Trautman, 1957; Zorach, 1969.

Present Range: Ohio River basin where it occurs widely but very discontinuously, and within streams, often localized (Zorach, 1969); some populations apparently extirpated.

Distribution in Virginia: Clinch River system: one specimen from Clinch River, Scott County, at Tennessee state line in 1972; one specimen from Clinch River, Russell County at Carbo in 1971 (Masnik, 1974); 11 specimens from Copper Creek, Scott County, just above mouth, during May-August 1967 (Denoncourt, 1969; Jenkins and Burkhead, manuscript) (Figure 4). (Elsewhere in Tennessee drainage known only in Clinch River between Virginia and Norris Reservoir, and in Duck River of lower Tennessee [D. A. Etnier, pers. comm.]).

Habitat and Mode of Life: Medium to large, warm streams and rivers, in sections with little or no siltation. Occupies gentle runs to swift riffles during most of year. Apparently closely associated in Clinch system with small to medium size gravel substrate. Usually uncommon to rare in Clinch River. Trautman (1957) noted wide fluctuations in population density in Ohio.

Reproduction: Apparently spawns in spring. Fecundity low, based on small size of females and normal size of ova. Trautman (1957) found that groups of males guarded eggs and territories in shallow, flowing areas of sandy gravel, and that the territories were usually deserted by storm-caused turbidity and siltation.

Number in Captivity: None known.

Status: *Threatened* in Virginia. Regarded as *Endangered* in Kentucky and Pennsylvania. *Rare* in West Virginia, *Depleted* in Tennessee (Miller, 1972); probably *Extirpated* in Indiana. Although early Clinch records of *Etheostoma tipecanoe* are lacking (only a paucity of ichthyological collections were made in the Virginia section of Clinch River prior to 1970), the current Virginia population probably is a remnant compared to that prior to the 1967 and 1970 fish kills which began at Carbo. The most severe kill, in June 1967, had drastic effects in 106 kilometers in Virginia, and killed organisms in 39 kilometers in Tennessee (Anonymous, 1967; McLeod and Moore, 1978 and references therein). The locality of capture of the specimens taken in 1971 and 1972 bracket the zone of severe kill, but significant repopulation of the Clinch probably would occur very slowly, if at all. The Copper Creek population may be extirpated. All of the Copper Creek specimens were adults and were taken during 1967 within approximately 1 kilometer of the mouth in Clinch River; the section has been intensively collected since 1967. It is likely that the Copper Creek population was reliant on recruitment from Clinch River, and that its apparent demise relates to the 1967 kill.

Protective Measures Proposed: Enforcement of law regarding Critical Habitat designation for Clinch River and Copper Creek.

Remarks: The diminutive golden and blue male Tippecanoe darter can be regarded as an ichthyological jewel.

Author: Robert E. Jenkins.

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5. DUSKYTAIL DARTER

Etheostoma (Catonotus) sp.

Phylum: Chordata
Class: Osteichthyes

Order: Perciformes
Family: Percidae

Description: Body moderately compressed; snout moderately pointed to, in adult males, well-rounded; jaws forming end of snout; life colors brownish to olive above, pale below, lacks bright coloration; body with 10-15 narrow, dark bars; caudal fin faintly barred to slightly speckled basally and medially, often slightly to markedly dusky along margin; pectoral, pelvic and anal fins unspotted but dusky along free margin in juveniles and females, black margined in breeding males; head of smaller specimens often dotted below eye with large melanophores. Lateral line incomplete, scales from head to caudal base 38-48, usually 40-45 (48-59 in Copper Creek population of closest relative, *Etheostoma flabellare*). Reaches approximately 50 millimeters SL.



Present Range: Upper Tennessee and middle Cumberland River drainages: Copper Creek, Scott County, Virginia; lower Little River, Blount County, Tennessee; Big South Fork Cumberland River at mouth Station Camp Creek, Scott County, Tennessee (Comiskey and Etnier, 1972). Formerly in South Fork Holston River and Abrams Creek, both Tennessee. Ridge and Valley and Cumberland Plateau provinces.

Distribution in Virginia: Copper Creek from mouth in Clinch River to about 29 kilometers upstream (Jenkins and Burkhead, manuscript) (Figure 2).

Habitat and Mode of Life: Warm, typically clear, medium to large streams and rivers. During other than reproductive period, usually occupies pools and slow runs in areas of, at most, slight siltation; generally under or near stones and other cover. Spawning apparently occurs in riffles or swift runs. Probably a diurnal species. Food habits unknown.

Reproduction: Probably spawns in mid to late spring, depositing egg clutch in a single layer on underside of stones. Gravid females as small as 26 millimeters SL; ages unknown.

Number in Captivity: None; has been kept in aquaria and probably would spawn therein as has its close relatives, *Etheostoma flabellare* and *Etheostoma kemiacotti* (Page, 1975a; 1975b and references therein).

Status: *Threatened* in Virginia. *Threatened* nationally as proposed at 1974 workshop sponsored by The Wildlife Society. *Threatened* in Tennessee. The Copper Creek population, the only one known in Virginia, and one of the only three extant, could disappear quickly in the event of a slight increase in siltation, insecticide spraying, or chemical spillage at a bridge or ford. The duskytail darter probably has an intense competitive relationship with the widespread *Etheostoma flabellare*, whose distribution within the Copper Creek system is complementary to that of the duskytail. Copper Creek has been designated as Critical Habitat for other species (Federal Register, Vol. 42, No. 8, 1977). Chronic stress and severe fish kills in Clinch River likely impede its establishment therein; it too has been designated as Critical Habitat for other species.

Protective Measures Proposed: Same as *Noturus flavipinnis* regarding Copper Creek.

Remarks: A somewhat divergent member of subgenus *Catonotus* by virtue of its typical habitation of large streams and rivers.

Author: Robert E. Jenkins.

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Diadromous (1)

6. ATLANTIC STURGEON

Acipenser oxyrinchus oxyrinchus
Mitchell

Phylum: Chordata
Class: Osteichthyes

Order: Acipenseriformes
Family: Acipenseridae

Description: A sturgeon which grows to a large size (over 1 meter) and which may be distinguished from its sympatric congener *Acipenser brevirostrum* by its larger overlapping dermal shields, smaller mouth (less than three fifths width of bony interorbit), a double row of dermal shields between the pelvic and anal fins, and its lightly pigmented intestine. Further diagnostic characters and illustrations may be found in Gorham and McAllister (1974) and Vladykov and Greeley (1963).

Present Range: Atlantic coast of North America from Hamilton Inlet, Labrador, south to the St. Johns River, Florida. A separate population in the Gulf of Mexico has been named *Acipenser oxyrinchus desotoi* Vladykov.

Distribution in Virginia: Recent catches from the Potomac, Rappahannock, York and James River estuaries (Wiley, 1970; Musick, 1972; VCU collection).

Habitat and Mode of Life: An anadromous species which ascends (or ascended) larger rivers to spawn, to about the Fall Line in the Chesapeake basin. Juvenile fish reported to remain in the river or estuary of their birth until about 5 years of age or a length of about 76-90 centimeters (Murawski and Pacheco, 1977). Post-spawning migrations to the sea take place from September to December. Coastal migrations are along the beach usually at depths less than 20 meters and may be as long as 1400 kilometers (Murawski and Pacheco, 1977; Holland and Yelverton, 1973). Surprisingly, evidence of inter-estuarine migration recently came to light when a sturgeon tagged at Montrose Point on

the Hudson River in New York on 19 October 1977 was recovered in a stake gillnet by a commercial fisherman in the York River, Virginia on 2 March 1978. The fish was 76 centimeters in length when tagged. Studies on length-weight relationships and age and growth have been summarized by Murawski and Pacheco (1977). The largest Atlantic sturgeon recorded was a 4.3 meters (14 feet) female weighing 358 kilograms (811 pounds) from New Brunswick, Canada (Vladykov and Greeley, 1964).

Acipenser oxyrinchus oxyrinchus is an opportunistic benthic feeder. In marine waters sturgeon have been reported to feed on blue crabs (*Callinectes sapidus*), polychaete worms, snails, shrimp, amphipods, isopods and small fishes (*Armadyltes* sp.). In fresh water food consists mostly of aquatic insects, amphipods and oligochaete worms (Vladykov and Greeley, 1964; Huff, 1975).

Reproduction: The anadromous spawning migration begins typically in April in Chesapeake Bay (Vladykov and Greeley, 1964). In the Hudson River males do not mature until about 9 years of age (32 kilograms) and females at 10 years of age (68 kilograms). In the St. Lawrence River sexual maturity is not reached by males until 22-24 years and by females until 27-28 years of age.

Fecundity has been estimated at 800,000 to 3,755,745 eggs per female (Vladykov and Greeley, 1964). Spawning occurs at 13.5 to 17.8°C (Borodin, 1925). Spawning usually occurs over hard bottom in running water, often below water falls. Even though spawning in tidal freshwater is probable, suggestions that *Acipenser oxyrinchus oxyrinchus* may spawn in brackish water (Murawski and Pacheco, 1977) are at present questionable.

Number in Captivity: Unknown.

Status: *Threatened* in Virginia. Considered *Depleted*, *Rare* and/or *Endangered* in 13 other states (Miller, 1972).

The history of sturgeon stocks along the eastern seaboard is one of overfishing and decimation by habitat destruction (pollution and dam construction). Even though *Acipenser oxyrinchus oxyrinchus* has a high fecundity, its great age to maturity makes the species particularly vulnerable to overfishing. Because it is anadromous in large rivers the species has been particularly susceptible to spawning habitat destruction. Industrial and domestic pollution associated with Fall Line population centers have led to degradation of adjacent riverine and estuarine habitats. Dam construction such as that on the lower Susquehanna River and possibly that associated with navigation canals in Virginia has further reduced the spawning habitat available to sturgeon.

The decline of the sturgeon fisheries has been well-documented by Ryder (1890) and several other authors summarized in Murawski and Pacheco (1977). In Chesapeake Bay, Hildebrand and Schroeder (1928) documented a drastic decline in sturgeon landings from 1880 to 1920. By 1938 a law was passed in Virginia stating that no sturgeon less than 4 feet in length might be removed from the waters of the state. After assessing the extremely depleted condition of sturgeon stocks in the early 1970's we suggested that further protection was needed, and Virginia laws relating to the Fisheries of Tidal Waters (Section 28.1-49.1) now state "It shall be unlawful for any person to take or catch and retain possession of any sturgeon fish..." A few sturgeon are still landed in Virginia because of provisions in the law which allow keeping dead or obviously injured fish (Anonymous, 1974a).

Even though sturgeon are protected in Virginia, our stocks may still be subject to fisheries during their post-spawning migration along the coast. During the colder months, substantial landings of sturgeon are still reported from North Carolina. It is possible that these landings are comprised of fish from Virginia and other mid-Atlantic states that spend the winter along the North Carolina coast.

Protective Measures Proposed: Tagging studies should be initiated to determine whether Virginia sturgeon are being taken by North Carolina winter fisheries. If so, consideration should be given to protection of sturgeon from coastal fisheries. Individual states might still allow estuarine and riverine fisheries for sturgeon where stocks are adequate to support such fisheries.

Author: John A. Musick.

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SPECIAL CONCERN (26)

Potomac-Shenandoah River Drainage (2)

1. PEARL DACE - *Semotilus margarita margarita* (Cope). Family: Cyprinidae.

This is a northern species, occurring across much of Canada and northern United States (Scott and Crossman, 1973) southward as ecologically restricted populations in Iowa (Menzel and Boyce, 1973), Maryland (Fava and Tsai, 1973), and the Appalachian section of the Potomac-Shenandoah drainage of Virginia. In the latter it is known recently only from cool streams and relatively large spring runs: Back Creek, South River (Ross, 1959; 1972b) and Mossy Creek in Augusta County; Opequon Creek and Chapel Run in Clarke County; Redbud Run and Turkey Run in Frederick County; and Crooked Run in Warren County (Figure 4). These populations appear to be localized remnants of probable wider distribution during Pleistocene glacial times. Distribution very similar to that of *Cottus cognatus*, slimy sculpin. Continued existence in Virginia relates to maintenance of adequate supply of clean cool water.

2. SLIMY SCULPIN - *Cottus cognatus* Richardson. Family: Cottidae.

Widely distributed virtually throughout Alaska, Canada, northcentral and northeastern United States (Scott and Crossman, 1973) southward in the Appalachians on the Atlantic slope into the Potomac-Shenandoah drainage. In the latter it has a fragmented range; it is unknown from the section in Maryland (Lee *et al.*, 1976), and in Virginia it is localized in a few of the smaller cool streams and larger spring runs -- Strait Creek, Laurel Fork and South Fork of the Potomac River in Highland County; Pass Run in Page County; Back Creek, Bakers Spring, Middle River and Mossy Creek in Augusta County (Figure 5). Another Pleistocene relict, similar in distribution and requirements to *Semotilus margarita*. Report of *Cottus cognatus* from the James River drainage (Raney, 1950) is based on one series (CU 10126) of apparently anomalous *Cottus bairdi*.

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James River Drainage (1)3. ROUGHHEAD SHINER - *Notropis semperasper* Gilbert. Family: Cyprinidae.

Recently described (Gilbert, 1961) and endemic to the Ridge and Valley province of the upper James River drainage in Virginia. Inhabits upper James River and all eight of its largest tributaries from Maury River upstream, totalling some 432 stream kilometers (Jenkins and Burkhead, 1975a). Occupies medium to large stream sections and often is common. Proposed for rare status by Jenkins (*In: Miller, 1972*) prior to discovery of additional populations. Merits status of *Special Concern* because species has a restricted total geographic range, is confined to main channels, and because of drainage modifications that have been recently completed or are underway or proposed that were discussed by Jenkins and Burkhead (1975a).

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Roanoke River Drainage (3)4. RUSTYSIDE SUCKER - *Moxostoma hamiltoni* (Raney and Lachner). Family: Catostomidae.

A swift-water inhabitant known only from relatively unsilted, cool creeks and small streams in the Blue Ridge and immediately adjacent Piedmont uplands of the upper Dan River system, Patrick County, Virginia. Was poorly known and rarely found from 1953 to 1975, after its description by Raney and Lachner (1946), hence thought to have declined and considered "rare" by Jenkins (*In: Miller, 1972*). However, an extensive survey of the Dan system in 1977 by the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Virginia Commission of Game and Inland Fisheries and Jenkins (1977c) found the species, often common, in all streams from which it was formerly known and in additional tributaries. It is known from 12 streams: Little Dan River, Browns Dan River, Hooker Creek, South Mayo River, North Fork South Mayo River, Anglin Branch, Spoon Creek, Rye Cove Creek, Poorhouse Creek, Rich Creek, Rhody Creek and Rockcastle Creek (Figure 3). It is here given status of *Special Concern* because of its small total range and apparent sensitivity to heavy or moderate siltation. Records of the species from the upper Roanoke drainage proper are based on the very similar torrent sucker, *Moxostoma rhothoecum* (Jenkins *et al.*, 1972; Buth, 1977).

5. ROANOKE BASS - *Ambloplites cavifrons* Cope. Family: Centrarchidae.

This species has a small geographic range for a centrarchid. It inhabits the Neuse and Tar drainages in North Carolina and the Roanoke drainage, including the Nottoway and Meherrin branches of the Chowan system, in Virginia (Cashner and Jenkins, manuscript). Although its biology is fairly well-known in North Carolina (W. B. Smith, 1971) and it is under culture in North Carolina (W. B. Smith, 1971) and Virginia, attempts to establish new populations in North Carolina have been unsuccessful (W. B. Smith, pers. comm., 1977), and its natural distribution and biology in Virginia are poorly known. Extant populations are verified in the following: Stony Creek in Sussex County; North Meherrin River in Lunenburg County; Meherrin River in Brunswick County; Falling River in Campbell County; Pigg and Blackwater Rivers in Franklin and Pittsylvania counties; and Town Creek in Henry

County (Figure 4). The upper Roanoke population, above the City of Roanoke, was extirpated during the 1950's, just subsequent to establishment by introductions of a population of northern rockbass, *Ambloplites rupestris* (Cashner and Jenkins, manuscript). It is listed as *Special Concern* because few populations are documented, the density and range limits of most populations are unknown, the species appears to avoid streams or stream sections with heavy siltation, and because of its suitability as a sport fish. Most citation size catches of "rock bass" in Virginia probably are of *Ambloplites cavifrons* rather than *Ambloplites rupestris*. The distribution and value of *Ambloplites cavifrons* may become augmented in the future, with greater control of sedimentation in Piedmont and other watersheds.

6. BLACKBANDED SUNFISH - *Erneacanthus chaetodon* (Baird). Family: Centrarchidae.

A small secretive sunfish ranging on the Coastal Plain from New Jersey to Florida. Only two Virginia records, both recent and in the Chowan system: Blackwater Swamp, a Blackwater River tributary in Prince George County (Jenkins *et al.*, 1975); and Game Refuge Lake, Nottoway River watershed in Sussex County (Figure 4). The species is unknown from the Coastal Plain of the entire western Chesapeake Bay basin, and it is rare in the lower Chowan and Roanoke of North Carolina. Graham (1977) found that *Erneacanthus chaetodon* has close competitive interactions with other centrarchids. Accorded status of *Special Concern* because only two populations are known in a fairly large and possibly more widely inhabitable area, namely the southeastern Coastal Plain backwaters. Not regarded as peripheral since the Virginia record sites are in a region that otherwise forms a major hiatus in the range of the species, the basis of which is not understood.

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Peedee River Drainage (4)

7. HIGHBACK CHUB - *Hybopsis hypsinotus* (Cope). Family: Cyprinidae.

Its range is the Piedmont and Blue Ridge sections of the Santee and Peedee drainages, South Carolina and North Carolina, just extending into Virginia in the Peedee via Yadkin River tributaries. Three records: Pauls, Lovels, and Brushy creeks in Carroll County (Figure 4). This and the following three species are given *Special Concern* status due to their extremely small range in Virginia, because they are uncommon to rare therein, and because the larger sections of Yadkin tributaries just above the North Carolina state line are considerably silted. The four species typically do not ascend into small creeks; sections producing the records may now be marginal habitat owing to continuing heavy silt and sand sedimentation and turbidity. The four are peripheral species.

8. THICKLIP CHUB - *Hybopsis labrosa* (Cope). Family: Cyprinidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*. Record: Ararat River in Patrick County. (May be extirpated as only record dates from 1933) (Figure 5).

9. SMALLFIN REDHORSE - *Moxostoma robustum* (Cope). Family: Catostomidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*, except occurs farther south on Atlantic slope. One record: Ararat River in Patrick County, 1972.

10. PIEDMONT DARTER - *Percina crassa* (Jordan and Brayton). Family: Percidae.

Distribution and reasons for status as with *Hybopsis hypsinotus*, except occurs also in Cape Fear River drainage in North Carolina. (Another form, formerly *Percina crassa roanoka*, is regarded as a full species according to Page [1974] and his subsequent study.) Three records: Halls Branch in Carroll County; Ararat River in Patrick County -- one of the records during 1976, another in 1977.

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New River Drainage (1)

11. SAND SHINER - *Notropis stramineus stramineus* (Cope). Family: Cyprinidae.

The sand shiner is widely distributed in southeastern and south central Canada, southward in much of the Ohio River basin and through central United States into Texas (Pflieger, 1975). Only one specimen is known from Virginia, at virtually the West Virginia state line, in an area that recently has been intensively collected: East River near its mouth in New River, just below a heated discharge, during 1973 (Stauffer *et al.*, 1975). Scattered populations of *Notropis stramineus* occur in the West Virginia part of the New drainage. The species merits status of *Special Concern* owing to the singularity of the record and industrial development of the area from which it emanated. Clearly peripheral in Virginia.

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Tennessee River Drainage (14)

12. PADDLEFISH - *Polyodon spathula* (Walbaum). Family: Polyodontidae.

An archaic riverine and lentic inhabitant widely distributed in Mississippi River basin and Mobile Bay drainage. One large, very robust specimen (about 30 kilograms, 1.5 meters FL) was first sighted in Clinch River approximately 4 kilometers above Tennessee state line on 13 June 1967. The specimen was drifting and in stress from a severe chemical spill and died upon being hauled into a small tributary. Two somewhat smaller specimens were reported by game wardens to have been found dead at the same time in the lower Clinch of Virginia. The species normally may not reside permanently in Virginia. It may regularly migrate into Virginia via the Tennessee stretch of Clinch and possibly Powell rivers, perhaps ultimately from Norris Reservoir. It probably has redispersed into Virginia following the 1967 kill. Anglers informed Masnik (1974) that paddlefish have occurred in the Clinch up to Dungannon, northeastern Scott County. *Endangered* in North Carolina (Bailey, 1977). *Rare or Depleted* in several other states (in part, Miller, 1972). Peripheral.

13. POPEYE SHINER - *Notropis ariommus* (Cope). Family: Cyprinidae.

Occurs widely in southern half of Ohio River basin, few old records from northern Ohio basin, one for Lake Erie drainage (where it is extirpated), and a questionable one for Missouri Ozarks (Gilbert, 1969). Typically in medium to large streams, in gentle flow over largely gravel substrate within relatively unsilted areas. Occasionally common. *Virginia records*: North Fork Holston River where it appears to be continuously distributed since 1970 from Tennessee

state line to slightly above Saltville; Clinch River since 1969 just above and below Carbo; Copper Creek once in 1971 just above mouth; Powell River since 1968 in Lee and Wise counties. Although there are a number of recent records from all of the above streams except Copper Creek, the species should be watched. Some of the northern populations apparently are extirpated, and it was almost totally absent from collections made in the Ohio basin during 1894-1948 (Gilbert, 1969). May be considered peripheral, a tenuous decision considering its distribution and abundance over total range.

14. EMERALD SHINER - *Notropis atherinoides* Rafinesque. Family: Cyprinidae.

Typically occupies large rivers and lakes and ranges widely in United States and Canada (Pflieger, 1975). Two records: Powell River, Lee County, in 1968; Clinch River, Russell County, at a short distance below Carbo, in 1969. Peripheral.

15. STEELCOLOR SHINER - *Notropis whipplei* (Girard). Family: Cyprinidae.

Widely distributed in central Mississippi River and Ohio River basins (Gibbs, 1963). Typically restricted in upper Tennessee River drainage to large streams and main rivers. Three records: Clinch River, Scott County, between Tennessee state line and Clinchport in 1954 and 1970, and Stock Creek just above its mouth at Clinchport in 1969. Peripheral.

16. FATLIPS MINNOW - *Phenacobius crassilabrum* Minckley and Craddock.

Family: Cyprinidae

Endemic to upper Tennessee River drainage, largely in Blue Ridge province, from Little Tennessee River system to South Fork Holston River, Georgia, North Carolina, Tennessee and Virginia (Minckley and Craddock, 1962; Dahlberg and Scott, 1971). Occupies moderate to swift waters of medium to large size, cool to warm, high gradient streams. *Virginia records*: South Fork Holston River from arm of South Holston Reservoir at Alvarado through 11 kilometers to Route 91 bridge; Laurel Creek, a major South Fork Holston tributary, just above Damascus; all records are from Washington County (Figure 4). Of *Special Concern* due to pollution as noted in account of *Etheostoma acuticeps*. Not regarded to be in greater jeopardy because species apparently persisted in Laurel Creek above outfalls in Damascus and occurs in South Fork Holston above (and below) mouth of Laurel Creek. Peripheral.

17. RIVER REDHORSE - *Maxostoma carinatum* (Cope). Family: Catostomidae.

Widely distributed in central United States, including nearly throughout the Ohio basin and with a relict population in Southern Canada (Jenkins, 1970). Depleted or extirpated in some areas, notably fringes of western and northern parts of range. A large stream and river migratory species that spawns in moderate to swift currents on clean gravel and small rubble. *Numerous records in Virginia*: Extends into all major Tennessee drainage tributaries except the North Fork Holston. The South and Middle Forks Holston records are from their lower section in Washington County. Occupies the Scott County and Russell County portions of Clinch River, and inhabits Powell River into eastern Lee County. Verbal reports of spawning in lower Copper Creek, but young probably disperse out into Clinch River fairly quickly as there are no records of capture for this intensively sampled section. Recent records for Clinch River only from fringes of highly stressed section. Probably once occupied North Fork Holston in Tennessee and Virginia up to Saltville area. Peripheral, but has declined widely outside of Virginia.

18. BROOK SILVERSIDE - *Labidesthes sicculus sicculus* (Cope). Family: Atherinidae.

Widely distributed from southern Canada to the Gulf of Mexico (Pflieger, 1975). Occupies small streams in many areas, but in upper Tennessee drainage it is usually found in large streams and rivers. *Virginia records*: Clinch River, Scott County, from Tennessee state line to Clinchport; Powell River, Lee and Wise counties; all records since 1967. Peripheral.

19. BLUEBREAST DARTER - *Etheostoma caeruleum* (Cope). Family: Percidae.

Confined to the Ohio River basin where it inhabits swift sections of medium to large streams and rivers (Zorach, 1972). Ranges widely throughout basin and is disjunct in many areas. *Virginia records*: Clinch River, lower Copper Creek and North Fork Holston River (Figure 5). In both the Clinch and Holston, the records are concentrated near the Tennessee state line and just above sites of major industry: Carbo in the Clinch and Saltville in the Holston. The intervening sections of approximately 100 kilometers and 80 kilometers in length, respectively, yielded few recent records, all within about 10-20 kilometers of the industrialized areas: two records at Carterton, Clinch River, in 1969 and 1972; two records at McKenna Island in North Fork Holston during 1973 and 1975. Hence, the bluebreast darter appears to be redispersing into formerly highly stressed areas. Considered peripheral, but the upper Tennessee drainage population is one of the healthier populations, and the species has declined in some parts of its disjunctive range.

20. GREENFIN DARTER - *Etheostoma chlorobranchium* Zorach. Family: Percidae.

Endemic to Blue Ridge section of upper Tennessee River drainage, Georgia, North Carolina, Tennessee (Zorach, 1972) and Virginia. In swift, hard-bottomed waters of cool to warm, medium to large streams. *Virginia records*: (Whitetop) Laurel Creek, tributary of South Fork Holston River, at Taylors Valley, Washington County, in 1970 and 1976. Rare at this locality (Figure 5). Here listed, although the locality is above pollution outfalls in Damascus, because species is probably limited to this one stream. Peripheral.

21. BLUESIDE DARTER - *Etheostoma jessiae* (Jordan and Brayton). Family: Percidae.

Endemic to certain parts of upper and middle Tennessee River drainage, Alabama, North Carolina, Tennessee and Virginia; replaced in upper Clinch and Powell River systems by another form of the *Etheostoma stigmaeum* species group (W. M. Howell, pers. comm.). Prefers small to medium size, moderate gradient streams that typically are clear. *Virginia records*: one specimen each from North Fork Holston River tributaries, Scott County - lower Cove Creek in 1937; lower Opossum Creek in about 1971 (Howell, pers. comm.). *Endangered* in North Carolina (Bailey, 1977). Peripheral.

22. TANGERINE DARTER - *Percina aurantiaca* (Cope). Family: Percidae.

This large, beautiful darter is restricted to the upper Tennessee River drainage in Georgia, North Carolina, Tennessee and Virginia (Howell, 1971; Thompson, 1972). Inhabits deeper runs and well-flowing parts of pools in sections of medium to large streams with firm substrate. Typically exists in low population density; easily inventoried by snorkeling. *Virginia records*: recent records for North Fork Holston River in western Scott County, above

Saltville, and one approximately 20 kilometers below Saltville (Hill *et al.*, 1975); Clinch River from Tennessee state line into western Russell County; lower Copper Creek and upper Guest River, both Clinch River tributaries; Powell River, Lee County. Depleted in highly stressed section of North Fork Holston and Clinch rivers; no recent record for Guest River, perhaps due partly to increased strip mining in the watershed (Masnik, 1974).

23. BLOTCHSIDE LOGPERCH - *Percina burtoni* Fowler. Family: Percidae.

Widely but rather disjunctively distributed in most upland and montane parts of Tennessee River drainage; known from middle Cumberland River drainage but no recent verified records (Jenkins and Zorach, under study). Occupies medium to large streams and small rivers, where it is found in shallow and deeper sections of riffles, runs and pools, but at least usually only in areas lacking appreciable siltation. Feeds often by turning stones, as noted for its close relative, *Percina rex*. Exists in low population density, determined partly by snorkeling. *Virginia records*: North Fork Holston River above Saltville; Clinch River from Tennessee state line to Copper Creek mouth, and above Carbo in Russell County; Copper Creek from mouth to lower headwaters; lower Little River, the major upper Clinch River tributary. Regarded as *Rare* in Tennessee and Virginia (Etnier and Jenkins *In*: Miller, 1972).

24. CHANNEL DARTER - *Percina copelandi* (Jordan). Family: Percidae.

This fairly widespread darter was depicted (Pflieger, 1975) as composed of three broadly separated populations: middle and upper Ohio River-Great Lakes basins; south-central United States; and southeastern Gulf slope. Clay (1975) and Comiskey and Etnier (1972) reported it additionally from the Cumberland drainage. It is now known also from the Tennessee drainage; but only in the Clinch system of Tennessee and Virginia (Etnier, pers. comm.; Masnik, 1974). *Virginia records*: Clinch River, Scott County, between mouth of Copper Creek and Tennessee state line, 1972; Powell River, Lee and Wise counties, 1968-1971. It is confined to the medium and larger sections of these streams, and is usually found in runs and riffles with gravel substrate (Figure 3). Not regarded as peripheral because of the disjunction of the population and because *Percina copelandi* appears to be a complex of species or subspecies (R. D. Suttkus, pers. comm.).

25. LONGHEAD DARTER - *Percina macrocephala* (Cope). Family: Percidae.

Ranges in eastern sector of Ohio River basin in New York, Ohio, Pennsylvania, West Virginia and Kentucky and in certain upper Tennessee River drainage tributaries of Virginia, Tennessee and North Carolina. Lives in moderate to large streams typically with little siltation but often with moderate amounts of detritus. Occupies riffles in some areas, but taken in Virginia by Jenkins only from pools or gentle runs. Never found to be common in Virginia. *Virginia records*: Middle Fork Holston River, Washington County (1937 and earlier); North Fork Holston River, several recent records above Saltville and one about 20 kilometers below (at Hayters Gap, Washington County) during 1973; Copper Creek from near mouth to stream kilometer 20 since 1969; Little River, upper Clinch system, at an unknown locality in 1967 (Figure 4). Known from upper section of South Fork Holston River in Tennessee near Virginia state line prior to filling of South Holston Reservoir. Although the longhead darter has a moderately wide range, it is not considered peripheral in Virginia. No recent records are known

from Ohio (Trautman, 1957); considered *Rare* in Kentucky and Pennsylvania (Miller, 1972), *Endangered* and probably *Extirpated* in North Carolina (Bailey, 1977), and *Threatened* in Tennessee.

Estuarine (1)

26. MARSH KILLIFISH - *Fundulus confluentis* Goode and Bean. Family: Cyprinodontidae.

Ranges from Chesapeake Bay, Maryland to vicinity of mouth of Pensacola Bay, Alabama (Miller, 1955; Musick, 1972). Typically in brackish water, but enters fresh and polyhaline water. Occupies muddy marshes and grass flats. *Virginia records*: Known only from Lynnhaven Inlet, Virginia Beach (several specimens including gravid females, Hildebrand and Schroeder, 1928), and recently from lower York River, Gloucester Point (three, possible strays, VIMS 206, 4947). The rarity of the species in Virginia could be due to marginal environmental conditions at edge of species' range. Conversely, this small species is superficially similar to the common *Fundulus heteroclitus*, and *Fundulus confluentis* may be more widespread but unrecognized. Such is the case with *Fundulus luciae*, which was once considered rare, but is known now to be a common inhabitant of very shallow high marsh habitats in Virginia (Byrne, 1976). It seems prudent to classify this species in Virginia under *Special Concern*; peripheral.

STATUS UNDETERMINED (5)

1. WHITEMOUTH SHINER - *Notropis alborus* Hubbs and Raney. Family: Cyprinidae.

Ranges from Santee drainage, North Carolina, to Roanoke drainage, Virginia (Hubbs and Raney, 1947; Menhinick *et al.*, 1974). Occupies creeks and small to medium size Piedmont streams. *Virginia records*: tributaries of Kerr Reservoir, Mecklenburg County; Horsepen Creek (a tributary of Roanoke Creek), Charlotte County (Figure 5). (Found in Roanoke and Dan River tributaries in North Carolina [Menhinick, manuscript] but not in Dan system during extensive 1977 survey.) All Virginia records date from 1938-1949 and all of the Mecklenburg County records are from streams subsequently impounded. A candidate for *Special Concern* status, but not so accorded, as little collecting effort has been made in the pertinent area since 1950. Occupies same area in Virginia as *Etheostoma collis* (see below).

2. ASHY DARTER - *Etheostoma cinereum* Storer. Family: Percidae.

This generally rare darter of the Tennessee River and the Cumberland River drainages (Clay, 1975; Ramsey, 1976) was taken once (one juvenile, VPI&SU 2153) in Virginia, from the Clinch River in either Scott or Russell County; the exact locality is unknown. The specimen was collected in 1964; hence, the ashy darter may be *Extirpated* due to the 1967 and subsequent fish kills.

3. CAROLINA DARTER - *Etheostoma collis lepidinon* Collette. Family: Percidae.

Etheostoma collis (Hubbs and Cannon) ranges on the outer and middle Piedmont from the Santee drainage, South Carolina, to the Roanoke drainage,

Virginia, except a record is lacking for the Tar drainage, North Carolina (Collette, 1962; Menhinick, manuscript). The species is represented in Virginia by the above subspecies. *Virginia records*: Wards Fork and a "tributary of Horsepen Cr. 2.4 mi NW of Wylliesburg on Rt. 607," both Roanoke Creek watershed, Charlotte County (Figure 5). The latter locality may have been misdetermined by the collector, and may actually be in Sandy Creek, a separate Roanoke River tributary just below Roanoke Creek. The four collections were taken during the period 1935-1959. May merit status of *Special Concern* or *Threatened*, but not so recommended here due to paucity of recent ichthyological survey of the lower Roanoke in Virginia and the fact that *Etheostoma collis* typically inhabits creeks and small streams that often are detritus cluttered; hence, often unattractive and difficult to seine. Would not be considered peripheral because few records of this subspecies exist for North Carolina, where all additional populations reside. Occupies same area in Virginia as *Notropis alborus* (see above).

4. VARIEGATE DARTER - *Etheostoma variatum* Kirtland. Family: Percidae.

Occurs in much of the upper and middle Ohio River basin (Hubbs and Black, 1940; Trautman, 1957). Continuing reports (Clay, 1975) of it from the Tennessee and Cumberland drainages apparently are founded solely on the record of one specimen by Evermann and Hildebrand (1916) from Indian Creek, a Powell River tributary, in Tennessee, near the Virginia state line. Hubbs and Trautman (1932) erroneously ascribed the record to the adjacent Cumberland River drainage. Hubbs and Black (1940) indicated earlier doubt of the "Cumberland" record, but confusingly listed the Tennessee as within the species range. Hubbs and Trautman (1932) and Jenkins could not locate the specimen, and Masnik (1974) thought the record may have been based on *Etheostoma caeruleum*. *Virginia records*: two from Big Sandy drainage, Buchanan County, in 1937 - Levisa Fork, about 5 kilometers above Grundy; Long Branch Creek, tributary of Tug Fork, about 1.6 kilometers above mouth (Figure 5). Possibly *Extirpated* because the Big Sandy in Virginia, Kentucky and West Virginia continues to be degraded by the coal industry. No fish collection data since 1938 are available from the Levisa and Tug Fork systems, except for extreme headwaters which the species usually avoids.

5. BLACKSIDE DARTER - *Percina maculata* (Girard). Family Percidae.

Ranges from southern Canada through central United States and onto Gulf of Mexico slope (Pflieger, 1975). *Virginia records*: two, in same collections as *Etheostoma variatum* (see above) (Figure 5). Possibly *Extirpated*, as considered under latter species. (The population, which is widespread in the New River drainage and until recently was thought to be *Percina maculata*, is being described as a separate species [Beckman, 1977]).

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RECENTLY EXTINCT or EXTIRPATED (3)

1. HARELIP SUCKER - *Lagochila lacera* Jordan and Brayton. Family: Catostomidae.

The monotypic genus *Lagochila* is *Extinct*, the last record of capture dated 1893. It ranged widely in the Ohio River basin and occupied the Maumee River system of the Lake Erie drainage and the White River drainage in the Ozarks (Jenkins, 1970). The sole Virginia record is from North Fork Holston River at Saltville, where Jordan (1889) took "a few specimens" in 1888. This sucker had peculiar, apparently specialized trophic morphology (Jenkins, 1970 and subsequent study). Its extinction may relate to general widespread increase in siltation and turbidity, impoundment, and competition with species with similar food habits.

2. TROUT-PERCH - *Percopsis omiscomaycus* (Walbaum). Family: Percopsidae.

Ranges widely in Canada and northeastern and northcentral United States (Pflieger, 1975). Southern limit on the Atlantic slope was the Potomac River, where it was found in the section between the mouth of the Shenandoah River and Washington, D.C., not later than 1911.

3. NORTHERN LOGPERCH - *Percina caprodes semifasciata* (DeKay). Family: Percidae.

The distribution of this subspecies of *Percina caprodes* (Rafinesque) is similar to that of *Percopsis omiscomaycus*. Its southernmost Atlantic slope population occupied the same part of Potomac River; the last record was in 1910. (The Ohio logperch, *Percina caprodes caprodes*, is widespread in the Tennessee drainage and inhabits a small section of the New River drainage in Virginia).

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STATUS UNWARRANTED (5)

The following species have been proposed, formally or informally, for conservation status, but they are thought to not merit status currently in Virginia or nationally. We here record reasons for the decisions.

1. BROOK TROUT - *Salvelinus fontinalis* (Mitchell). Family: Salmonidae.

The natural range of the brook trout is eastern Canada, northeastern United States and the Appalachian chain southward into northeastern Georgia. This species has been introduced widely elsewhere in North America and onto other continents (MacCrimmon and Campbell, 1969; MacCrimmon *et al.*, 1971). In Virginia it occurs in the Blue Ridge and westward, and has an apparently natural population in Difficult Run on the Piedmont of Fairfax County, near Washington, D.C., that was noted as far back as the late 1800's (Smith and Bean, 1899; McAtee and Weed, 1915) (Figure 6). It is stocked annually in the cold tailwaters of Smith River, a medium size stream on the upper Piedmont of Henry County, but it is not known to have become established by natural reproduction.

Many populations are present in Virginia. Nearly all occupy small streams, far into upper headwaters, with cold, usually clear, unpolluted water, and little or insignificant amounts of siltation. The nearly completed intensive survey of trout waters by the Virginia Commission of Game and Inland Fisheries (L. O. Mohn, pers. comm.) has estimated that approximately 1100 to 1200 miles (1970 to 1920 kilometers) of stream currently support wild brook trout. Some of the populations may have been established or re-established by stocking of hatchery-reared fish, but the great majority probably is composed at least largely of ancestors of native fish.

Brook trout populations have become depleted, extirpated or had their range constricted in many Virginia streams. This is a serious trend that has been effected largely by the following: warming of streams due to loss of vegetational shade and hence increased insolation; reduction or increased variation of instream flow volume due to channel modification and deforestation; pollution; siltation; impoundment; and competition with introduced brown and rainbow trout. The rainbow trout often seems to nearly or completely replace brook trout in streams where it becomes naturalized.

We have elected to not recommend the brook trout for formal conservation status. The large number of populations extant in Virginia places the species outside the concept of status categories employed herein. The species is not confined to a few main channels. Instead, the vast majority of the populations are physiographically and/or ecologically isolated from others, and perturbation of one population would not necessarily affect others. Many of the populations are situated in areas that are remote or have little or no disturbance. We feel that problems of this trout are being given considerable attention and that the status of the species may be enhanced upon completion of the statewide trout survey and implementation of recommendations that result. We sense that maintenance of wild trout populations and protection of their habitat are becoming increasingly popular concepts in Virginia at the regulatory and other levels. Additionally, Trout Unlimited, Inc., has gained foothold in Virginia; this group is dedicated to conservation of coldwater fisheries and already has had positive impact.

The guard on brook trout populations should not diminish. This beautiful species is a symbol of Virginia's wildness and healthy watersheds. It is extremely important as a recreational resource, but is rather sensitive to environmental stresses and occupies a habitat that is fragile.

Recently we have heard statements or implications that the "southern Appalachians" brook trout is taxonomically distinct from more northern populations. However, current studies at Tennessee Tech University indicate that no block of southern populations merits separate status on the subspecific or higher levels (R. D. Estes, pers. comm.). It is likely, though, that some populations have developed racial or physiological differences from other populations, and we agree with Behnke (1972) and Trojnar and Behnke (1974) that preservation of intraspecific variability or genetic diversity is of great practical importance.

2. BIGEYE JUMPROCK - *Moxostoma ariommum* Robins and Raney. Family: Catostomidae.

This morphologically peculiar sucker is restricted to the Roanoke drainage, inhabiting both the upper and middle Roanoke proper and upper Dan systems. In the latter, it extends into North Carolina, and the species has been recommended for *Special Concern* status in that state (Bailey, 1977). It was considered to be rare over its range by Jenkins (*In*: Miller, 1972). Subsequently it was newly discovered in several small to medium size streams. Notably, it is unknown to inhabit impoundments, but two of the populations occupy small streams each having its mouth in a large reservoir (Smith Mountain and Philpott); each population has persisted for more than 10 years despite apparent lack of recruitment from larger streams. A measure of the earlier concept of its rarity was based on inadequate knowledge of its typical habitat, now known to be deeper, rocky and well-flowing waters that are difficult to seine effectively. (Jenkins *et al.* [1975] listed *Moxostoma ariommum* from the Chowan system of the Roanoke, but the single series involved [CU 32032, formerly VPI&SU "989" but probably 686] has since been detected to have faulty locality data.)

3. NEW RIVER SHINER - *Notropis scabriceps* (Cope). Family: Cyprinidae.

4. KANAWHA MINNOW - *Phenacobius teretulus* (Cope). Family: Cyprinidae.

5. KANAWHA DARTER - *Etheostoma kanawhae* (Raney). Family: Percidae.

These three lotic species are endemic and unique to the New River drainage and have been recommended for *Threatened* or *Special Concern* status in North Carolina (Bailey, 1977). Two of the species, *Notropis scabriceps* and *Phenacobius teretulus*, occur in all three states drained by the New -- North Carolina, Virginia and West Virginia; *Etheostoma kanawhae* appears to be excluded from the lower and much of the middle section of the drainage by its close relative, *Etheostoma osburni*. There are many Virginia records available for the three species, but most are concentrated in the Blue Ridge province section of the drainage and the species seem to prefer medium and large size streams (Figure 5). *Phenacobius teretulus* best exemplifies such a distribution pattern (map in Hambrick *et al.*, 1975). The main problem that has jeopardized the species was the proposal for a two-dam pumped storage project on New River, the "Blue Ridge project," which was to have extended through the Blue Ridge section of New River in Virginia, well up its main forks in North Carolina, and would have inundated lower reaches of other tributaries. It was questionable that in the event the project became a reality the populations in unimpounded sections of tributaries of the impoundments would survive without recruitment, and that those above and below the project area were sufficiently viable or numerous enough to negate

granting of conservation status to the species. It is now a somewhat moot problem, as 42.6 kilometers of the New River in North Carolina, down to the Virginia line, has been declared a national Wild and Scenic River (Public Law 94-407), thereby blocking the Blue Ridge project.

* * * * *

Addendum

The Roanoke bass, *Ambloplites cavifrons*, ranked of *Special Concern* herein and thought to have been extirpated since about 25 years ago from the upper Roanoke River drainage above Smith Mountain Reservoir, was discovered during August 1978 in upper Bradshaw Creek, a North Fork Roanoke River tributary in Montgomery and Roanoke counties. The remnant population is living syntopically with the rockbass, *Ambloplites rupestris*, and may be localized in the creek. Disturbances to the Roanoke bass population and the stream itself should be avoided. The population is under study.



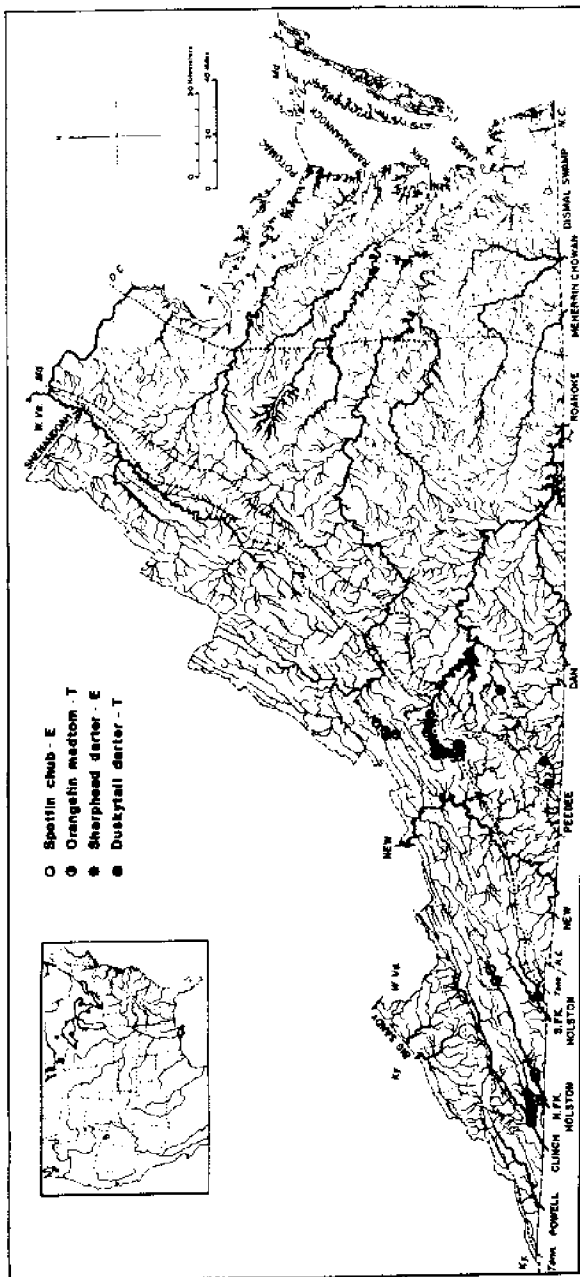


Figure 2. All known locality records of four fishes of Endangered or Threatened status

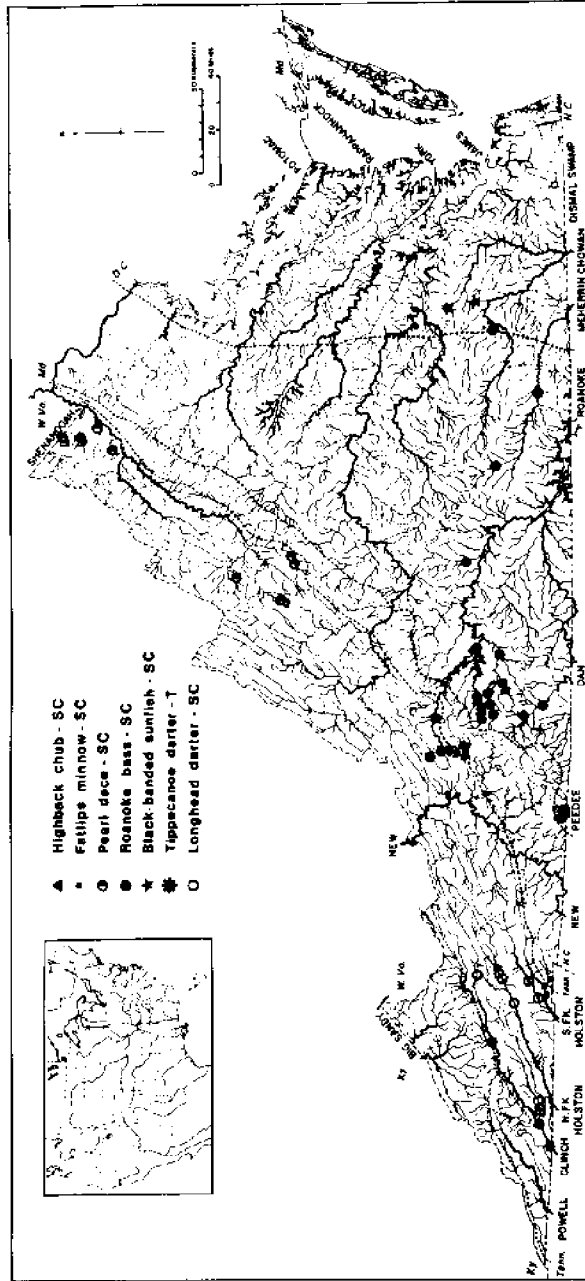


Figure 4. All known locality records of seven fishes of Threatened or Special Concern status

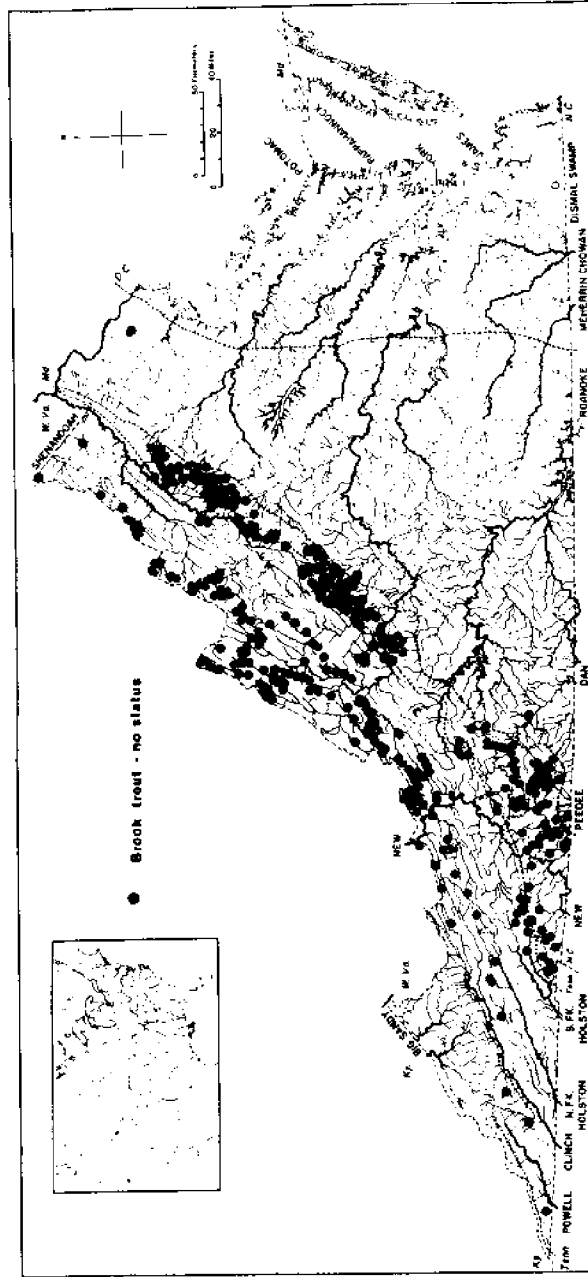


Figure 6. Records of brook trout, status unwarranted; range in extreme western part of state incompletely surveyed



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AMPHIBIANS AND REPTILES

Franklin J. Tobey

Introduction

As recently as 1956, the official state list of amphibians and reptiles carried a mere fifty names. The list was nearly trebled by 1959 through the efforts of biology faculty at Virginia's colleges and universities (Burger, 1958; 1959). Between 1958 and 1978, knowledge of the state's herpetofauna has been rounded up, recorded, and shared through a loosely organized network of interested persons. University vertebrate zoologists, ecologists and other natural science faculty, high school biology and science teachers, their advanced students, and many full-time and part-time naturalists have aided in defining the normal distribution ranges of most Virginian amphibians and reptiles. Despite these efforts the actual distribution of some species within the state remains a mystery.

One dramatic example is the southeastern crowned snake (*Tantilla coronata*), for which there are four recorded specimens from as many localities. These collecting sites are evenly spaced along a nearly straight line running across the state from Danville to Charlottesville. Two additional localities where the species has been seen (but not collected or photographed) only extend the line and do little to add a second dimension. This may be a collecting fluke or "artifact" but to Virginia herpetologists it has proved a persistent puzzle.

Another species, the eastern tiger salamander (*Ambystoma tigrinum tigrinum*), is so secretive that a gap of nearly 100 years separates the collection in this state of the first and second recorded specimens (Tirrell, 1974). Additional field work is needed to determine the health of tiger salamander populations on the Coastal Plain. The tiger salamander, one of the well-named mole salamander group, is only seen in late winter under skim ice on temporary ponds in cornfields adjacent to woods. Help is needed from hardy naturalists who will brave the penetrating chill of those humid later January or mid-February nights that signal the first thaws.

The state's herpetofauna consists of 141 species and subspecies almost equally divided: 73 amphibians and 68 reptiles. These figures are subject to minor changes as studies either confirm the existence of named species or subspecies, or indicate that some distinctions lack meaning and should be discarded. A comparison of the 1958 and 1975 editions of Dr. Roger Conant's "A Field Guide to the Reptiles and Amphibians..." will illustrate this point. Refinements in taxonomy continue to be made. Despite recent changes not yet reflected (Collins *et al.*, 1978) in the field guides, we will adhere to the standard common and scientific names used in Conant (1975). Where there has been a change, it will be noted in the species account.

For Virginia, the present number of forms (species and subspecies) in each group are as follows:

<u>Group</u>	<u>Number of Species</u>	<u>Number of Species and Subspecies</u>
Amphibians	61	73
Salamanders	36	47
Frogs and Toads	25	26
Reptiles	62	68
Turtles	23	25
Lizards	9	9
Snakes	30	34
Total:	123	141

The rich variety of reptiles and amphibians is related, beyond a doubt, to the diversity of habitat, elevation, and climate presented by the geography of the Commonwealth of Virginia.

The greatest variety of salamanders is to be found in the Virginia Highlands including the Valley and Ridge Province. Frogs, treefrogs and toads, as might be expected, are in greatest assortment on the Coastal Plain and in Tidewater Virginia. Some of the treefrog species for which few records existed before 1960 are being encountered more frequently in the southeastern Virginia counties above the Great Dismal Swamp, and seem to be moving on Richmond from the south. This range extension is being studied by graduate and undergraduate biologists at Virginia Commonwealth University. About six salamanders and six frogs and toads are truly statewide in their distribution. Four salamanders are virtually confined to a limited range on the tops of mountains in the Shenandoah National Park, or at Mount Rogers-Whitetop near the southwestern edge of the state.

Among the reptiles, turtles show a greater affinity for the Coastal Plain, Tidewater, and Chesapeake Bay or ocean. These include, of course, the five sea turtles which are transient visitors to Virginia's coast and the barrier islands. Of the remaining 20 forms, seven occur in the Coastal Plain and on the Piedmont, eight occur in the Highlands, and five may be considered statewide in distribution. Four of the nine lizard species are found on the Coastal Plain and Piedmont, and four may be deemed to be nearly statewide in range. One variety, the anole (*Anolis carolinensis*) is reported (observed), but not yet recorded from the state, in the Great Dismal Swamp near the North Carolina line. Only about half of Virginia's 30 species of snakes are considered to be truly statewide in range.

In general, many species of amphibians and reptiles that occur statewide are widely distributed throughout the eastern United States; examples are the spotted salamander, spring peeper, snapping turtle, five-lined skink, black rat snake, and the poisonous copperhead. Several of the amphibians and reptiles found in the Great Dismal Swamp, or at Mount Rogers-Whitetop in Washington and Grayson counties, are at the northernmost limits of their range. Among these forms are the southern dusky salamander, the little grass frog and scarlet kingsnake in the southeast, and Weller's salamander and the shovel-nosed salamander in the southwest. At the top of the state, a smaller group of northern varieties extend southward along the Appalachians and reach the southern limits of their natural ranges in Virginia's highland counties. The Blue Ridge provides cool, moist, forest habitat to several

species of lungless salamanders, and the northern tier of counties shelters the wood frog, wood turtle, and the eastern milk snake.

Since amphibians and reptiles are secretive, information on the populations and ecology is skimpy or lacking. The amphibians and reptiles panel tried to focus on the more obviously indigenous Virginia forms, and endeavored to keep peripheral species in proper perspective. Some exceptions do occur: populations of the bog turtle (*Clemmys mühlenbergi*) appear to be reasonably healthy on the Virginia-North Carolina border but this species' ability to inflame passions among herpetologists could not be denied. It has been placed on the *Special Concern* list because of the destruction of habitat by drainage, channelization of streams, and expansion of road networks. On the other hand, in the case of the wood turtle (*Clemmys insculpta*), healthy populations have been found in its normal range by Simpson (1977) and it does not appear to be *Endangered* or *Threatened*. On the basis of the handful of recorded specimens known at the time, the wood turtle had been considered *Endangered* or *Rare* by Russ (1973) and Ashton, Edwards and Pisani (1976). The amphibian and reptile panel considered the complete list of Virginia's 73 amphibians and 68 reptiles (Tobey, 1976). Deliberations on each species and subspecies included examination, as needed, of collecting data recorded for each species and subspecies on the Virginia distribution maps (U.S. Geological Survey, Virginia outline, 1: 1,000,000).

The panel agreed to list the five marine turtles as *Endangered* in Virginia and adjacent waters. This is a special group of transient visitors to the Eastern Shore, the barrier islands, Hampton Roads, Chesapeake Bay, Back Bay, Virginia Beach, and the estuaries and rivers to the fall line. Sea turtles are dependent for their survival on the utmost international cooperation among those countries where they nest.

It may come as a surprise to some that despite their being found here, albeit infrequently, Virginia has no native crocodylians. Alligators (or caimans) hit the newspaper headlines in the vicinity of the Great Dismal Swamp when they are apprehended in a canal or ditch. More recently, a large specimen turned up in an industrial plant's warmwater effluent in less likely 'gator country -- Lake Anna. Neither the fact that the animal may have survived the winter under the circumstances nor the perpetration of the hoax set any new herpetological or journalistic record. Central North Carolina is still accepted as the northernmost range for breeding populations of the American alligator (*Alligator mississippiensis*), the Eastern coral snake (*Micrurus fulvius*), and the diamond-backed rattlesnake (*Crotalus adamanteus*). Virginia collection records, if any, are credited to escaped or released specimens.

Given the current status of Virginian herpetology, the preparation of a comprehensive state *Endangered* species list is at best an educated guessing game. The panel members were painfully aware of that fact. As Dr. George R. Zug (1978) observed, some species are represented in scientific collections by so few specimens because "there has never been any serious attempt to collect or study them. If we knew where and how to look for them we probably would find that their populations are in a healthy state."

Of the 141 amphibian and reptilian forms known to occur in Virginia, the panel designated eight as being of *Special Concern*. Fifteen were put in the *Status Undetermined* category because of the lack of good population data. The latter include several large aquatic salamanders which require clean flowing water, and are considered to be extremely vulnerable to pollution or impoundment for reservoir, flood control, or hydroelectric purposes. Chemical pollution in the Tennessee River drainage basin of western Virginia poses a real threat to the eastern hellbender, mudpuppy, and the eastern spiny softshell turtle.

Many of the species of *Special Concern* occur on publicly-owned lands: national parks, national seashores, wildlife refuges, national forests or state parks. Within such areas these species ought to be reasonably manageable. However, we recognize that this provides no guarantee. Therefore, we recommend to the managers of recreation areas and preserves the exercise of a more even-handed treatment of the animal vis-à-vis the human populations. The burden of educating the public on the care needed for continued survival of these species will fall, perhaps unfairly, on the full-time and part-time (or seasonal) rangers, naturalists, wardens, biologists, and others who meet the public. During the past few years the Virginia Commission of Game and Inland Fisheries' *Virginia Wildlife* magazine has carried a commendable series of articles on the animals believed to be *Endangered* or *Threatened*.

The basis of wildlife management is a knowledge of the natural habitat needed by each species for its survival, plus a good knowledge of the biology of that species. There is some question whether such knowledge is in ample supply, at present, and considerable misgiving about the adequacy of its circulation among those who need to know. Most species with which we deal here are poorly known. Amphibians and reptiles are inconspicuous to most people, including some who consider themselves sophisticated conservationists. More regrettably, few field personnel have the training and experience required to make field identifications of some reptiles and amphibians. And, of course, even herpetologists specialize. We can only hope that recent persistent educational and public information efforts will eventually pay off (see Literature Cited). Continuing efforts are called for. This includes mutual cooperation and coordination with wildlife management people to assure that there are appropriate habitats and conditions for survival for these interesting and important constituent members of the state's fauna. (See p. 379).

In the discussions, panel members Ashton and Dodd expressed a desire for specific comment in this section on amphibians and reptiles with regard to the collection of specimens for scientific studies:

"Those species listed as either of *special concern* or of *undetermined status* do not require federal or state protection at this time. It is absolutely essential that scientific studies of these species be undertaken to determine their limits of distribution, ecological requirements, and any possible threats to their continued survival within the Commonwealth of Virginia. Such studies should be allowed without interference and with an absolute minimum of red tape."

The panel is on record as opposed to restrictive actions that would hamper the badly needed scientific study of the listed species, as stated.

In *Science* magazine (1976) Harcombe and Marks noted that "extensive search and study efforts would take many years of field work. ... Yet, only through such efforts can we know which species really need special attention for their preservation. ... Preserved natural habitats would provide a standard for judging the quality of habitats to be destroyed or significantly altered by a particular (construction) project. ... In the long run," they reason, "it would seem prudent to approach the problem of species preservation as part of the broader program of regional habitat preservation." It was in this spirit that the panel chairman, as a member of the Committee on Geographic Areas of Special Concern, presented the names of two areas and, by inference, a third. The two primary areas for which species lists have been prepared are: The Great Dismal Swamp in southeastern Virginia, and the Mount Rogers-Whitetop area of southwestern Virginia. Both areas are the natural habitat for unique combinations of plants and animals, among them several rare species of amphibians and reptiles. The third region is the barrier island chain off the Delmarva Peninsula. Known as the Virginia Coastal Reserve,

these islands fall largely under the protection of The Nature Conservancy. The barrier islands provide a haven, albeit sporadically, for the semitropical marine turtles which have been classed as *Endangered*.

You may gather, correctly, that there is plenty of frontier to Virginian herpetology. If a number of persons who are sufficiently interested in the task would devote just part of their time to population density studies it would contribute much in a surprisingly short period. It is a large state and it can absorb the efforts of many field workers. Some day, with better population data at hand, the effort will permit a future panel to arrive at more justifiable conclusions.

SPECIES ACCOUNTS - AMPHIBIANS

SPECIAL CONCERN (6)

1. PIGMY SALAMANDER

Desmognathus wrighti King

Phylum: Chordata
 Class: Amphibia

Order: Caudata
 Family: Plethodontidae

Description: The most distinctive characteristic of this minute bronze-colored salamander is the dark herring-bone pattern down the center of its back. Total length seldom exceeds 2 inches (51 centimeters). Its tail is rounded and is less than one-half the total length. There is silvery pigment along the side and a mostly unmarked ventral surface. Because of the restricted range, size and coloration, this species is not likely to be confused with any other species. An illustration and additional descriptive data are available in Conant (1975).

Present Range: Elevation of 2750 to over 6500 feet (800 to 2000+ meters) from southwestern Virginia to near the Georgia state line in southwestern North Carolina.

Distribution in Virginia: Restricted to Mount Rogers and Whitetop Mountain in Grayson County, Virginia (Figure 1).

Habitat and Mode of Life: This non-aquatic salamander is concentrated in the spruce-fir zone at higher elevations. It is nocturnal and tends to feed in the hours after midnight when the atmosphere is saturated. It does a significant amount of its foraging in trees. Its food consists of small arthropods that average about 1.1 millimeters in length with oribatid mites and mycetophilid flies of principal importance (Hairston, 1949).

Reproduction: Both fall and spring courtship have been described. Nests with between three and eight eggs were collected in mid-October. Females attend the clusters of eggs that are laid in gravel seeps at stream headwaters (Organ, 1961).

Number in Captivity: Not significant.

Status: *Special Concern.* This species deserves *Special Concern* because of its restricted geographic and ecological range. In Virginia, it is restricted to Mount Rogers and Whitetop and is most frequently found in the Canadian Zone forests. It also deserves *Special Concern* because of the increased recreation pressures and elaborate development plans that are proposed for the Mount Rogers National Recreation Area. Reducing the preferred habitat or dividing the habitats into smaller units are apt to have adverse effects on this species. Population numbers appear healthy at this time, but the species bears monitoring in the light of potential habitat destruction and increased human interference.

Protective Measures Proposed: Keep development of the spruce-fir zone of Mount Rogers and Whitetop to a minimum.

Remarks: Scientific collecting in the past has been a major source of predation upon *Desmognathus wrighti* in Virginia.

Author: Thomas Krakauer.

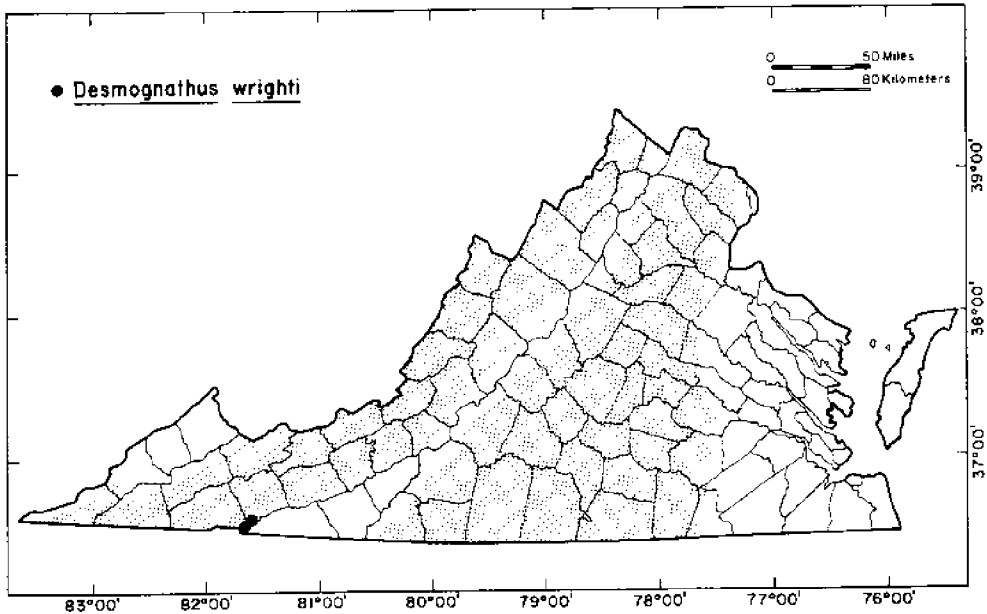


Figure 1. Distribution of *Desmognathus wrighti* in Virginia

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2. SHOVEL-NOSED SALAMANDER

Leurognathus marmoratus (Moore)

Phylum: Chordata
Class: Amphibia

Order: Caudata
Family: Plethodontida

Description: A large robust desmognathine (illustrated in Conant, 1975) with squarish yellowish-brown alternating dorsal blotches, a pale underside, and poorly defined line from the eye to the angle of the jaw. Superficially similar (especially in younger stages) to the black-bellied salamander, *Desmognathus quadrimaculatus*, but distinguishable by the pale (instead of the nearly black) venter, and by the absence of distinct internal nares (nasal opening - see Conant 1975, end papers).

Present Range: The total range of the species extends from northern Georgia to Whitetop Mountain, Grayson County, Virginia (Pope and Hairston, 1947; Hoffman and Hoffman, 1956).

Distribution in Virginia: This species is known in Virginia, definitely, only from Big Branch, a Laurel Creek tributary, on the north slope of Whitetop Mountain (Figure 2). So far, it has not been found in nearby streams with similar characteristics. A second Virginia locality in southeastern Floyd County has not been confirmed by subsequent collections at the specified site.

Habitat and Mode of Life: This is the most aquatic member of the desmognathine group and rarely leaves the water. It occurs under submerged rocks and stones, sometimes at a depth of 1 foot or more. Virtually nothing is known of the life cycle or population dynamics of this species.

Reproduction: Little or nothing has been published on the reproductive biology of this species.

Number in Captivity: There are probably no specimens currently in captivity.

Status: *Special Concern*. Although Big Branch arises in protected land (Mount Rogers National Recreational Area, MRNRA), the lower reaches where *marmoratus* has been found flow across privately-owned land. Local deforestation, or even a small forest fire, might render the entire stream uninhabitable. Authorities on MRNRA are aware of the *Special Concern* status of this animal and mention it in the developmental plans for the region, but not in specific terms.

Protective Measures Proposed: Careful but systematic field studies might be conducted to firmly establish the actual status and local distribution before recommendations are made. The extent of the Big Branch population is not fully known.

Author: Richard L. Hoffman.

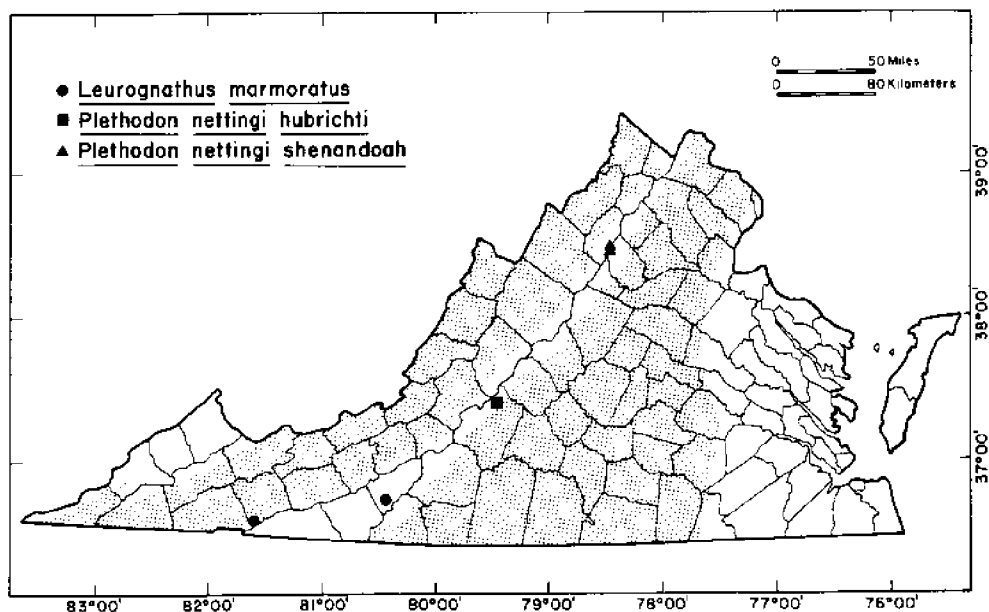


Figure 2. Distribution of *Leurognathus marmoratus* (●), *Plethodon nettingi hubrichti* (■), and *Plethodon nettingi shenandoah* (▲) in Virginia

3. PEAKS OF OTTER SALAMANDER

Plethodon nettingi hubrichti Thurow

Phylum: Chordata
 Class: Amphibia

Order: Caudata
 Family: Plethodontidae

Description: This is a slender woodland salamander which reaches a total length of almost 5 inches (13 centimeters). The dorsum is black or very dark brown with abundant brassy metallic spots or blotches, occasionally forming an irregular stripe. The sides and ventral surface are plain dark gray to black. There are usually 19 costal grooves.

Present Range: This species is known only from a number of localities primarily along the Blue Ridge Parkway between mile 78 and mile 84 in Bedford, Botetourt and Rockbridge counties, Virginia (Highton, 1971) (Figure 2).

Distribution in Virginia: Endemic (see above).

Habitat and Mode of Life: The Peaks of Otter salamander inhabits cool moist forest, characterized by the presence of oak, rhododendron, yellow birch and hemlock at higher elevations of the Peaks of Otter region (Thurow, 1957). Salamanders are found abundantly under cover of rocks, logs and surface debris where suitable moisture conditions prevail. When the habitat becomes hot and/or dry, the salamanders retreat further underground. Like all *Plethodon*, food consists of nearly any invertebrate that can be caught and consumed. The defensive mechanisms of this species have been reported and include immobility, tail autotomy, coiling, and noxious secretions (Dodd, Johnson and Brodie, 1974). This species is probably nocturnal or crepuscular although occasional individuals may be encountered by day in its deeply shaded habitat.

Reproduction: Development is direct in this species and fertilization is internal by means of a spermatophore. Data concerning other aspects of its reproductive characteristics are lacking but probably similar to other small eastern *Plethodon*. Males have a well-developed mental hedonic gland-cluster (Dodd and Brodie, 1976).

Number in Captivity: Unknown, but probably few.

Status: *Special Concern.* The limited distribution of this subspecies merits *Special Concern* status within the state. At present, much of its range is within the confines of Blue Ridge Parkway-managed lands and the George Washington National Forest. No imminent threats to its survival are foreseen. Scientific collecting does not appear to be having an impact on the species and no habitat modification has been noted. However, any future expansion of the parkway or associated facilities (pull-offs, etc.) within the range of this subspecies would prove detrimental. Logging on the lands adjacent to the parkway which contain populations of this salamander could also deplete the subspecies. Collecting within the boundaries of the Blue Ridge Parkway is allowed only with a permit from the National Park Service.

Protective Measures Proposed: Lands adjoining the Blue Ridge Parkway containing known populations of this salamander should be protected from logging and commercial development. The habitat should be continuously monitored and studies should be undertaken to define the limits of distribution and ecological requirements.

Remarks: Studies currently underway suggest that this salamander may warrant full specific recognition (R. Highton, pers. comm.).

Author: C. Kenneth Dodd, Jr.

4. SHENANDOAH SALAMANDER

Plethodon nettingi shenandoah
Highton and Worthington

Phylum: Chordata
Class: Amphibia

Order: Caudata
Family: Plethodontidae

Description: The Shenandoah salamander is an elongate slender salamander reaching a length of about 4-3/4 inches (12 centimeters). There are two color phases, striped and unstriped. The striped phase is characterized by a narrow red stripe down the back whereas the unstriped phase is uniformly dark; reduced brassy pigmentation may be present on the dorsum of the unstriped phase. The lateral and belly pigmentation are black. Normally there are 18 costal grooves as opposed to sympatric *Plethodon cinereus* which has 19 costal grooves and a wide dorsal stripe.

Present Range: This subspecies is known only from the north and northwest facing slopes of Hawksbill Mountain, Stony Man Mountain, and The Pinnacles in Shenandoah National Park, Madison and Page counties, Virginia, at elevations above 3000 feet (Highton, 1971; Highton and Worthington, 1967; Jaeger, 1970, 1971, 1974) (Figure 2).

Distribution in Virginia: Endemic (see above).

Habitat and Mode of Life: The Shenandoah salamander is confined to deep pockets of soil within the talus on the north and northwest faces of its three mountains in mixed conifer-deciduous forest. This area is shaded and moisture is present from seeps along the bases of rock ledges. Occasional individuals may be found away from the talus, but generally within 80 meters of it. The salamanders occur under rocks and surface debris where moisture conditions are favorable. When unfavorable conditions prevail, individuals seek shelter in burrows or crevices. Food consists of insects and other small invertebrates. In various papers, Jaeger (see Literature Cited) has reported on the ecology of this species and its interrelationships with *Plethodon cinereus*, with which it apparently is in competition for food and shelter.

Reproduction: As in all woodland salamanders (*Plethodon*), fertilization is internal and development direct. Nothing further is known about its reproductive characteristics. Eggs are probably deposited in moist sheltered nests and attended by the female, with hatching occurring in the late summer or early fall. Males have a crescent-shaped mental hedonic gland-cluster.

Number in Captivity: Unknown, but probably few.

Status: *Special Concern.* This salamander exists entirely within Shenandoah National Park and collecting is strictly regulated for scientific purposes only. No habitat alterations are occurring, and the subspecies does not appear to be in any danger from human-related causes. However, the work of Jaeger strongly suggests that *Plethodon nettingi shenandoah* may be experiencing intense competition from allopatric *Plethodon cinereus* and that its present range may be the result of this competition. As long as the talus habitat remains, this subspecies will probably be able to maintain itself. However, this subspecies "is faced with potential extinction due to the erosion of soil into its talus refugium followed by a subsequent encroachment of (*Plethodon cinereus*, and due to the paucity of isolated pockets of soil which are the centers of its distribution" (Jaeger, 1970).

Protective Measures Proposed: The habitat of this subspecies should be continuously monitored to insure that it is not modified to the detriment of the salamander. The Appalachian Trail passes directly through its limited range

and a study should be undertaken to determine its effect on the salamander. The National Park Service should continue to allow collecting only for scientific purposes.

Remarks: Studies currently underway suggest that this salamander may warrant full specific recognition (R. Highron, pers. comm.).

Author: C. Kenneth Dodd, Jr.

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5. WELLER'S SALAMANDER
(Spot-bellied Salamander)

Plethodon welleri Walker
*Plethodon welleri ventromaculatum**

Phylum: Chordata
Class: Amphibia

Order: Caudata
Family: Plethodontidae

Description: A small slender *Plethodon* that seldom exceeds 2 inches (4.7 centimeters) snout-vent length. The upper surface has a profusion of dull golden or silvery blotches. The ventral surface in Virginia specimens is black but spotted with white. Because of the restricted range, size and coloration, the species is not likely to be confused with other species of *Plethodon*. An illustration and additional descriptive data are available in Conant (1975). *Two subspecies of uncertain validity are recognized at present (Thurrow, 1964). (Conant [1975] refers to this population as the spot-bellied salamander, *Plethodon welleri ventromaculatum*, and Collins *et al.* [1978] refer to it as the spotbelly salamander.)

Present Range: Extreme northeastern Tennessee, Whitetop and Mount Rogers in Virginia and northwestern North Carolina including Grandfather Mountain. The vertical range extends from 2500 feet (760 meters) to 5700 feet (1700 meters), but is most frequently encountered in spruce forests above 5000 feet.

Distribution in Virginia: Mount Rogers and Whitetop Mountain in Grayson County, Virginia (Figure 3).

Habitat and Mode of Life: A terrestrial salamander that is generally found beneath logs and stones in the spruce forest covering the upper slopes of the mountains. It is active primarily at night and feeds on small arthropods.

Reproduction: Eggs are laid in well-rotted conifer logs. The female remains in attendance until after the young hatch. Courtship takes place in the fall. Brooding of eggs and young takes place in the summer. A clutch of eggs was collected on August 16 in a late stage of development (Organ, 1960).

Number in Captivity: Not significant.

Status: *Special Concern.* This species deserves *Special Concern* because of its restricted geographic and ecological range. In Virginia, it is restricted to Mount Rogers and Whitetop and is most frequently found in the Canadian Zone forests. It also deserves *Special Concern* because of the increased recreation pressures and elaborate development plans that are proposed for the Mount Rogers National Recreation Area. Reducing the preferred habitat or dividing the habitats into smaller units are apt to have adverse effects on this species. Population numbers appear healthy at this time, but the species bears monitoring in the light of potential habitat destruction and increased human interference. Its nesting in well-rotted logs makes it particularly vulnerable to development, clean-up operations and primary activities.

Protective Measures Proposed: Keep development of the spruce-fir zone of Mount Rogers and Whitetop to a minimum.

Author: Thomas Krakauer.

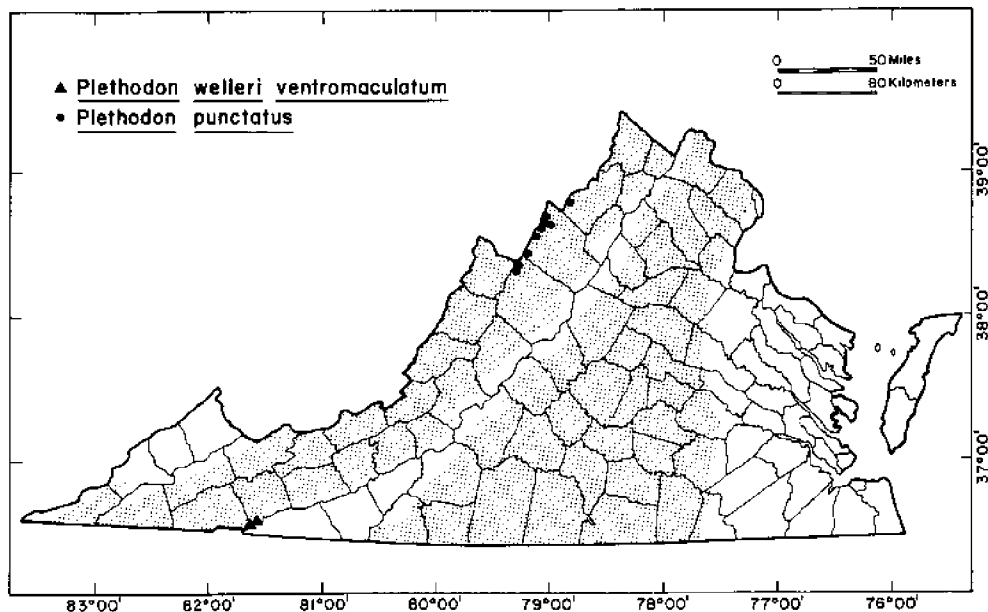


Figure 3. Distribution of *Plethodon welleri* [*ventromaculatum*] (▲) and *Plethodon punctatus* (●) in Virginia

6. COW KNOB SALAMANDER

Plethodon punctatus Highton

Phylum: Chordata
Class: Amphibia

Order: Caudata
Family: Plethodontidae

Description: A dark gray or brownish colored salamander with a row of white or yellow spots along the side of the body, the Cow Knob salamander is very similar in appearance to the more widespread Wehrle's salamander. However, it lacks the brassy flecking and red spots of that species, and has a tendency to have numerous white or yellowish-white spots on the back. The belly is uniformly gray and the underside of the throat is pinkish. There are usually 17 or 18 costal grooves and adults may reach a total length of nearly 6-1/2 inches (16 centimeters). Conant (1975) provides a black and white sketch of this species.

Present Range: This species is known from elevations above 3000 feet on Shenandoah Mountain (Pendleton County, West Virginia; and Augusta and Rockingham counties, Virginia) and above 2800 feet on North Mountain (Hardy County, West Virginia; and Shenandoah County, Virginia) (Highton, 1971). These two populations are probably isolated from one another.

Distribution in Virginia: The eastern sides of Shenandoah and North Mountains in Augusta, Rockingham, and Shenandoah counties (see above) (Figure 3).

Habitat and Mode of Life: The Cow Knob salamander is terrestrial. It lives under rocks, logs, and other surface debris. This micro-habitat must be moist and cool; when hot and/or dry weather sets in, such as in mid-summer, this species retreats underground. Like most woodland salamanders, it is primarily nocturnal or crepuscular and is only occasionally encountered during the day. Food consists of insects, as well as just about any other invertebrate that can be caught and eaten.

Reproduction: Fertilization is internal and development is direct, as it is in all species of *Plethodon*. At present, nothing further is known about its reproductive behavior or population characteristics.

Number in Captivity: Unknown, but probably few.

Status: *Special Concern*. The reason for considering this species of *Special Concern* is its rather limited distribution. Much of the habitat is in the George Washington National Forest although a small number of private holdings, some of which have been cleared, are located on the tops of the mountains. Threats appear to be minimal at present, although any large scale removal of canopy forest within its range could prove detrimental. Scientific collecting does not appear to be having an impact on this species.

Protective Measures Proposed: Logging on lands which contain this salamander should be discouraged unless accompanied by forestry practices which minimize the effect on the salamander's habitat. Additional studies on its distribution and ecology should be undertaken.

Author: C. Kenneth Dodd, Jr.

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STATUS UNDETERMINED (?)

1. HELLBENDER

*Cryptobranchus alleganiensis
alleganiensis* (Daudin)Phylum: Chordata
Class: AmphibiaOrder: Caudata
Family: Cryptobranchidae

Description: The hellbender is the largest North American salamander and may reach a length of almost 30 inches (76 centimeters). It has a flattened head with small eyes and a tail with a prominent keel. Normally, one pair of gill openings is present on the side of the head. The body and limbs are stocky and powerful. Dorsolaterally, there are flesh folds on the body. Hellbenders are entirely aquatic and, although lungs are present, they rely primarily on cutaneous respiration. The dorsolateral folds are involved with this cutaneous respiration. The skull retains certain semilaval characteristics. The coloration is usually chocolate brown with dark blotches or mottling. Larvae up to about 5 inches (13 centimeters) total length possess gills. The generally ugly appearance of this salamander, coupled with its large size and slimy body, has given rise to the myth that this animal is poisonous and dangerous to humans. Nickerson and Mays (1973) and Conant (1975) provide complete descriptions and illustrations of hellbenders.

Present Range: Hellbenders occur in four apparently isolated areas: (1) the Susquehanna drainage of south central New York, central Pennsylvania, and Maryland, (2) major and minor tributaries of the Ohio and Tennessee River systems from southwestern New York south to northern Georgia and Alabama, and west to southern Illinois and western Kentucky, (3) the Missouri drainage in Missouri and (?) southeastern Kansas, and (4) the Ozark Plateau of Missouri and Arkansas.

The hellbenders of the Ozark Plateau have been described as a distinct subspecies, *Cryptobranchus alleganiensis bishopi*, although some authors doubt its validity.

Distribution in Virginia: Literature records are available for Floyd, Giles, Lee, and Montgomery counties (Dunn, 1918; Hutchinson, 1956; Bogert, 1961). Unpublished museum records and individuals in private collections are known from Grayson, Pulaski, Russell, Scott, Smyth and Washington counties. Hellbenders are probably also present in Bland, Carroll, Tazewell and Wythe counties; they may be present in Buchanan, Craig, Dickenson, Franklin and Wise counties. These areas are all within the Big Sandy, New, and Tennessee drainage systems (Figure 4).

Habitat and Mode of Life: Hellbenders inhabit clean, clear, well oxygenated waters of moderate to fast-flowing larger creeks and rivers. Preferred shelter and nesting sites are located underneath large flat rocks, boulders, logs, and other debris. The larvae utilize smaller rocks for shelter and protection and may be found occasionally in the interstices of gravel in the stream bed. The greatest degree of population diversity is located in areas with rock piles on gravel beds. In a study on Ozark hellbenders, it was found that density is directly proportional to the number of large suitable shelter rocks. Invertebrates are abundant in this micro-habitat. Hellbenders are primarily nocturnal. Food consists of crayfish as a main item plus snails, insects, worms and fish.

Reproduction: Male hellbenders select a nesting site beneath a flat rock or other large object and prepare a nest cavity. Females are lured to the nest perhaps by the use of pheromones; if reluctant to enter, the male may forcibly drive the female into the nest. Females lay eggs (300-500) in two strings, one from each oviduct. The strings of eggs resemble a rosary in appearance. As the eggs are deposited, the male sheds sperm over them; thus, fertilization is external. Following egg laying and fertilization, the male ejects the female from the nest and actively guards it for a varying amount of time (such nest guarding has been observed to occur for at least 21 days). Multiple nesting is known to occur with as many as 2000 eggs laid per nesting cavity. Hatching occurs in the fall, generally 68 to 84 days after laying. Both males and females practice oophagy, but its significance, if anything other than as a food source, is not known.

Number in Captivity: Unknown, but probably few.

Status: *Undetermined.* The range of the hellbender in Virginia is incompletely known and there are no comprehensive works on its biology within the state. Additional localities undoubtedly exist in the southwestern drainages of the New, Tennessee (including the Clinch, Holston, and Powell rivers), and perhaps Big Sandy drainages. The adverse modification of the clean swift-flowing rivers in this part of the state, including pollution, run-off from mining operations and dams, could be having a detrimental impact on this species. It is unlikely that the occasional individuals caught by fishermen or collected for scientific study have a significant effect on the population within the state (Bruce, 1977). There are no protective measures currently in effect in Virginia.

Protective Measures Proposed: A thorough study of the species in Virginia, including possible threats to it, is definitely warranted. In any case, the maintenance of river and stream habitats free from various forms of pollution and obstruction is absolutely necessary.

Remarks: Nickerson and Mays (1973) have reviewed the biological information on all aspects of the life history of this species.

Author: C. Kenneth Dodd, Jr.

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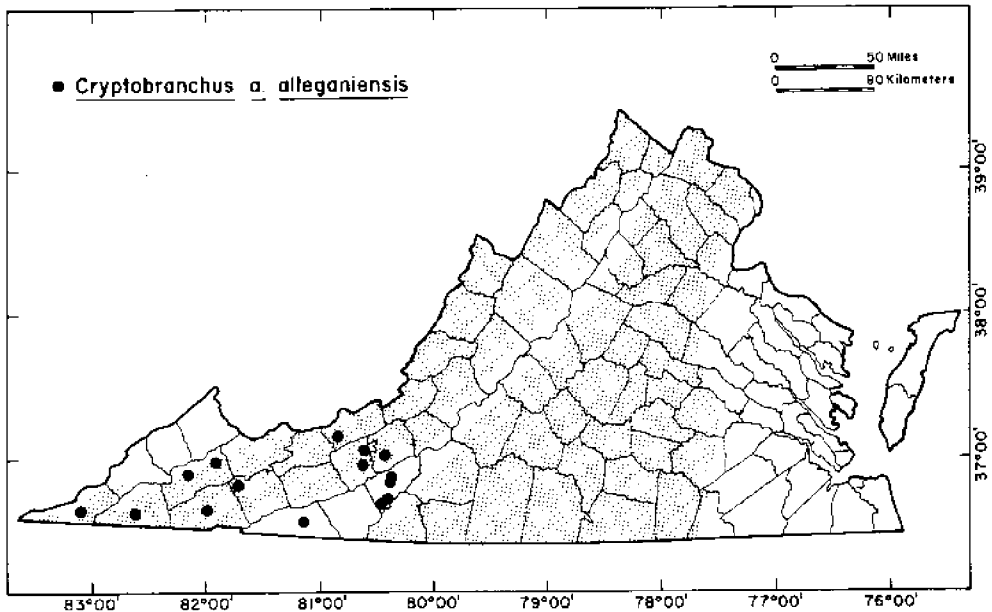


Figure 4. Distribution of *Cryptobranchus alleganiensis* in Virginia

2. GREEN SALAMANDER

Aneides aeneus (Cope and Packard)

Phylum: Chordata
Class: Amphibia

Order: Caudata
Family: Plethodontidae

Description: The average adult size of *Aneides* is approximately 102 millimeters total length. Dorsally, the salamander is black to gray-brown with large, light green to metallic yellow-green mottling. The coloration resembles dark rock or tree bark encrusted with lichens. The venter is bluish-gray to cream-yellow and immaculate or lightly flecked with yellow. The toes of the fore- and hindfeet end in squared fleshy pads, with the exception of the innermost which are greatly reduced in size. The interdigital spaces are slightly webbed in the forefeet and moderately webbed in the hindfeet. The head is vertically depressed and broadened horizontally, especially in males, and in adults is usually wider than the body. The tail is rounded and slightly longer than the body. Descriptions and photographs are in Barbour (1971), Bishop (1943), Conant (1975), Leviton (1970), and Mount (1975).

Present Range: The primary range of this species is restricted to the Allegheny and Cumberland, and portions of the Blue Ridge mountains, from southwestern Pennsylvania and western Maryland through part of eastern Tennessee, to northeastern Mississippi. Isolated populations occur in southwestern North Carolina and extreme western South Carolina and the unglaciated areas of

extreme southern Ohio. Distributions are described and mapped in Conant (1975), Gordon (1953, 1967), and Mount (1975).

This species is absent from many seemingly suitable habitats in its expected range, and many of the existing populations appear to be widely disjunct.

Distribution in Virginia: Lee County, Cumberland Mountains (Dolomite caves); Washington County, Hayters Gap; Wise County, High Knob south of Norton and Powell Mountain east of Norton; Russell County, Johnson's Cave No. 2; Tazewell County; Scott County (Figure 5).

Habitat and Mode of Life: The green salamander lives on moist cliff faces, in caves (Dunn, 1926; Holsinger, 1961), and occasionally on dead tree trunks and under ground cover. It usually occurs in rock outcroppings surrounded by rhododendron (*Rhododendron* sp.) and eastern hemlock (*Tsuga canadensis*), often adjacent to stream valleys or cove hardwood communities, but is not restricted to such habitat. The rocky slopes or cliffs preferred are permanently moist but not wet, and are covered in part with mosses and liverworts. Inhabited rock faces are shaded from direct sunlight and have extensive fissures and cracks, some of which afford the salamanders relatively low temperatures and high humidity during dry summer months. Some are deep enough to provide winter retreat areas that extend beyond the freeze level. Aggregations of *Aneides* in these areas have been reported in the fall and spring, indicating that the species may overwinter in groups.

The food of *Aneides* consists of small invertebrates. The ring-necked snake, *Diadophis punctatus*, has been reported as a predator on eggs and adults of this salamander.

Reproduction: Gordon (1952) presented extensive data on reproduction and life history. Breeding can occur from May through September, and timing apparently has little to do with geographic location, but varies from one population to another. Eggs, averaging 17 in number, are deposited on the upper surface of nesting cracks or crevices. Females remain with and actively guard the eggs until they hatch, 84 to 91 days from deposition. There is some indication that parental care is essential to hatching. Juveniles disperse from the relatively clear nesting crevices to those that support moss growth.

Number in Captivity: Unknown. There are several in captivity (locality unknown) at the Cincinnati Zoo where a successful salamander breeding program is being undertaken:

Status: *Undetermined.* The range of *Aneides* is restricted to four counties in the southwestern part of the state. Known populations in the Carolinas have been greatly depleted or extirpated (A. L. Braswell, pers. comm.; K. C. Dodd, pers. comm.). The reasons for this decline may be overcollecting, or the severe droughts of the past few years. Also, increased development of mountain areas and the damming of certain major rivers and streams have destroyed habitat for some populations. The species is listed as *Endangered* in Mississippi (Cliburn *et al.*, 1972) and in Maryland (Cooper *et al.*, 1973). It is considered *Threatened* by impoundments in South Carolina (Saunders, 1976) and as a *Rare* or *Unusual* species in Georgia. In North Carolina, *Aneides* is listed as a species of *Special Concern* (Bruce, 1977). Populations in Kentucky, Ohio, and Pennsylvania are apparently stable. No current information is available on *Aneides* in Virginia, but if the factors causing apparent decline of the southeastern peripheral populations extend into the state a status of *Threatened* may be valid.

Protective Measures Proposed: Attempts to learn more about the status and range of *Aneides* in Virginia should be undertaken. Every attempt should be made to conserve the habitat of this species in the state. The relatively isolated and sparse populations that represent this species throughout its entire range may indicate that the existence of *Aneides* is extremely vulnerable.

Author: Ray E. Ashton, Jr.

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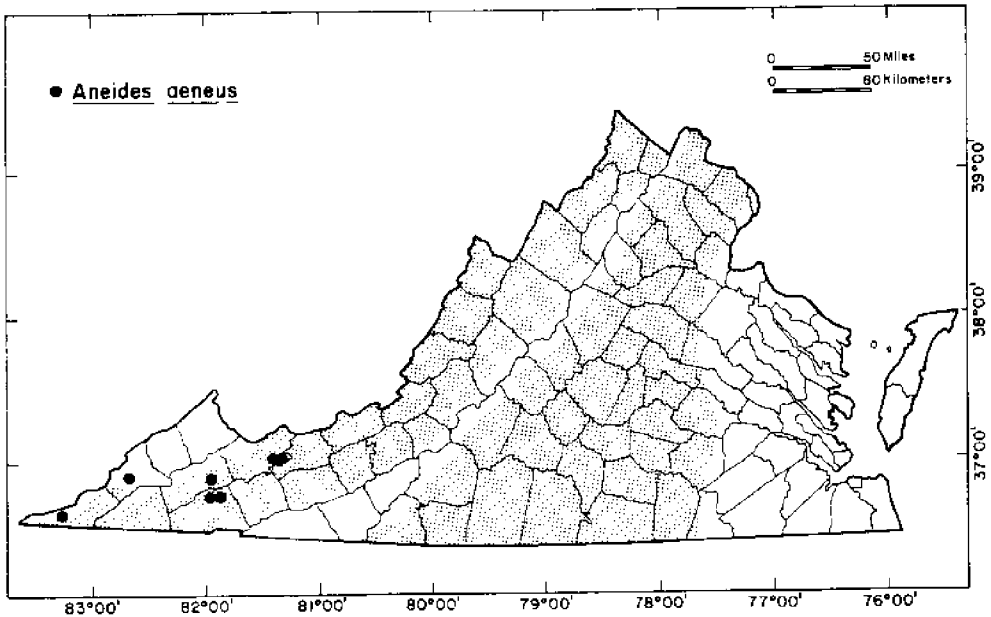


Figure 5. Distribution of *Aneides aeneus* in Virginia

Other Status Undetermined Species

Two entirely aquatic species of fairly large salamanders, the mudpuppy (*Necturus maculosus maculosus*) and the dwarf waterdog (*Necturus punctatus punctatus*), reside in two very different Virginia regions. The mudpuppy is in the southwestern end of the state in the Tennessee-Mississippi River drainage -- principally in the New, Clinch, Holston and Powell rivers. Virginia Herpetological Survey collecting records, at hand, are for Lee and Washington counties. The dwarf waterdog is found in southeastern Virginia

in the Meherrin River drainage (to Albemarle Sound) with records from Brunswick, Greensville, and Dinwiddie counties, Virginia. Water quality as affected by impoundment and industrial effluent may greatly influence survival of these species. Dr. Hoffman has suggested that they may not be truly rare, but simply hard to collect.

The greater siren (*Siren lacertina*) is a large (20 to 30 inches) eel-like salamander. There are only four historic collection records: "Potomac Flats" near Washington, D.C., "Guiney Station" in Caroline County, Virginia, and two sites in the Virginia Beach (formerly Princess Anne County) area. There is strong evidence that few people have attempted systematic collection. The fully aquatic species --hellbender, mudpuppy, waterdog and siren -- are exposed to poisonous chemicals leached from the soil or dumped into the rivers. We have already spoken above of the scant record for the eastern tiger salamander (*Ambystoma tigrinum tigrinum*). The carpenter frog (*Rana virgatipes*) has been reported from three counties: Caroline, Nansemond, and Virginia Beach (Princess Anne), and should be looked for in suitable habitat in the intervening spaces.

* * * * *

SPECIES ACCOUNTS - REPTILES

ENDANGERED (5)

The Amphibians and Reptile Committee recommended five species of reptiles as *Endangered*. All five of these species are sea turtles.

The five species of sea turtles comprise one of the most interesting parts of Virginia's migratory marine fauna. They include the world's largest living reptile, the leatherback, *Dermochelys coriacea*, the common and very large loggerhead, *Caretta caretta*, the less common and much smaller ridley, *Lepidochelys kempi*, the rare green turtle, *Chelonia mydas*, and the hawksbill, *Eretmochelys imbricata*, a species for which no verifiable Virginia records have been found (Figure 6).

All of the marine turtles may be recognized by their flipper-like limbs, adaptations for their highly aquatic existence. Marine turtles spend their entire lives in the water, emerging on beaches only to lay their eggs.

Despite their apparent armored immunity, all five marine turtles in Virginia are highly susceptible to annihilation by man. With the exception of the leatherback, all species are considered edible if not epicurean by man. In the tropics, active fisheries for sea turtles have been in existence for centuries. The amphibian and reptile panel agreed to list these five turtles as *Endangered* in Virginia.

Marine turtles reach their highest vulnerability when they emerge from the sea to bury their eggs in nests on sandy beaches. Then, not only are the adults slaughtered for food, but also the eggs (even of the leatherback) are collected by the thousands to be prepared and eaten much as hen's eggs are. In addition to harvesting by man, the eggs are vulnerable to predation by many other animals including pigs, dogs, raccoons, and skunks. If a nest full of eggs remains undisturbed and the eggs hatch after a month or more, the young turtles usually emerge at night and head for the sea. Artificial lighting near nesting beaches sometimes disorients the hatchlings and may cause them to head inland instead of seaward. Natural predation by mammals, birds, fishes, land crabs and other animals on these nestling turtles can be very high because the turtles are small, awkward, relatively thin-shelled, and defenseless.

The greatest threats to the survival of all the marine turtles are human harvesting of nesting females and eggs at nesting beaches, and the actual destruction of such beaches because of real estate development. Further to the south, shrimp trawling is a factor, if not the major mortality-producing factor, along the southeastern coast, and one of the greatest threats to turtle survival.

Jack A. Musick

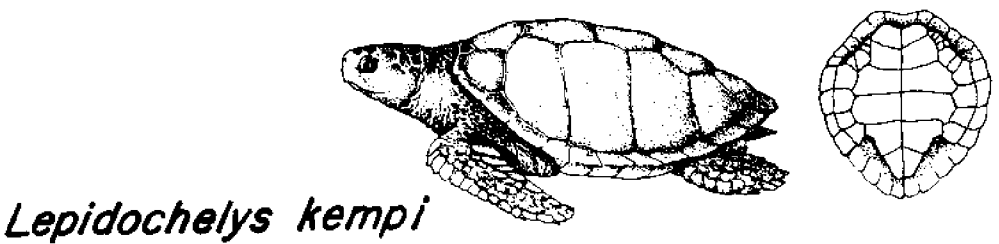
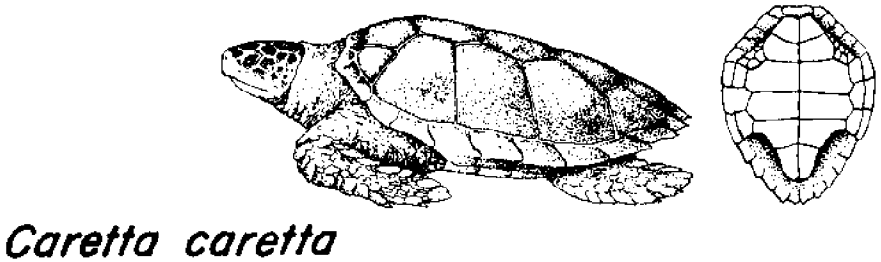
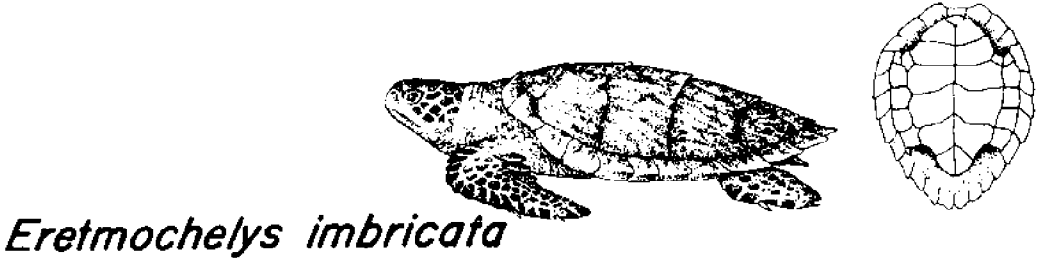
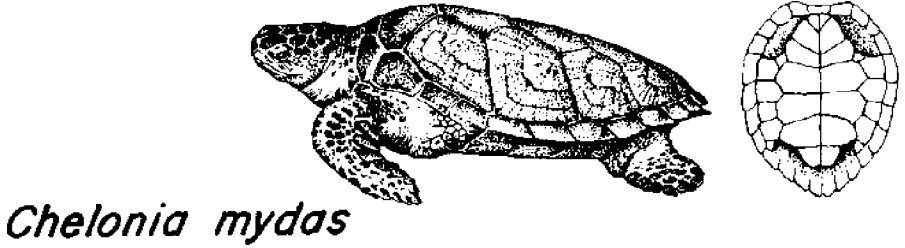
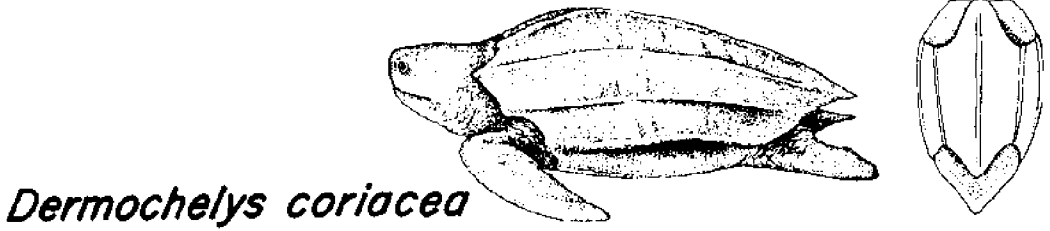


Figure 6. The Sea Turtles of Virginia

1. LEATHERBACK

Dermochelys coriacea (Linnaeus)

Phylum: Chordata
 Class: Reptilia

Order: Testudines
 Family: Dermochelyidae

Description: The leatherback is our only black sea turtle. It may be distinguished from all other marine turtles because it has no plates or scutes on its shell, and no scales on its head or body. Instead, the leatherback is covered by a heavy skin that resembles leather or rubber (Figure 6). The carapace (top shell) has seven longitudinal ridges (Ernst and Barbour, 1972; Conant, 1975). This species attains a weight of at least 1600 pounds in the Atlantic and may reach a ton. A Pacific specimen has been recorded at 1900 pounds. Most Virginian specimens examined by Virginia Institute of Marine Science personnel have probably weighed less than 1000 pounds; straight-line carapace lengths range from 34 to 63 inches.

Present Range: Worldwide. In the Atlantic it is found from Newfoundland to Argentina, including the Gulf of Mexico and Caribbean Sea.

Distribution in Virginia: An occasional summer visitor (Musick, 1972) (Figure 7).

Habitat and Mode of Life: The leatherback is pelagic, spending most of its life in the open ocean, although specimens have been reported from upper Chesapeake Bay and in Virginia estuaries as far upstream as Severn River in the Mobjack Bay system. This species is the only turtle known to be homeothermic (warm-blooded). It is capable of maintaining body temperatures near 80°F, even when living at ambient sea temperatures near 45°F. Because leatherbacks can maintain their body temperature, they are capable of surviving in cool northern waters, and apparently many individuals migrate in summer from the tropics to the productive waters off New England and the Canadian maritime provinces where they feed on the abundant boreal jellyfish *Cyanea* sp. Similarly, a large leatherback appeared to be feeding on the sea nettle *Chrysaora quinquecirrha* and other jellyfish, *Aurelia aurita*, in a tide line off Fort Story, just northeast of Cape Henry, Virginia, on 19 July 1977. A leatherback was also observed there on 24 August when VIMS personnel returned. The same turtle may have been a resident for several days in the area where prevailing currents formed a large back eddy concentrating flotsam including planktonic (free-floating) jellyfishes.

Leatherbacks have been reported to be capable of swimming very rapidly despite their cumbersome appearance. Estimates of 10 knots may not be excessive because we observed a large leatherback breach at Triangle Wrecks, 18 miles north-northeast of Chesapeake Light Tower on 29 August 1977. The turtle must have been swimming at some considerable speed in order to propel its entire massive body from the water.

Reproduction: In the western Atlantic, the leatherback nests from April through November on beaches in the West Indies, Bahamas, Central America, U.S. Virgin Islands and Florida, with one nesting reported as far north as North Carolina (Schwartz, 1976). Reportedly, nests contain from 50 to 175 eggs; the incubation period is estimated to be from 50 to 75 days.

Number in Captivity: No information given.

Status: *Endangered*. See introductory comments on the five marine turtles. The U.S. List of Endangered and Threatened Wildlife and Plants includes this species as *Endangered*.

Author: Jack A. Musick.

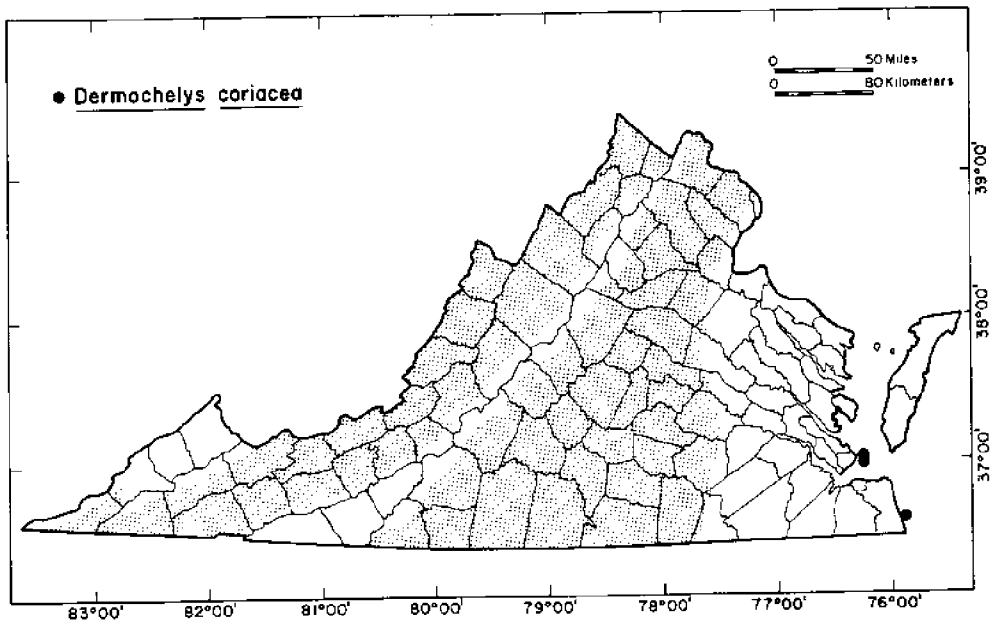


Figure 7. Distribution of *Dermochelys coriacea* in Virginia

The four other species of sea turtles (*Cheloniidae*) may be identified by using two kinds of characters: color, and scale or plate pattern. The pattern of plates on the carapace (upper shell) is important in distinguishing the loggerhead and ridley from the green and hawksbill.

2. LOGGERHEAD

Caretta caretta (Linnaeus)

Phylum: Chordata
Class: Reptilia

Order: Testudines
Family: Cheloniidae

Description: The loggerhead may be distinguished from the ridley by color. The loggerhead is reddish-brown with some yellow on the head and limbs, whereas the ridley is gray with some white on the head and limbs. In Virginia, most loggerheads seen are large (over 100 pounds), and most ridleys are small (under 40 pounds). The loggerhead and ridley may be further distinguished by examining the large plates on the bridge between the upper and lower shells. The loggerhead usually has three large plates (rarely four) and the ridley has four or five (Figure 6). In addition, ridleys have pores in their bridge plates and loggerheads do not. (Ernst and Barbour, 1972; Conant, 1975). The

loggerhead attains a weight of at least 1000 pounds and perhaps 1200 pounds, the largest of the hard-shelled sea turtles. Most Virginia specimens examined by VIMS personnel have been medium-sized adults (33 to 36 inches in carapace length) (Musick, 1972).

Present Range: Atlantic Ocean from Newfoundland south to Argentina, including the Gulf of Mexico and the Caribbean and Mediterranean Seas.

Distribution in Virginia: In Virginia, it is by far the most common marine turtle occurring near shore in spring, summer, and fall. There is a record for this species at Four-mile Run in Alexandria, Virginia (Figure 8).

Habitat and Mode of Life: The loggerhead is a ubiquitous subtropical marine turtle. It has been observed several hundred miles at sea, yet also penetrates estuaries far up into brackish water. The loggerhead's diet is as broad-ranging as its habitat and it includes jellyfishes, sponges, bivalve molluscs, gastropods, squid, crabs, shrimp, barnacles, fishes, and various sea grasses (*Zostera*, *Thalassia* and *Sargassum*).

Reproduction: In the western Atlantic the loggerhead nests from April through August on beaches in Costa Rica and Cuba, and in the United States from Florida to Virginia, with isolated accounts of nesting as far north as New Jersey. Nesting in Virginia has been reported on the barrier beach islands off the Eastern Shore (Castagna, pers. comm.), and in and near the Back Bay Wildlife Refuge south of Sandbridge in Virginia Beach (formerly Princess Anne County). A dead hatchling was found by VIMS scientists at Sandbridge on 11 August 1973, and a loggerhead nest was examined south of the refuge on 24 August 1972. In addition, U.S. Fish and Wildlife Service (U.S.F.W.S.) personnel have transplanted eggs from South Carolina to wildlife refuges in Virginia at Assateague Island and Back Bay over several years. Incubation takes from 55 to 70 days.

Status: *Endangered*. The National Marine Fisheries Service (N.M.F.S.) and the U.S.F.W.S. nominated the species for inclusion on the U.S. List of Endangered and Threatened Wildlife and Plants as *Threatened*. On 28 July 1978 the loggerhead was officially classified as *Threatened* throughout its range. This species is, by far, the easiest to manage in the United States because there are nesting colonies along the eastern coast. In fact, many such beaches are already protected by inclusion in the wildlife refuge system, or the National Park Service's National Seashore system, or in preserves managed by The Nature Conservancy (TNC). In addition, the loggerhead appears presently to be common off Virginia. It is an unusual day when boating off the Virginia Capes in summer that one or more of these turtles is not sighted. Conversely, actual or projected real estate development in North Carolina, South Carolina, Georgia and Florida will certainly lead to destruction of some loggerhead nesting beaches. Such development must be strenuously discouraged, not only for the sake of sea turtle survival but also for a host of other reasons associated with the degradation and destruction of delicate and dynamic barrier beach ecosystems. Another point of concern regarding survival of the loggerhead is adult mortality induced incidentally by established fisheries. Specifically, the inshore trawl fishery for shrimp and fishes off the Carolinas and Georgia often takes loggerheads, many of which are drowned in the nets. In addition, in Chesapeake Bay there is a substantial loggerhead mortality during late May and June every year. For instance, between mid-May and late June, 1977, seven dead loggerheads were reported to VIMS and examined in Mathews, Gloucester, and York counties. Most of these were bloated and stranded by the tide. Seven turtles may seem like a small number, but the reports were unsolicited (with no public awareness campaign), and all were within a 30-mile (50 kilometer) radius of the VIMS laboratory. It is probable

that even within this radius not all dead loggerheads present were reported or found, and this area represents only a small proportion of the entire Chesapeake Bay system. The enduring question is what are the sources of these mortalities? They cannot be attributed to a trawl fishery because Chesapeake Bay is closed to trawling. The most active bay fishery in May and June is the poundnet fishery. Most turtles captured in poundnets should survive because the nets are constructed so that the turtles can reach the surface to breathe. Turtles can be released from such nets although there is a possibility that some poundnet fishermen might kill the turtles so that they do not re-enter the nets (thus causing the repeated labor of releasing them again). Some loggerhead carcasses examined show evidence of trauma (cuts on limbs or head, or even bullet holes). Most show no such overt signs. The advanced state of decomposition of some carcasses makes any conclusions concerning cause of death quite speculative. These spring loggerhead mortalities have been occurring in lower Chesapeake Bay at least since 1970, when we began to keep cursory records of them. Research on the number and source of loggerhead mortalities in lower Chesapeake Bay should be supported as soon as possible. The amphibians and reptiles panel agreed the loggerhead should be considered *Endangered*.

Author: Jack A. Musick.

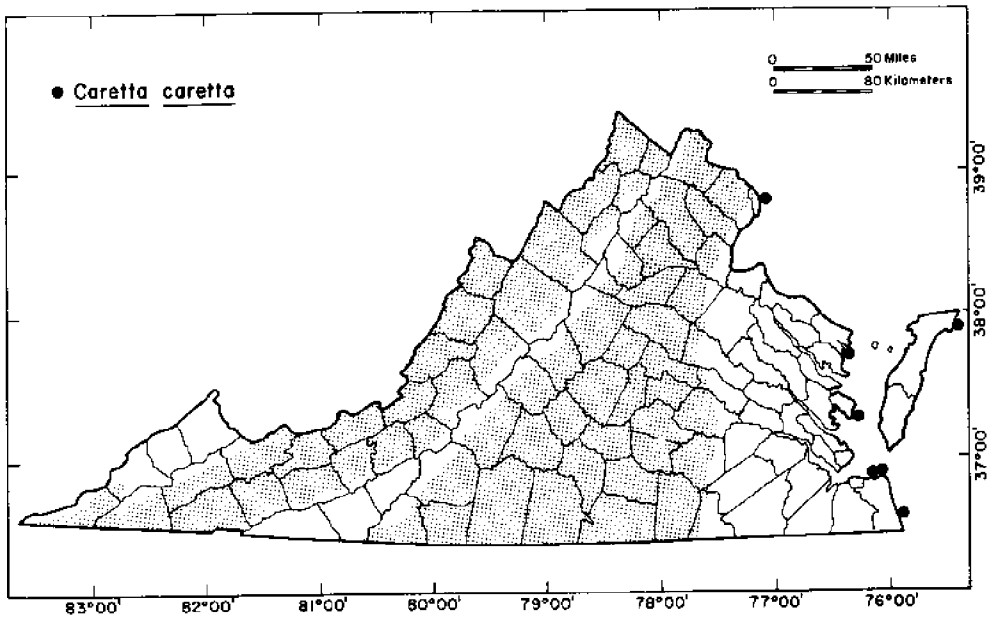


Figure 8. Distribution of *Caretta caretta* in Virginia

3. RIDLEY

Lepidochelys kempfi (Garman)

Phylum: Chordata
 Class: Reptilia

Order: Testudines
 Family: Cheloniidae

Description: See preceding species account for the loggerhead. This species is our smallest marine turtle and attains a maximum weight of 110 pounds. Most Virginia specimens have been small (under 40 pounds) with adult carapace length ranging from 24 to 30 inches (Ernst and Barbour, 1972; Conant, 1975).

Present Range: Western Atlantic Ocean from Nova Scotia to Bermuda and Mexico to Western Europe.

Distribution in Virginia: The ridley is recorded occasionally during the summer (Musick, 1972) (Figure 9).

Habitat and Mode of Life: The ridley is a coastal sea turtle, being most often encountered in mangrove habitats. In Virginia, it has been taken far up into estuaries including the Ware River (Mobjack system) and York River. The ridley's diet consists mostly of benthic (bottom-dwelling) animal matter, including molluscs and crustaceans.

Reproduction: In the western Atlantic the ridley nests from April to August, primarily on beaches from southern Texas to Vera Cruz, Mexico. Very heavy nesting concentrations called "arribadas" (Spanish "arrival") occur north of Tampico, Mexico at Aldana (Rancho Nuevo). The average egg clutch is about 100 and incubation reportedly takes 50 to 70 days.

Number in Captivity: No information given.

Status: *Endangered*. The ridley is classified on the U.S. List of Endangered and Threatened Wildlife and Plants as *Endangered*. Ridley populations have been depleted by trawling and particularly by nest-robbing and slaughter of nesting females on the Mexican beaches, where nesting has been heavily concentrated. A program to transplant eggs from Mexico to Padre Island National Seashore, Texas, may aid in the recovery of the ridley.

In Virginia, we have not recorded ridleys since the summer of 1973. Lazell (1976) has suggested that the ridley's occurrence off New England may be cyclic, and this may be true for Virginia as well. The amphibian and reptile panel has recommended this species be considered *Endangered*.

Author: Jack A. Musick.

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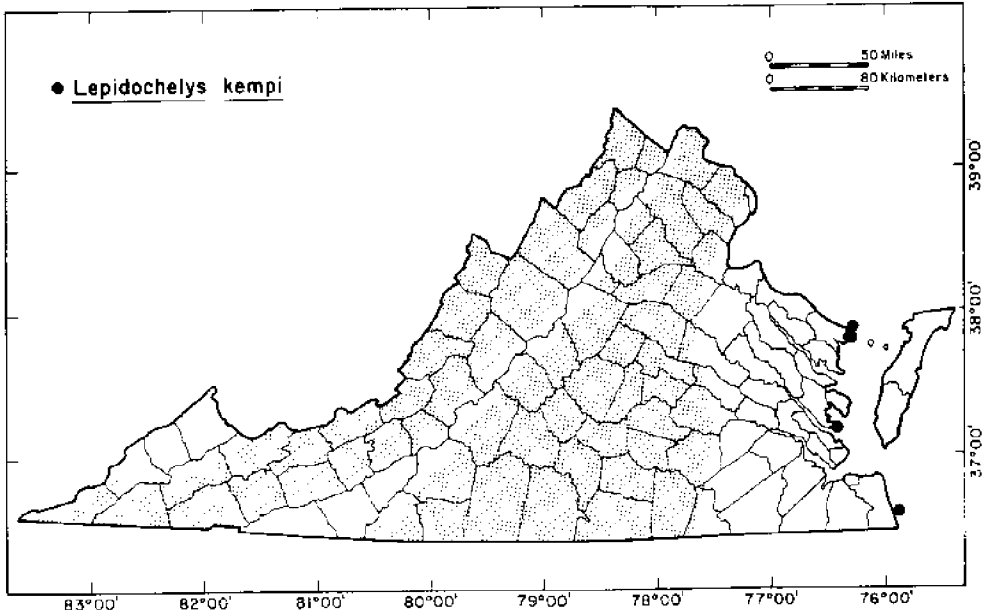


Figure 9. Distribution of *Lepidochelys kempi* in Virginia

4. GREEN TURTLE

Chelonia mydas (Linnaeus)

Phylum: Chordata
Class: Reptilia

Order: Testudines
Family: Cheloniidae

Description: The green turtle may be distinguished from the hawksbill by carefully examining the plates on the carapace and also examining the scales on the head between the eyes. The hawksbill has plates on the carapace that broadly overlap one another like shingles on a roof, whereas the plates on the green turtle do not overlap (or do so only slightly toward the rear of the shell) (Figure 6). In addition, the hawksbill has four scales (two pairs) on the head between the eyes; the green turtle has only two scales (one pair) (Ernst and Barbour, 1972; Conant, 1975). The green turtle attains a weight of 850 pounds. Records for Chesapeake Bay have included mostly juveniles (less than 100 pounds) (Musick, 1972). The straight line carapace length of a large specimen may approach 60 inches, although the average specimen, reportedly, is about 40 inches in length.

Present Range: Atlantic Ocean from New England to Argentina, including the Gulf of Mexico and Caribbean Sea.

Distribution in Virginia: The green turtle is rare, occurring occasionally during the summer (Figure 10).

Habitat and Mode of Life: The green turtle is a tropical species which undertakes long oceanic migrations but feeds in shallow areas, particularly in the vicinity of sea grass beds (Carr, 1955). The juveniles tend to wander farther from the tropics than do the adults. Thus, most records from New England and the Middle Atlantic states are of juveniles. In addition, the juveniles tend to be more carnivorous (jellyfish, molluscs, and crustaceans), than the adults which feed on submerged sea grass (*Thalassia*) and other marine plants (Carr, 1967).

Reproduction: In the western Atlantic the green turtle nests from March to October (peak: May-June) primarily on beaches in the West Indies, the Caribbean shore of South and Central America and on the Dry Tortugas. Occasional nesting occurs on the coasts of the Gulf of Mexico, Florida, and Bermuda. Egg clutches may vary from 20 to 200; incubation is from 45 to 60 days in duration.

Status: *Endangered*. The green turtle is the most highly valued sea turtle for food. Consequently, it has been intensively harvested and depleted throughout its range. On July 28, 1978, this species was officially classified on the U.S. List of Endangered and Threatened Wildlife and Plants as *Endangered* in Florida and *Threatened* elsewhere in the United States. The green turtle's rare occurrence in Virginia might suggest that it is extralimital. However, considering the depleted population levels of the species in the Caribbean center of distribution, it is probable that juvenile green turtles were at one time more common in Virginia waters. Thus, the species should be accorded full protection in Virginia and be considered *Endangered*.

Author: Jack A. Musick.

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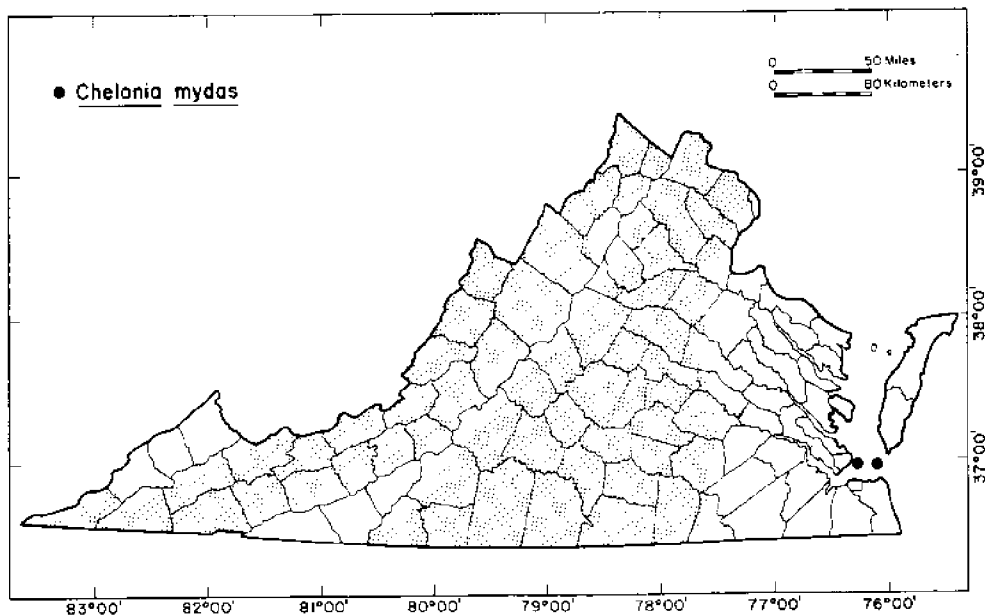


Figure 10. Distribution of *Chelonia mydas* in Virginia

5. HAWKSBILL

Eretmochelys imbricata (Linnaeus)

Phylum: Chordata
 Class: Reptilia

Order: Testudines
 Family: Cheloniidae

Description: See description under preceding species account. While this species may attain a weight of 280 pounds, moderate-sized specimens are more frequently encountered. These have weights averaging around 50 pounds. The straight-line carapace length is 20 to 30 inches.

Present Range: Atlantic Ocean from Massachusetts through the Gulf of Mexico to southern Brazil.

Distribution in Virginia: There are no confirmed reports of this species from Virginia. It is known in the area only from a shell labelled "Chesapeake Bay" that is in the collection of the Natural History Society of Maryland (Musick, 1972) (Figure 11). There are a few other records from north of Cape Hatteras including one shell from Massachusetts. Schwartz (1976) has reported four specimens from North Carolina. Probably this species is extra-limital in Virginia waters, occurring, if at all, as a stray.

Habitat and Mode of Life: The hawksbill tends to be restricted to the tropics more so than any other of the marine turtles. It has been found most often in shallow areas near rocky reefs or coral reefs and in estuaries and lagoons. The hawksbill, reported to be omnivorous, tends to include more animal than plant material in its diet. A wide variety of animal food has been recorded, including sponges, coral, Portuguese man-of-war, ectopods, sea urchins, molluscs, fishes and crustaceans (Pritchard, 1967).

Reproduction: In the western Atlantic Ocean, the hawksbill nests from April through November on scattered beaches from Florida (rare) and Mexico through the West Indies and, less extensively, along the Caribbean coasts of South and Central America. Its major nesting beach is Mona Island, Puerto Rico. Egg clutches vary from 50 to 100 with an average of about 150, reportedly. Incubation is said to require 50 to 70 days.

Status: *Endangered*. The hawksbill's shell has long provided the tortoise shell of commerce. In addition, the eggs and flesh are marketed for food (even though the flesh of some hawksbills has been reported to concentrate toxins found in their food). Consequently, the hawksbill has been depleted throughout its range, and is classified as *Endangered*.

Author: Jack A. Musick.

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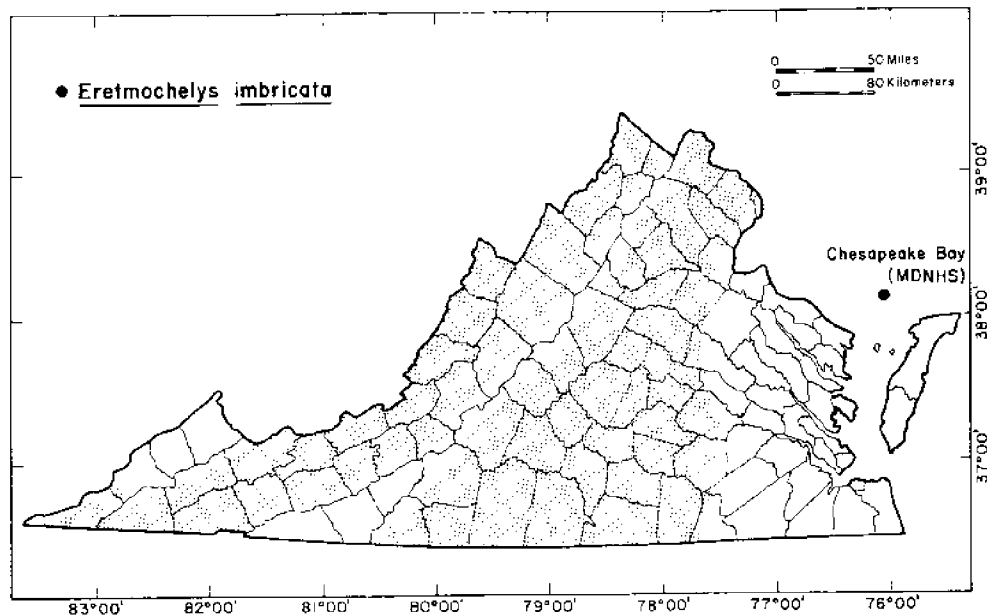


Figure 11. Distribution of *Eretmochelys imbricata* in Virginia

SPECIAL CONCERN (2)

1. BOG TURTLE

Clemmys mühlenbergi (Schoepff)

Phylum: Chordata
Class: Reptilia

Order: Testudines
Family: Emydidae

Description: Adults are 3 to 4-1/2 inches (76 to 115 millimeters) in carapace length. Carapace color varies from light brown to black; each scute usually has a light center. The plastron is dark brown to black with a few irregularly spaced light marks. The head is brown with a large orange, yellow, or red patch on each side behind the eye. The large bright patch on the head distinguishes this species from others with which it could be confused, such as the wood turtle, *Clemmys insculpta*, and the spotted turtle, *Clemmys guttata*. These two species are also geographically separated from *Clemmys mühlenbergi* in Virginia. A key to the genus *Clemmys* is in Bury and Ernst (1977). A literature survey was compiled by Ernst and Bury (1977). Color illustrations are to be found in Ernst and Barbour (1972) and Conant (1975).

Present Range: The bog turtle has a discontinuous range with portions in western New York; western Pennsylvania; eastern New York through Pennsylvania, New Jersey, to northern Delaware and Maryland; and in western North Carolina and southwestern Virginia (Ernst and Bury, 1977).

Distribution in Virginia: In Virginia, the bog turtle is apparently restricted to altitudes above 1850 feet (610 meters) according to Nemuras (1974). It has been reported from five locations in Floyd County along the Blue Ridge Parkway. Individuals have also been seen at one location in Carroll County and at one location in Grayson County (Nemuras, 1974) (Figure 12).

Habitat and Mode of Life: *Clemmys muhlenbergi* is found primarily in sphagnum bogs or wet sedge meadows with clear slow-moving streams. A muddy bottom seems to be required. Highest density populations occur in early successional stages with shrubs well represented but with few trees (Barton and Price, 1955). The bog turtle is active during the months of April, May, June and September. It apparently aestivates to escape high temperatures during July and August. It is active only during the warmer part of the day (11 a.m. to 4 p.m.) according to Ernst and Barbour (1972). Arndt (1977) reports that at the time of capture 70% were engaged in either sunning or moving overland. Both of these activities usually occurred in or near a rivulet. When disturbed it burrows into the mud (Ernst and Barbour, 1972).

The bog turtle is omnivorous, eating primarily berries and insects. Campbell (1960) reported that bog turtles were seen feeding on a dead pickerel frog. Arndt (1977) reported that one was seen feeding on a dead fish, suggesting that they are also scavengers.

Ernst (1977) reported a mean home range of 3.2 acres (1.28 hectares) for *Clemmys muhlenbergi* based on mark-recapture data for 19 individuals. He also reported some homing ability after one individual had been displaced 0.24 miles (0.4 kilometers).

Reproduction: Sexual maturity is reached at a plastral length of 3 inches (70 millimeters), equivalent to an age of 6 years, according to Ernst (1977). The breeding season is late May and early June. Nesting occurs in June and July (Ernst and Barbour, 1972) although Nemuras (1967) reported nesting by one individual in late August. Zovickian (1971) reports two clutches per year, with each clutch containing three to five eggs. From deposition of the eggs to hatchling emergence requires 50 to 59 days (Arndt, 1977). Based on observations of Cramer and reported by Barton and Price (1955), mating has occurred in captivity. Zovickian (1971) and Arndt (1977) have reported successful egg-laying by the bog turtle in captivity.

Number in Captivity: Unknown.

Status: *Special Concern.* The primary factor supporting this status is the restricted habitat requirements of the bog turtle and the likelihood that the habitat is often destroyed by draining and filling. Furthermore, the extent of the range in Virginia is not yet known. The size of the known populations has not yet been determined.

Protective Measures Proposed: Major protection could be provided by preventing the draining or filling of bog turtle habitats throughout its range. Hence, an effort must be made to determine the range limits in the state of Virginia.

Author: Eugene V. Gourley.

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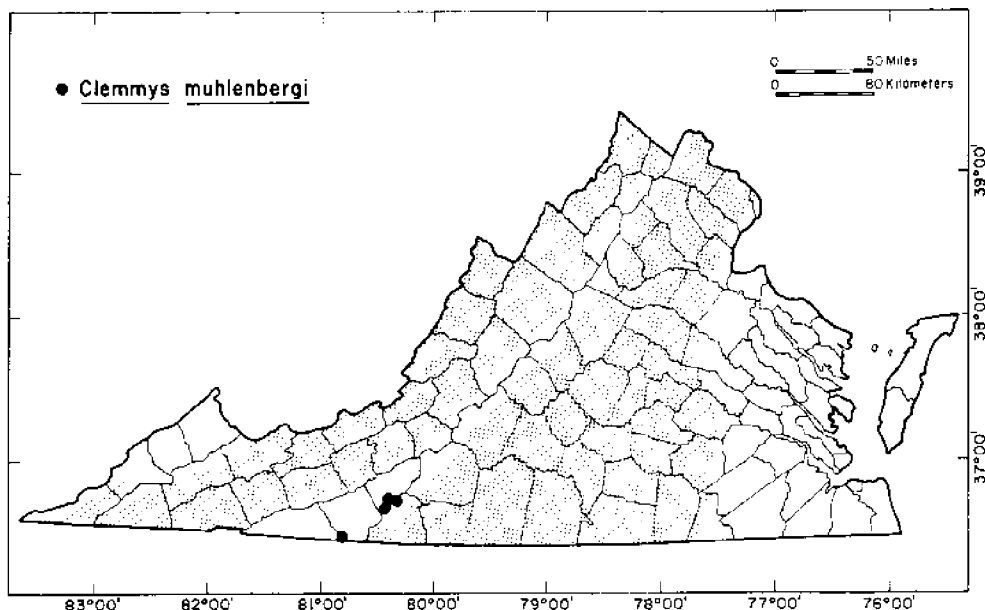


Figure 12. Distribution of *Clemmys muhlenbergi* in Virginia

2. CANEBRAKE RATTLESNAKE

Crotalus horridus atricaudatus
(Latreille)

Phylum: Chordata
Class: Reptilia

Order: Squamata
Suborder: Serpentes
Family: Viperidae
Subfamily: Crotalinae

(EDITOR'S NOTE: This account concerns the southeastern population of the timber rattlesnake, *Crotalus horridus horridus*, which is carried as a subspecies in current identification sources (Conant, 1975). The recent decision to abolish the subspecies (Pisani *et al.*, 1973) falls hardest on Virginia where the canebrake rattler and timber rattler populations are most distinct and widely separated geographically. We must recognize, however, that this gap may have been produced by man within the past 200 years. For practical purposes, within Virginia, we will continue to use the common name of the former subspecies and leave the technical debate to others.)

Description: Virginia's largest rattlesnake. Adults measure 42 to 66 inches. Distinguishing markings are a rusty to tannish mid-dorsal stripe splitting the sooty black chevrons in half; a broad dark stripe running back from eye to angle of the jaw and beyond. The ground color may range from pale

gray, tan, yellow, brown, to pinkish buff. The timber rattler of the highland counties is generally smaller, lacks the facial stripe, and infrequently has a mid-dorsal stripe. It also, typically, has two color phases: sulfur and black, with some specimens having a brownish combination. Color phases are supplanted in the Tidewater population by the color variation noted above (Klauber, 1956; Wright and Wright, 1957).

Present Range: The canebrake rattler follows the lowlands of the Atlantic Coastal Plain from southeastern Virginia southward to northern Florida, west to central Texas, then north along the Mississippi River drainage to southern Illinois (Klauber, 1956; Wright and Wright, 1957).

Distribution in Virginia: In Virginia, there are local populations in the vicinity of Hampton and Newport News. The snake's last stronghold in southeastern Virginia appears to be in the Great Dismal Swamp. There are records from Prince George and Southampton counties. There are still sizable populations in the southern sector of Virginia Beach (formerly Princess Anne County). In southern Chesapeake, along the Northwest River, the snake is fairly common (Figure 13).

Habitat and Mode of Life: The canebrake rattler likes the higher ridges that adjoin river swamps. It frequents open areas with little understory; stumps and logs are preferred. These rattlers are diurnal in the spring and fall, whereas in the summer they are crepuscular and nocturnal. In Virginia, they are active from late April until early November, when they seek suitable logs and stump holes for hibernation. They feed primarily on small mammals: rabbits, squirrels, mice, rats, shrews, and young raccoons. They also feed on birds such as the bobwhite. This snake is not aggressive but will take a defensive posture when cornered. Generally it seeks escape rather than a confrontation.

Reproduction: The canebrake is viviparous. Mating takes place in mid-May and 5 to 17 young are born in early September. The young are 12 inches long and resemble their parents in pattern, but are paler. Following birth they are on their own; there is no parental care. The canebrake is sexually mature by its fourth year.

Number in Captivity: Probably not more than half a dozen Virginia canebrakes are in captivity. In 1976, the Nature Center at Newport News City Park had one in captivity. In 1977, Northwest River Park in Chesapeake had two adults in captivity, but since have been released. The number of canebrakes in the collections of amateur herpetologists is not known.

Status: *Special Concern.* The Amphibian and Reptile Committee decided on a *Special Concern* status for the canebrake rattlesnake for the following reasons: (1) the snake's range in southeastern Virginia is restricted; (2) it has a low population density; (3) it may become endangered through loss of habitat as a result of habitat destruction; (4) hunters have taken heavy tolls on the known population, and (5) Tidewater Virginia is the northern limit for this primarily southeastern form.

It would be difficult to estimate the number of canebrake rattlers in the wild. There may be a population of several thousand canebrakes in the Tidewater area. Breeding in captivity would not be difficult; many of the country's zoological parks and research institutions have had good success with captive propagation. As far as protective measures in effect, the Virginia Commission of Game and Inland Fisheries listed the canebrake rattler as an *Endangered* species in Virginia in 1974, as a result of the study by Wayne P. Russ (1973). However, public education and enforcement will be a tall order to fill.

Protective Measures Proposed: The establishment of the Great Dismal Swamp National Wildlife Refuge has provided more than 60,000 acres, much of it prime habitat for the canebrake rattler. The City of Chesapeake recently opened Northwest River Park that has 763 acres of fine river bottom swamp habitat. It has a healthy population of canebrake rattlers which are protected along with the other animals and plants found there. Research studies on the population density, habitat, and food requirements of this species are needed.

Remarks: Other common names are: wood rattler, swamp rattler, and "diamond-back" -- a misnomer. The canebrake rattler is under pressure, not from collectors but from indiscriminate shooting and from loss of habitat.

Author: Gary M. Williamson.

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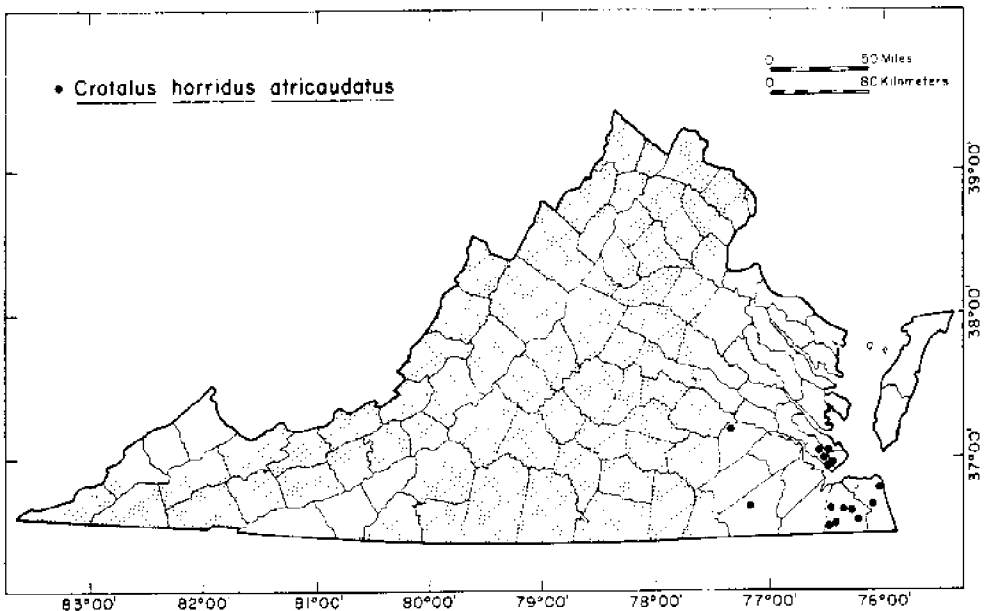


Figure 13. Distribution of *Crotalus horridus (atricaudatus)* in Virginia

STATUS UNDETERMINED (8)

Little is known about a cluster of species of turtles peculiar to the southwestern Virginia counties. Those on our list as of *Undetermined Status* are: the stripe-necked musk turtle (*Sternotherus minor peltifer*), the map turtle (*Graptemys geographica*), the Ouachita map turtle (*Graptemys pseudogeographica ouachitensis*), and the eastern spiny softshell (*Trionyx spiniferus spiniferus*). All seem to be confined to the Tennessee-Mississippi River drainage, but the softshell may have been introduced elsewhere and should be looked for in the eastward-flowing rivers of highland Virginia. Map turtle specimens have been collected from Lee and Washington counties. Spiny softshells have been recorded for Lee and Smyth counties. The infrequency of contacts may reflect industrial pollution.

The green anole (*Anolis carolinensis carolinensis*) has been seen by or adequately described to competent observers in the Great Dismal Swamp at Lake Drummond and near Cypress Chapel. But actual specimens have yet to be collected in habitat that can be accepted as natural. Escapees of the species are typically urban or suburban and follow carnival or circus sales. The only Virginia records for the glossy water snake (*Regina rigida rigida*) are those of Neil D. Richmond for Lanexa, New Kent County, Virginia. The northern pine snake (*Pituophis melanoleucus melanoleucus*) is restricted to the western highlands. Collecting records are known for Augusta, Alleghany, Bath, Craig and Giles counties. The status of the southeastern crowned snake (*Tantilla coronata coronata*) has been covered in the opening paragraphs of the Introduction.

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BIRDS

Mitchell A. Byrd

Introduction

The Committee on Birds has carefully reviewed the status of the species which comprise the Virginia avifauna. Birds do, of course, comprise a surprisingly mobile component of the fauna. Many of the breeding species which occur in Virginia have a wide breeding distribution in other areas of the country. Many additional species do not breed in Virginia but occur in the state either as transients or as winter residents.

All members of the Committee are professional or semi-professional ornithologists. Because many of the contributions to our knowledge of birds derive from the amateur, we have made use of the extensive body of data gathered by this group.

One of the major decisions the Committee found necessary to make was that of delineating the scope of its species considerations. Of all of the species of birds which occur in Virginia, none is endemic to the state. A species may be considered *Threatened* or *Endangered* on the basis of its status as a breeding bird in Virginia, or on the basis of its declining breeding population in other portions of its range, in which case population declines in transient and wintering numbers may be noted in the state.

The Committee felt that it could not evaluate adequately the status of a species which does not breed within the state. Accordingly, we have restricted our accounts to those species which breed within the confines of Virginia. Comments are made on several other groups of species in this introduction.

One of the major problems which the Committee encountered was the lack of information on the current population status of many species in the state. Breeding ranges are not adequately known for many species. Breeding bird forays conducted in recent years by the Virginia Society of Ornithology have greatly broadened our knowledge of breeding birds in areas which previously were poorly known. A revised annotated checklist scheduled for publication in 1979 by the same organization will do much to consolidate the data currently available on bird distribution and populations in the state.

There are at least two species of now extinct birds which formerly occurred in Virginia. Both the passenger pigeon and Carolina parakeet were reported in Virginia. Although there appear to be no documented records of the great auk in the state, the wintering area for the species extended along the coast to Florida, and it is likely that it infrequently appeared in the coastal waters of Virginia.

At least three species -- the peregrine falcon, roseate tern, and Bachman's sparrow -- appear to have been extirpated as breeding species within the state. The peregrine falcon currently is listed as an *Endangered* species throughout its range and is treated separately elsewhere. The other two species should be sought for in the state in proper habitats and their status evaluated if found.

A large group of wading species, including the great blue heron, green heron, little blue heron, snowy egret, Louisiana heron, black-crowned night heron, yellow-crowned night heron, least bittern, and American bittern are all associated with habitats which are restricted and which constantly are in danger of destruction or modification. The Committee feels that all of these species are of concern and that populations should regularly be monitored. We have not included many of these species as *Threatened* or *Endangered* unless there is some evidence that the breeding population has suffered a recent decline. Louisiana herons and little blue herons both utilize restricted and similar habitats for nesting, and both utilize the critical coastal zone for foraging. The breeding population of the Louisiana heron is stable or increasing, whereas little blue herons have definitely suffered a population decline in the past 5 to 10 years. Among wading birds, the little blue heron would be a species considered *Threatened* or *Endangered* at the present time.

Similarly restricted nesting habitat is utilized by many beach nesting species such as the American oystercatcher, piping plover, Wilson's plover, black skimmer, gull-billed tern, common tern, least tern, royal tern, and sandwich tern. These birds nest in greatest abundance on the outer barrier islands although increasing numbers are utilizing areas artificially created by the deposition of dredge spoil. In contrast to the situation in North Carolina, most of the population of these colonial species in Virginia breed on the barrier islands which are relatively free of human and vehicular disturbance. Most of these barrier islands in Virginia are under the protective custody of the Nature Conservancy or Federal or State agencies. Despite protection of the islands from developments and other encroachments, these are fragile environments, highly susceptible to tidal inundation and the forces of erosion. In addition, the artificial substrata created by dredge spoil typically undergo vegetative succession, ultimately resulting in their unsuitability as nesting habitat for many sand-nesting species. Some of these species such as the gull-billed tern, least tern, and Wilson's plover are listed because of evidence either of declining populations or poor reproductive success. All of these species should be closely and continuously monitored because of the restricted and unstable nature of their breeding habitat.

A number of species reach the limits of the breeding range in Virginia where they are uncommon. Most of these species do not appear to be in serious trouble in other parts of their breeding range. If the species appears to be a regular established breeder in the state but has shown erratic numbers in recent years, as the sandwich tern, it is included on the list. Bachman's sparrow is not included because of its apparent extirpation.

A number of species have been recorded once or only a few times as breeding birds in the state. In a number of instances, *i.e.*, Swainson's thrush and white ibis, there appears to be very small disjunct breeding populations. Until the populations of these species are consolidated in Virginia, or until their status is better understood, it does not seem feasible to include them as *Threatened* or *Endangered* species at this time.

At least five species of birds which are on the federal list of *Endangered* species occur within the boundaries of Virginia. These species are considered *Endangered* throughout their range. Bachman's warbler has been recorded a few times but must be considered a casual transient or vagrant. The brown pelican has suffered many population declines throughout much of its breeding range, primarily because of reproductive failure. The nearest known breeding colony to Virginia is located near Ocracoke Island in North Carolina. This species occurs in Virginia as a casual vagrant along the Coast, most often between mid-summer and fall. For inexplicable reasons, a relatively large group of at least 25 brown pelicans occurred

at Fishermans Island in the summer of 1977, and a few individuals remained on the Eastern Shore through much of the summer. The origin of these and other visitors of this species is unknown, but in any event the species is not a regular component of the Virginia avifauna and is not included on the Virginia list.

The peregrine falcon, another species on the federal list, has been extirpated as a breeding bird in Virginia. It formerly bred in the mountains of Virginia, and in a few cases, in eastern Virginia. In contrast to Bachman's sparrow, also apparently extirpated as a breeding bird, the peregrine falcon is *Endangered* throughout its range and is included on the Virginia list. In addition, a program currently is underway to attempt to reestablish the peregrine as a breeding species in the state.

The southern bald eagle also is *Endangered* throughout its range. The continental population of this race has been characterized by poor reproductive success and general decline. The Chesapeake Bay population (Virginia, Maryland, Delaware) was estimated to be 250 breeding pairs in 1936. The known breeding population in 1977 was approximately 80 pairs of which 32 pairs occurred in Virginia. In addition, there appeared to be a number of nonbreeding adults as well as some juvenile birds. The Virginia population has not achieved a productivity level adequate to sustain a stable population since at least 1962, although the number of known active nests during that period has remained relatively constant. The southern bald eagle clearly is an *Endangered* species in Virginia and should be monitored carefully in the future.

The fifth *Endangered* species on the federal list which occurs in the state is the red-cockaded woodpecker. It is a species which essentially reaches the northern limit of its breeding range in Virginia, although it does reach the state of Maryland. There are few historical data to suggest either the former distribution or abundance of this species, although there is some evidence that it was earlier a more common species. The species requires stands of mature pine for nesting purposes. Under the present monoculture management for pine and the short harvest rotations, habitat for this species has become a critical limiting factor. The species presently appears to be limited to a few counties south of the James River and as far west as Brunswick County. An extensive survey currently is in progress to determine the status of this species in Virginia. At the present time, the total state population may be no more than 50 individuals, thus making it one of the most *Endangered* breeding birds in the state. Under present patterns of land management and ownership, it does not appear that this species can survive in the Commonwealth except as an isolated remnant population.

The following list of *Threatened* and *Endangered* species probably is a very conservative one. Part of this conservatism derives from a lack of knowledge of the status of many species. In view of the continuing loss and modification of all habitats, nearly every species potentially is a case for *Special Concern*.

The following list, therefore, is only a beginning and reflects the opinions of the Committee with respect to the species of greatest and most immediate concern. There undoubtedly are other species which may be equally threatened by habitat loss or other environmental hazards. This list should only serve as a basis for further study of species.

With many species we have opinions, sometimes subjective, that populations are declining. This only points up the dire need to obtain more field data on species populations in the state. With the possible exception of some of the colonial species, the bald eagle, osprey, and the red-cockaded woodpecker, we do not have substantial information on the population of individual species (reflecting size trends and productivity). There is no other group of vertebrates which provides a greater

opportunity for both professionals and amateurs to gather valuable data on species distribution and populations. We trust that the following list will serve as an inducement for both groups to concentrate efforts on determining the status of individual species. As a result of such effort, many species may be added to the following list, but, hopefully, many may eventually be deleted.

Members of the Committee on Birds included Mitchell A. Byrd (*Chairman*), J. William Akers, Jerry W. Via, Curtis S. Adkisson, Ruth A. Beck, Bill Williams, and F. R. Scott.

* * * * *

ENDANGERED AND THREATENED SPECIES OF BIRDS OF VIRGINIA

Status

SC = Special Concern
 SU = Status Undetermined
 T = Threatened
 E = Endangered

Ciconiiformes

Ardeidae

<i>Ardea herodias herodias</i>	Great Blue Heron	SC
<i>Florida caerulea caerulea</i>	Little Blue Heron	SC
<i>Casmerodius albus egretta</i>	Great Egret	SC
<i>Nycticorax nycticorax hoactli</i>	Black-crowned Night Heron	SC
<i>Nyctanassa violacea violacea</i>	Yellow-crowned Night Heron	SU
<i>Ixobrychus exilis exilis</i>	Least Bittern	SU
<i>Botaurus lentiginosus</i>	American Bittern	SU

Threskiornithidae

<i>Plegadis falcinellus falcinellus</i>	Glossy Ibis	SC
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Falconiformes

Accipitridae

<i>Accipiter striatus velox</i>	Sharp-shinned hawk	T
<i>Accipiter cooperii</i>	Cooper's Hawk	SU
<i>Buteolineatus lineatus</i>	Red-shouldered hawk	SC
<i>Haliaeetus leucocephalus leucocephalus</i>	Southern Bald Eagle	E
<i>Pandion haliaetus carolinensis</i>	Osprey	T
<i>Falco peregrinus</i> ssp.	Peregrine Falcon	E
<i>Falco sparverius sparverius</i>	American Kestrel	T

Gruiformes

Rallidae

<i>Gallinula chloropus cachinnans</i>	Common Gallinule	SU
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Charadriiformes

Charadriidae

<i>Charadrius melodus melodus</i>	Piping Plover	T
<i>Charadrius wilsonia wilsonia</i>	Wilson's Plover	T

Scolopacidae

<i>Bartramia longicauda</i>	Upland Sandpiper	T
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(continued)

Laridae

<i>Geochelidon nilotica aranea</i>	Gull-billed Tern	T
<i>Sterna forsteri</i>	Forster's Tern	SC
<i>Sterna albifrons antillarum</i>	Least Tern	T
<i>Thalasseus maximus maximus</i>	Royal Tern	SC
<i>Thalasseus sandvicensis acuflavidus</i>	Sandwich Tern	SC

Cuculiformes

Cuculidae

<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	SU
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Strigiformes

Tytonidae

<i>Tyto alba pratincola</i>	Barn Owl	SU
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Piciformes

Picidae

<i>Sphyrapicus varius appalachiensis</i>	Yellow-bellied Sapsucker	SU
<i>Dendrocopos borealis borealis</i>	Red-cockaded Woodpecker	E

Passeriformes

Tyrannidae

<i>Empidonax alnorum</i>	Alder Flycatcher	SU
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Hirundinidae

<i>Petrochelidon pyrrhonota pyrrhonota</i>	Cliff Swallow	SC
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Troglodytidae

<i>Thryomanes bewickii altus</i>	Bewick's Wren	T
<i>Cistothorus platensis stellaris</i>	Short-billed Marsh Wren	SC

Turdidae

<i>Sialia sialis sialis</i>	Eastern Bluebird	SC
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Laniidae

<i>Lanius ludovicianus migrans</i>	Loggerhead Shrike	T
<i>Lanius ludovicianus ludovicianus</i>	Loggerhead Shrike	T

Vireonidae

<i>Vireo gilvus gilvus</i>	Warbling Vireo	SC
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(continued)

Parulidae

Dendroica virens waynei

Wayne's Black-throated Green Warbler

SC

Fringillidae

Spiza americana

Dickcissel

SU

Ammodramus savannarum pratensis

Grasshopper Sparrow

SC

Ammodramus henslowii susurrans

Henslow's Sparrow

T

* * * * *

SPECIES ACCOUNTS

ENDANGERED (3)

1. SOUTHERN BALD EAGLE

Haliaeetus leucocephalus leucocephalus
(Linnaeus)Phylum: Chordata
Class: AvesOrder: Falconiformes
Family: Accipitridae

Description: This is a large brownish-black bird of prey, with white head and white tail. Immature birds have both head and tail brownish as is the rest of the body. Some immature birds may have the plumage blotched with white or buff. Attainment of adult plumage is very gradual, the white head and tail usually being achieved by the fifth year, although there may be dark areas on the tail feather shafts for some years thereafter (Brown and Amadon, 1968).

Present Range: This species breeds from northeastern Siberia, northern Alaska, Mackenzie, Manitoba, southeastern Quebec, Newfoundland south to Baja, California, Arizona, New Mexico, southern Texas, the Gulf Coast, and Florida.

Distribution in Virginia: This bird is a breeding species only in the Coastal Plain region of the state. There are more breeding pairs along the Potomac and Rappahannock rivers than anywhere else in the state. Breeding pairs also occur on the York, Pamunkey and Mattaponi rivers, as well as near Mobjack Bay and on the Eastern Shore of Virginia (Figure 1).

Habitat and Mode of Life: This species requires open water and marsh areas for feeding. It also nests within a few miles of water. The preferred nest site appears to be loblolly pine, although some few pairs nest in hardwood trees or other species of pine. It is a diurnal predator with fish comprising a large portion of its diet. Bald eagles are very opportunistic feeders and will feed on a variety of prey items including carrion. Among the prey species are small mammals, waterfowl and turtles. The migration status of the species is not clearly known. There appears to be a post-nesting dispersal of young following fledging. Because of a winter influx of birds into Virginia from other states, the status of adult birds during this season is not known.

Reproduction: Bald eagles build large nests that frequently are used from one nesting season to the next. Some individual pairs often alternate in different years between several nests within the same territory. Nest repair begins in December and eggs usually are laid between mid-February and mid-March. Two eggs are normally laid, sometimes 1 or 3. Females normally incubate, although, at least at some nests, the male may incubate a small part of the time. Incubation time appears to be about 35-37 days. Although there is evidence of some sibling competition, it does not appear to be as severe as with some species of eagles (Maestrelli and Wiemeyer, 1975). Young fledge at about 11 weeks of age, although parents may continue to feed them for a short time after that.

Status: *Endangered.* The southern bald eagle population has declined radically throughout its range, particularly during the past 25 years. Tyrrell (1936) reported on the bald eagle nesting population of the Chesapeake Bay region. Although some of his data are difficult to interpret, it would appear that there were at least 200 pairs, and depending upon interpretation, as many as 800 nesting pairs. In 1936, productivity was calculated to be 1.7

fledglings per active nest. The Chesapeake Bay eagle population reached minimal levels in the early 1960's. Abbott (1963) estimated there were only 32 nestling pairs in the Chesapeake Bay area. Production was estimated to be 0.19 fledglings per active nest with known outcome. Abbott, in conjunction with F. R. Scott, continued eagle nest surveys through the 1960's and early 1970's. In addition, the Virginia Commission of Game and Inland Fisheries and Maryland Wildlife Administration initiated studies of the bald eagle in 1977 and 1978, thus expanding the efforts of Abbott and Scott. In 1977, 33 active nests were located in Virginia (Byrd, 1977). Productivity was 0.54 fledglings per active nest. In 1978, 37 active nests were located in the state (Byrd, 1978b). Productivity was 0.49 fledglings per active nest. Although productivity has improved greatly in two years when compared with the low point in 1963, the Virginia bald eagle population is not reproducing at a level adequate to sustain the population.

Protective Measures Proposed: One of the major factors involved in the decline of the bald eagle in Virginia has been the lowered productivity. Chemical contaminant levels continue high in the tissues of bald eagles (R. M. Prouty *et al.*, 1978). There appears to be a high correlation between high contaminant levels and reproductive failure. Since the ban on the use of DDT in 1973, the productivity of the Virginia bald eagle population has slowly improved. Eagle eggs and tissues from Virginia show high levels of Kepone (unpublished data, Patuxent Wildlife Research Center). Future studies on this species should include an evaluation of the biological role of Kepone. There presently appears to be more available nesting habitat than breeding birds to occupy that habitat. Ever increasing development of the shorelines of the waterways of Virginia may ultimately seriously reduce foraging and breeding habitat. Extensive studies of the habitat requirements of the species in Virginia should be conducted in order to develop management plans for each individual nest site. An ultimate objective might be the development of cooperative agreements between landowners and the state to insure protection of nesting habitat.

Author: Mitchell A. Byrd.

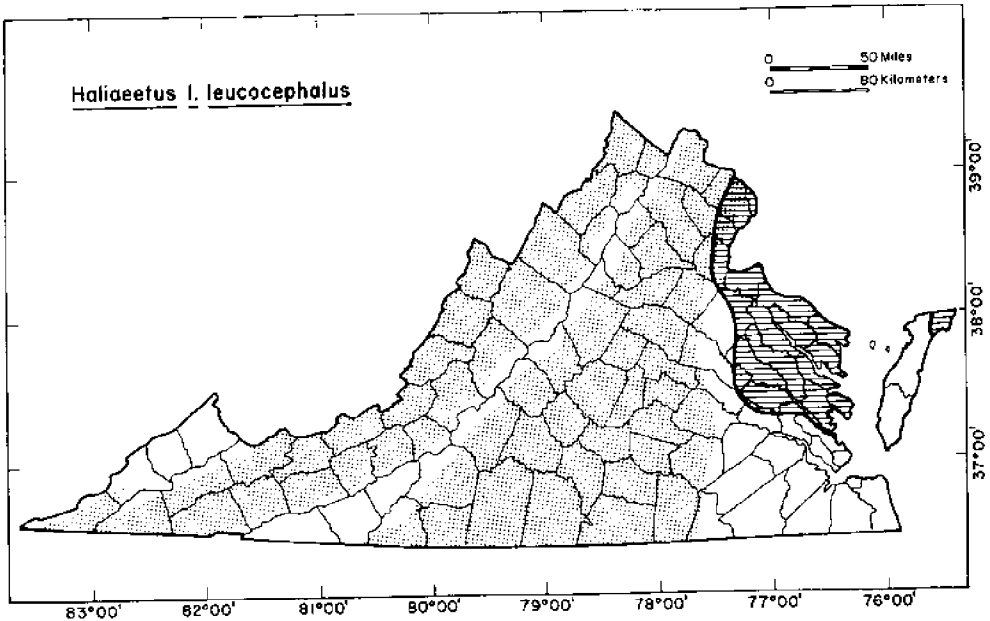


Figure 1. Distribution of Bald Eagle (*Haliaeetus leucocephalus leucocephalus*) in Virginia

2. PEREGRINE FALCON

Falco peregrinus ssp.

Phylum: Chordata
Class: Aves

Order: Falconiformes
Family: Falconidae

Description: Peregrines may be described as medium to large size falcons; slaty or blue gray above; normally without chestnut on the nape; white below, narrowly barred in adult, and streaked in the immature. Area around eyes, a broad moustachial streak, and ear coverts blackish; a small grayish-white patch between moustachial stripe and ear coverts. Eyes brown, cere and orbit yellow, tinged greenish. Adult female often darker on lower back and rump; breast often more heavily barred than in male. (Brown and Amadon, 1968).

Present Range: This species is practically cosmopolitan with 18 races being described from various parts of the world and breeding occurring on all continents and on many island groups. The northern races migrate in winter to tropical or subtropical climates.

Distribution in Virginia: The race *anatum* formerly nested in Virginia but has been extirpated as a breeding bird in Virginia as well as in eastern United States. It originally nested in limited numbers in the mountain and tide-water areas of the state. Murray (1952) listed the bird as breeding in Shenandoah National Park with eggs on April 14, 1946; a few nesting sites from the Shenandoah Valley; young on the wing, June 22, 1947, at Mountain Lake;

and a pair which nested regularly on a cliff on New River below Radford, until they were shot in 1933. Jones (1946) reported two occupied nests not far from the coast. Jones (unpublished data), an oologist, reported collecting several clutches of peregrine eggs from nests in Rockingham County between April 4, 1934 and April 26, 1934.

Habitat and Mode of Life: The peregrine originally nested in Virginia in nests located on rocky cliffs. Cliff sites are used by all races of peregrines when available. Some birds nest on the ground in the tundra. Two tree nests have been reported from Virginia (Jones, 1946). Prey consists chiefly of birds, the smaller races killing passerines down to the size of small finches, the larger races killing birds up to the size of wild duck and small geese. The great majority of prey is taken on the wing, either by a direct stoop or by a long chase in which the peregrine repeatedly stoops at the quarry.

Reproduction: Courtship entails vigorous and elaborate nuptial flights. The same nesting site may be used for many years in succession. The falcons make no nest, and use only a scrape or sometimes appropriate the nest of another species. Two to five eggs, occasionally six, are laid at two- to three-day intervals, three or four being the normal clutch for most races. Incubation begins with the second or third egg as a rule, and, in any case, before the completion of the clutch. Young hatch after an incubation period of 28 to 29 days.

Status: *Endangered*. This species is considered endangered throughout its North American range. The race *anatum*, which formerly bred in Virginia, occurs in limited numbers in other parts of the country. Despite occasional reports of breeding peregrines in the mountains of Virginia, none of these records has been verified. The peregrine occurs as a fairly common transient in the fall with peak numbers being seen on the Eastern Shore, particularly on Assateague Island. Some birds winter in the state, most commonly on the Eastern Shore and in the Tidewater. It is likely that transient and wintering birds belong to the race *tundrius*.

Protective Measures Proposed: Efforts should be made to eliminate illegal trapping of passage peregrines during the fall migration. Although illegal, this practice may still continue in certain areas. In 1978, the Virginia Commission of Game and Inland Fisheries in collaboration with the Peregrine Fund of Cornell University established a hacking station for peregrine falcons on Cobb Island off the eastern shore of Northampton County. This program should be continued and expanded in an effort to reestablish the peregrine falcon as a breeding bird in the state.

Author: Mitchell A. Byrd.

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3. RED-COCKADED WOODPECKER

Picoides (=Dendrocopos) borealis borealis
(Vieillot)

Phylum: Chordata
Class: Aves

Order: Piciformes
Family: Picidae

Description: This small woodpecker is somewhat larger than the common downy woodpecker. It measures 7 to 8-1/2 inches in length. In the male, the top of the head is black; a patch of white on the cheeks; back and wings black with cross bars of white; underparts dull white, with black spots on sides;

a red streak on each side of head above ear. The female is like the male but lacks the red streaks on the head.

Present Range: Breeding range extends from Virginia to Florida; west in the southern states to southeastern Texas and northeastern Oklahoma. Occurs in small numbers in Kentucky (Mengel, 1965). Meanley (1943) reported the species breeding in Maryland but it appears absent from that state at the present time as a breeding bird.

Distribution in Virginia: A comprehensive survey of the distribution of this species in the state was conducted from 1976-1978 (Byrd, 1978b). Cavity trees of the species were located in Virginia Beach, Southampton, Isle of Wight, Surry, Sussex, Brunswick and Prince George counties. Birds were observed only in Isle of Wight, Sussex and Prince George counties, with nesting verified only in Sussex County (Figure 2).

Habitat and Mode of Life: The species nests primarily in living pine. Steirly (1957) found that nest sites always were in pine stands of the 70-year-old age class or older, and that trees used for the excavation of cavities were almost always infected with red heart fungus (*Fomes pini*). Nest holes observed by Steirly ranged from 23.6 feet to 50 feet above the ground. The species characteristically drills nest holes in living pine trees. The deliberate chipping of numerous horizontal wounds above and below the hole is characteristic behavior of this species. In active nest trees, these are kept open so that sticky, fresh resin exudes from the hole. Although old trees are preferred for nesting, the species does use young pine plantations for foraging (Byrd, 1978b).

Reproduction: Nesting begins in Virginia in May. Each of four clutches observed contained three eggs (Byrd, 1978b). Ligon (1970) reported that birds in Florida laid an average clutch of 3.3, based on six clutches, with a total of 19 of 20 eggs hatching. The earliest egg laid in his study was April 21 and the last on June 4. He also reported the very short incubation period of 10 days for the species. Feeding of young by non-breeding individuals frequently has been reported for this species.

Status: *Endangered*. Steirly (1957) reported the occurrence of a number of cavity trees in Southampton, Isle of Wight, Sussex, Prince George, and Greenville counties. Many of these sites since have been logged. Murray (1952) summarized other records from Virginia, including sightings in Brunswick County, Norfolk, Swift Creek near Richmond, Dinwiddie County, and, surprisingly, Albemarle County. Extensive surveys from 1976-1978 (Byrd, 1978b) revealed a number of sites with one or more cavity trees. Sussex County contains more sites (32) than any other county. In 1977, red-cockaded woodpeckers were seen in the vicinity of 16 of these 32 sites, and more than one bird was observed at 9 of the 16 sites. However, in 1978, birds were seen at only 9 of the sites, and pairs were observed at only 3 of the 9 sites. In 1977, nesting was actually observed at 6 of the 16 active sites but in 1978 nesting was noted at only 2 sites. Four sites with one or more cavity trees were found in Surry County in the winter of 1978, although no birds were seen at these sites in the subsequent breeding season. Five sites were discovered in Isle of Wight County. Although red-cockaded woodpeckers were seen at two of these sites, no nesting activity was observed. One site each was discovered in Prince George County and Southampton County. Three birds were seen in Prince George County in 1977, although an active nest tree was not found. Based on the number of cavity tree sites discovered in Surry, Sussex, Isle of Wight, Southampton, and Prince George counties, the population could be as high as 95 individuals. This maximum number seems unlikely at the present time because of the large number of abandoned sites. The present population probably is less than 50 individuals.

Protective Measures Proposed: This may be the most endangered species in the state. Available nesting habitat continues to disappear at an alarming rate, including many areas presently occupied by the species. It is imperative that sanctuaries of several hundred acres each of mature loblolly pine be established for this species. Areas must be selected which presently contain birds since it is unlikely that birds would be recruited from elsewhere. In the absence of such areas, the species cannot long survive in the state.

Author: Mitchell A. Byrd.

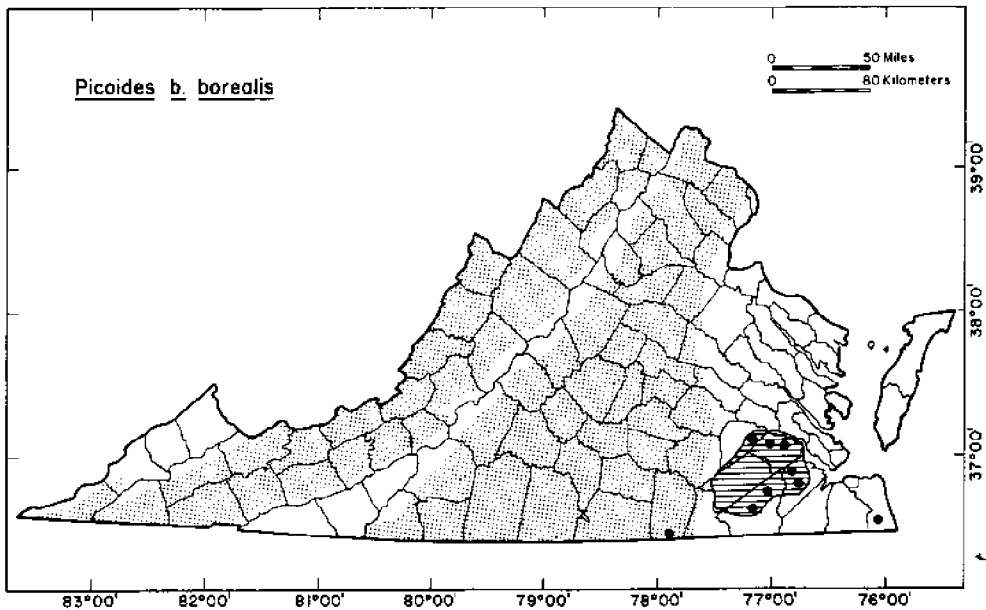


Figure 2. Distribution of Red-Cockaded Woodpecker (*Picoides borealis borealis*) in Virginia

Threatened (11)

1. SHARP-SHINNED HAWK

Accipiter striatus velox (Wilson)

Phylum: Chordata
 Class: Aves

Order: Falconiformes
 Family: Accipitridae

Description: This is the smallest accipiter; separated in the field from the larger Cooper's hawk -- which it greatly outnumbers during migration -- by its narrower and more square-cut tail (Robbins *et al.*, 1966; Bent, 1937).

Present Range: All of North America to northern Canada and throughout Alaska. Winters in Central America (Bent, 1937).

Distribution in Virginia: An abundant fall migrant along the Eastern Shore, becoming less common inland. Common fall migrant through the mountains and valleys. Uncommon throughout the state in winter. This species has nested in Virginia on a very limited basis from Tidewater to the mountains.

Habitat and Mode of Life: The sharp-shinned hawk prefers open woods, hedgerows, bushy pastures and shore lines where it stalks small birds for food by day. For nesting, it prefers dense stands of pines or other evergreens (Bent, 1937).

Reproduction: Breeding commences as early as May 5 and may continue throughout July. During that time only one brood is raised. The average clutch size is 4 eggs and incubation lasts 21 to 24 days. Adult plumage is achieved after the second summer's postnuptial molt.

Status: *Threatened*. Not only does this species suffer due to lack of appropriate nesting habitat in Virginia but, like all birds of prey, can suffer the ill effects of pesticide residues in eggs. This simply furthers the decline of breeding efforts. At present there is little or no reliable information on the total breeding population (if any) and where these birds breed within the state.

Protective Measures Proposed: A concerted effort should be made to locate all breeding sharp-shinned hawks statewide. A detailed analysis of their nesting habitat preference should be conducted and, once completed, an inventory of similar areas throughout Virginia should be catalogued and monitored. Further, efforts to control the use of pesticides should be continued and the public educated to the benefits derived from birds of prey.

Remarks: Locally, the sharp-shinned hawk is referred to as "chicken-hawk" or "bird hawk."

Author: Bill Williams.

2. OSPREY

Pandion haliaetus carolinensis (Gmelin)

Phylum: Chordata
 Class: Aves

Order: Falconiformes
 Family: Pandionidae

Description: This is a relatively large hawk, essentially the size of a small eagle. The wings are long and rather narrow. The lower surface of the toes is covered with sharp spicules. Feathers of the nape are pointed and somewhat elongated. The osprey is approximately 32 inches in length with a wingspread of 54 inches. The adult is characterized by dark plumage on the back; hind crown and nape buff; and a broad black line through the eye to the hind neck, separating the pale nape from the pale throat. Below, chin and throat white, finely streaked with dark brown. Lower throat and breast pale brown or rusty, forming a pectoral band. Rest of underparts white. Young are similar to the adult, but more streaky above; feathers of upperparts tipped with white or buff (Brown and Amadon, 1968).

Present Range: The osprey is almost cosmopolitan in its distribution, although it is rarer in the Southern Hemisphere and does not appear to breed regularly there except in Australia and adjacent islands. North American populations migrate to the Caribbean and South America for the winter months.

Distribution in Virginia: This species occurs as a breeding bird only in Tidewater Virginia. It occurs regularly along most of the streams of the Tidewater with the exception of the James River, where it is sporadic in occurrence. It also occurs regularly on the entire Eastern Shore, including both the ocean and Chesapeake Bay islands (Figure 3).

Habitat and Mode of Life: This species nests either close to water or on man-made structures over water. In recent years ever increasing numbers of pairs have shifted from natural nesting sites to man-made nesting sites (Seek, 1977). Natural nest sites include living and dead pine, cypress and hardwood trees. The diet consists almost exclusively of fish which are captured by diving into the water. Other prey items such as small mammals are very infrequently captured.

Reproduction: Ospreys build large nests of twigs and sticks, often using the same nest site for a number of years. Eggs are laid between late March and late April, with the peak of egg-laying occurring about April 15. Clutch size ranges from 1 to 4 eggs, with an average of 2.86 (Kennedy, 1971). Although broods of four occur, they are uncommon. Since incubation begins with the first egg, hatching of young is asynchronous. Young birds fledge at about seven weeks, although they may be fed some while longer by the parents (Stinson, 1976). Young birds normally do not breed until the third year.

Status: *Threatened.* This species has declined over much of its North American range (Henny, 1977). In Virginia, the population may have declined by as much as 79% since the pre-1947 period (Stinson and Byrd, 1976). Henny and Wight (1969) have indicated that it requires 1.22 fledglings per active nest to maintain a stable population. Kennedy (1971) found a production of only 0.96 fledglings per active nest in his Virginia study areas in 1970, and this declined to 0.69 fledglings per active nest in 1971. Seek (1977) showed an increase in productivity in these same areas to 0.74 and 0.98 fledglings per active nest in 1972 and 1973, respectively. Byrd (unpublished data) had found that the productivity increased to 1.41, 1.27, 1.62 and 1.28 fledglings per active nest in 1974, 1975, 1976 and 1977, respectively. It appears that the Virginia osprey population now is reproducing at a rate adequate to sustain a stable or slightly growing population.

Protective Measures Proposed: There has been a definite trend toward off-shore nesting by ospreys in Virginia. Off-shore nest sites include a variety of man-made structures such as duck blinds, pilings, and artificial nesting platforms. Over one-half of the nesting ospreys in Virginia currently utilize Coast Guard navigational aids as nest sites (Byrd, unpublished data). The presence of nesting birds on these structures undoubtedly obstructs maintenance activity. Cooperative management of ospreys on these navigational aids is in effect between the Coast Guard and the various resource management agencies. In view of the importance of these structures, it is essential that this cooperation be maintained. A continued ban on the use of DDT and related chlorinated hydrocarbon pesticides is necessary in order for this species to show continued improvement in productivity.

Author: Mitchell A. Byrd.

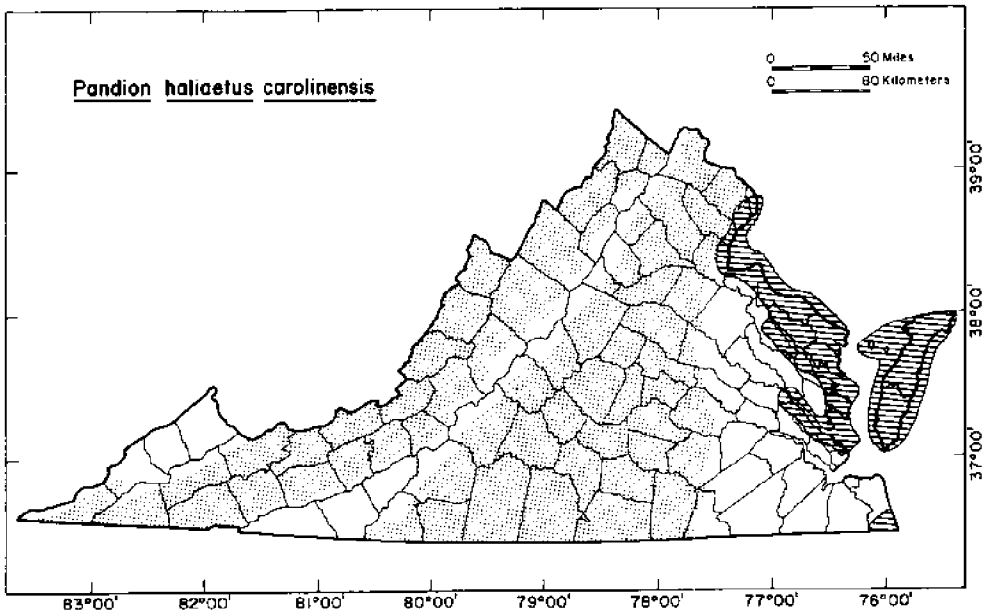


Figure 3. Distribution of Osprey (*Pandion haliaetus carolinensis*) in Virginia

3. AMERICAN KESTREL

Falco sparverius sparverius Linnaeus

Phylum: Chordata
Class: Aves

Order: Falconiformes
Family: Accipitridae

Description: This is the smallest of our falcons. Its distinctive color pattern is well-known to most observers. See Robbins *et al.* (1966) for a full description and illustration.

Present Range: Breeds over most of North, Central, and South America south of the tundra. During the winter the bird withdraws somewhat from the most northern part of its range.

Distribution in Virginia: Permanent resident over entire state. Generally uncommon in summer but still common to abundant as a transient and winter resident, especially near the coast.

Habitat and Mode of Life: This bird prefers open or partially-open country, including agricultural fields and salt marshes. It is also found frequently in built-up urban areas.

Reproduction: The American kestrel prefers a natural or artificial cavity for its nest, only rarely utilizing the open nest of another bird. Four to five eggs are the usual clutch size. In Virginia these birds often nest in urban situations, and nests have been found on office and apartment buildings, churches, and private homes. Eggs have been found as early as March 31 and as late as August 4 (J. J. Murray, 1952).

Status: *Threatened.* Although still to be found in good numbers in migration and during the winter, this species has declined dramatically as a breeding bird in the state over the last 25 years. Although the reasons for the decline are in doubt, the increase in the use of agricultural chemicals is thought to have a bearing on the problem.

Author: F. R. Scott.

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4. PIPING PLOVER

Charadrius melodus melodus Ord

Phylum: Chordata
Class: Aves

Order: Charadriiformes
Family: Charadriidae

Description: This is a small plover about 5 inches in length with a pale sandy-colored back. Males have a single, often partial, black neck band. Both sexes have yellow legs and a yellow bill.

Present Range: Breeds on coastal beaches from southeastern Quebec, southwestern Newfoundland and southern Maine south through Virginia. An inland race (*Charadrius melodus circumcinctus*) breeds in the Midwest from central Alberta and southern Manitoba south through northeastern North Dakota, southeastern South Dakota and central Nebraska.

Distribution in Virginia: This species is restricted as a breeding bird to only two counties of eastern Virginia (Accomack and Northampton) and the city of Hampton, Virginia (Bailey, 1913; Akers, 1975) (Figure 4).

Habitat and Mode of Life: The piping plover is an inhabitant of broad sandy dunes which are relatively undisturbed (Bent, 1927). It feeds on crustaceans,

insects and seeds which it gleans from the dry sandy areas of the beaches. It is a migratory species and arrives on the breeding ground in early May and departs for the wintering grounds in late September.

Reproduction: The piping plover makes a shallow scrape in the sand for a nest. The nest almost always contains 4 eggs. Nesting may last from mid-May to late July, but only one brood is raised annually. The young are precocial and spend most of their time feeding in the vegetated areas of the sandy dunes.

Status: *Threatened*. This is a declining breeding species in Virginia. The species was virtually wiped out in Virginia by the spring and fall gunning during the early 1900's. Populations have not since recovered. The development of the sandy Grand View beaches on the Chesapeake Bay in Hampton, Virginia will probably eliminate this species as a breeding bird on the Chesapeake Bay. Only the populations on the barrier islands of Virginia are assured of undisturbed breeding areas. The piping plover has been included on the "Blue List" -- a list of potentially *Endangered* species published by the National Audubon Society (Arbib, 1976). This list is a consensus of bird population experts throughout the country. Approximately 90% of the experts were in favor of retention of the piping plover on the "Blue List" for 1977.

Protective Measures Proposed: Continued protection of the barrier islands of Virginia is essential for the breeding of this species. It is unlikely that any new, sufficient habitat could be generated or maintained on the Chesapeake Bay.

Author: Jerry W. Via.

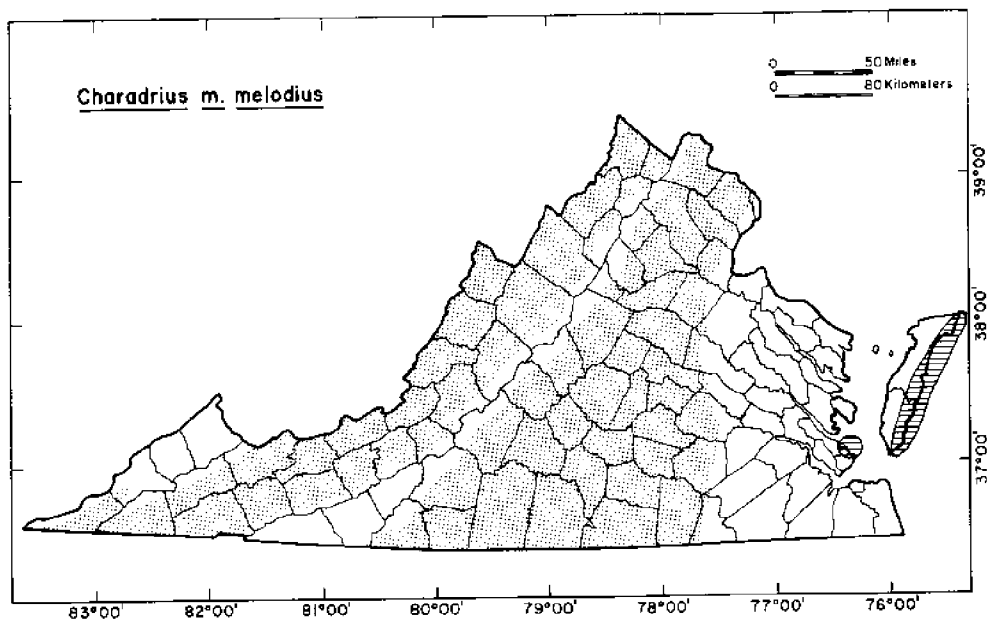


Figure 4. Distribution of Piping Plover (*Charadrius melodius melodius* in Virginia)

5. WILSON'S PLOVER

Charadrius wilsonia wilsonia Ord

Phylum: Chordata
 Class: Aves

Order: Charadriiformes
 Family: Charadriidae

Description: This is a medium-sized plover approximately 6 inches in length. It has a gray-brown back and a white belly, and in the male, a wide black neck band. The most distinctive feature is the heavy black bill. This species is more erect in posture and noticeably larger than the small plovers.

Present Range: This species breeds from central Baja California, Central Sonora and the Gulf Coast of the United States along both coasts of Mexico and Central America to Columbia and Peru; also from southern New Jersey to Florida and through the West Indies to Venezuela and British Guiana.

Distribution in Virginia: Found as a breeding bird on the barrier islands of Accomack and Northampton counties (Figure 5).

Habitat and Mode of Life: This species prefers rather broad, sandy, undisturbed beaches and mudflats which contain shells for its breeding and foraging areas (Bent, 1927). It feeds at or near the tide line on the beach where it gleans small crustaceans, molluscs and flies from the moist sand. It is a solitary species and usually does not forage with other beach dwellers. This is a migratory species which arrives on the breeding grounds in late April and departs for the wintering grounds in mid-to-late September.

Reproduction: Nests are very simple scrapes on elevated areas of beaches. A substrate with a mixture of sand and shells is preferred to one of just sand. A clutch of eggs usually consists of 3 eggs. The bird nests between early May and late June. Only one brood is reared annually. The young are precocial and leave the nest soon after hatching.

Status: *Threatened*. Like the piping plover, this species was virtually extirpated by gunners in the early 1900's. Recent loss of the nesting habitat due to development has restricted this species to the barrier islands of Virginia.

Protective Measures Proposed: Continued maintenance of the pristine nature of the barrier islands of Virginia is necessary to ensure future breeding populations of this species.

Author: Jerry W. Via.

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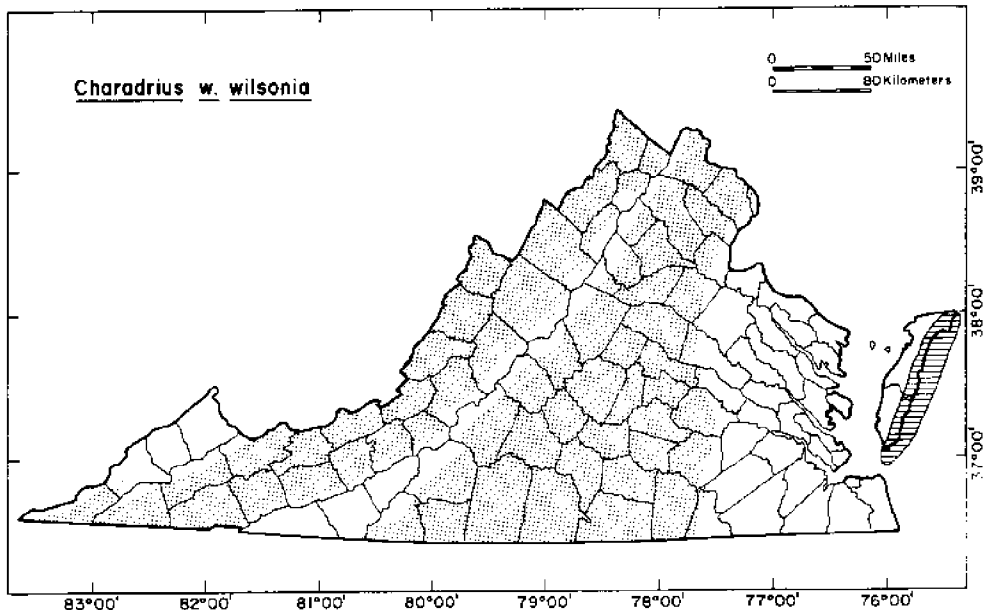


Figure 5. Distribution of Wilson's Plover (*Charadrius wilsonia wilsonia*) in Virginia

6. UPLAND SANDPIPER

Bartramia longicauda (Bechstein)

Phylum: Chordata
Class: Aves

Order: Charadriiformes
Family: Scolopacidae

Description: This large, attractive sandpiper of the open fields is well-known where it occurs. See Robbins *et al.* (1966) for description and illustration.

Present Range: Breeds locally from central Alaska and Maine south to Oregon; in the northern Great Plains states, the central Midwestern states, and western Virginia. Winters in southern South America.

Distribution in Virginia: Currently known as a breeding bird only locally on the northern Piedmont in Loudoun County. Scarce as a spring migrant but locally common in late summer as a fall migrant, principally on the Coastal Plain (Figure 6).

Habitat and Mode of Life: Rich pastureland and hayfields are the preferred nesting habitat of this species, though in migration it is also found in grainfields, on golf courses and airfields.

Reproduction: This bird nest in a hollow in the ground, usually lined with a bit of grass, and lays 4 eggs. Eggs are usually laid in May. J. J. Murray (1957) recorded 2 eggs and 2 downy young in a nest in Rockbridge County on May 27, 1935.

Status: *Threatened*. This species was formerly a common summer resident in the Great Valley of Virginia south at least to Montgomery County (J. J. Murray, 1952 and 1957; J. W. Murray, 1974). The last nest was reported in Montgomery County about 1960, and there have been no records here since 1965 (J. W. Murray, 1974). It is not currently known as a summer resident in the Great Valley, and the size and extent of its present breeding population in Loudoun County are unknown. Changing land-use patterns obviously have had an effect but there is still plenty of suitable unoccupied habitat in this bird's former breeding range. The change in this bird's breeding range in this state may merely be typical of what occurs along the edge of a bird's range.

Author: F. R. Scott.

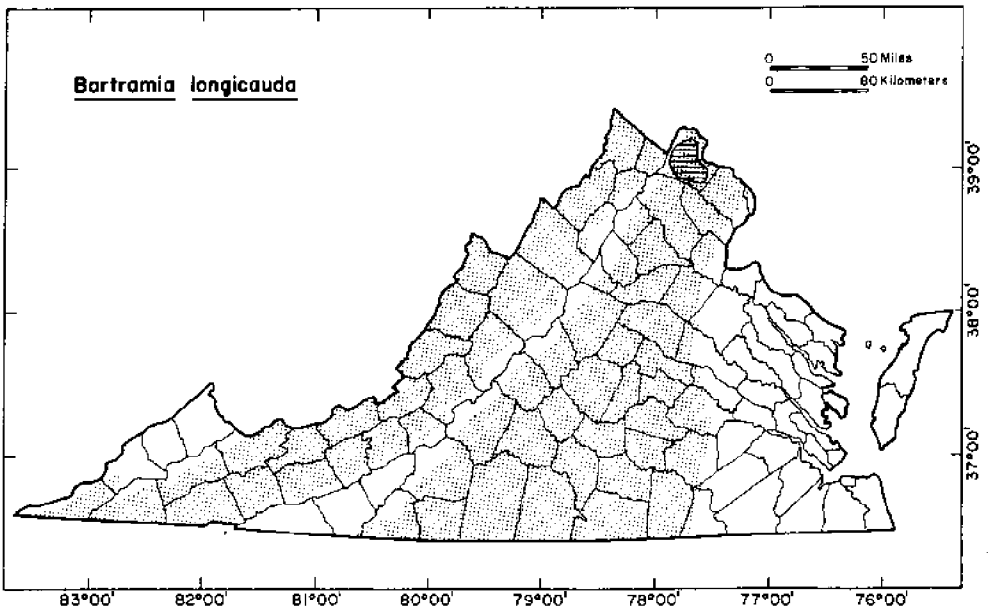


Figure 6. Distribution of Upland Sandpiper (*Bartramia longicauda*) in Virginia

7. GULL-BILLED TERN

Gelochelidon nilotica aranea
(Wilson)Phylum: Chordata
Class: AvesOrder: Charadriiformes
Family: Laridae

Description: This species is distinguished from other intermediate-sized terns by its heavy black bill and its habit of feeding by hawking insects. See Robbins *et al.* (1966).

Present Range: Breeds on all continents except Antarctica. In North America the gull-billed tern breeds from Maryland south along the coast to Florida and along the Gulf to Texas. For further details see *Check-list of North American Birds*.

Distribution in Virginia: The gull-billed tern is found on the Eastern Shore. All known breeding colonies are on the barrier islands. The largest concentrations in the last few years have been on Metomkin, Smith, Myrtle, and Hog islands. Approximately 1000 pairs were found in 1977, as compared with nearly 2000 pairs in 1975 (J. W. Williams, pers. comm.) (Figure 7).

Habitat and Mode of Life: Breeds on the higher areas of beaches and over-washes usually near the dunes. See Bent (1921).

Reproduction: Gull-billed terns build a nest simply by scraping out a depression in the sand and lining it with bits of shell and/or dead vegetation. The amount of lining is variable. Clutch size ranges from 2 to 5 eggs with 3 or 5 the most common (Bent, 1921).

Status: *Threatened*. The breeding population of the gull-billed tern has been reduced by nearly one-half from 1975 to 1977. No explanation is readily apparent. The common tern (*Sterna hirundo*) and the black skimmer (*Rhyncoops nigra*) are two species which nest in mixed colonies with the gull-billed tern, but the numbers of these species have remained stable during the same period. There is also concern for the breeding habitat of this species.

Protective Measures Proposed: Preservation of adequate breeding habitat is essential. This species should be studied closely to try to determine the factor or factors causing the rapid decline in its numbers. One possible factor may be the impact of agricultural pesticides on fertility, since this species relies more heavily on insects than other species of terns.

Author: J. William Akers.

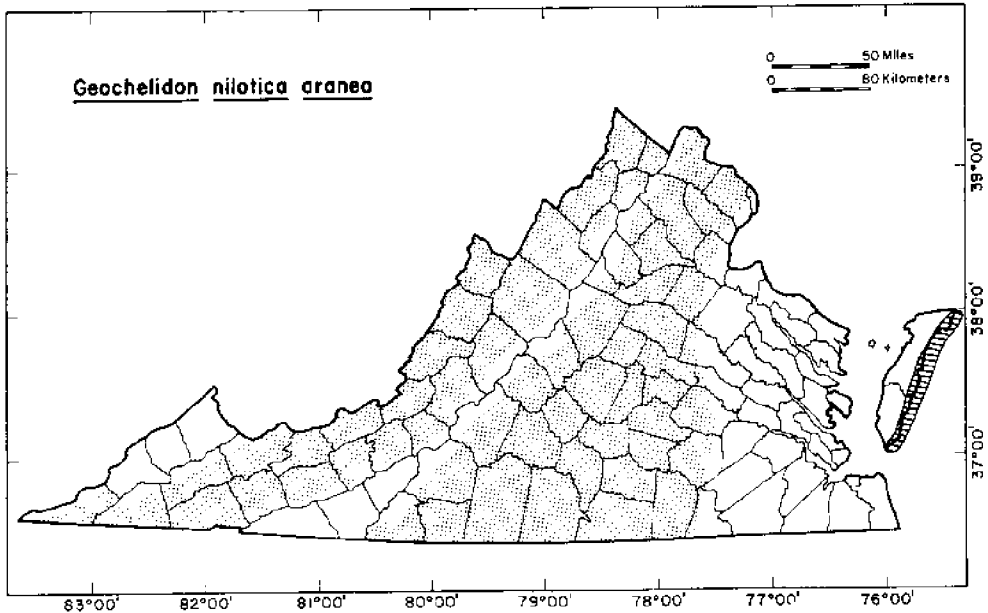


Figure 7. Distribution of Gull-Billed Tern (*Gelocheidon nilotica aranea*) in Virginia

8. LEAST TERN

Sterna albifrons antillarum (Lesson)

Phylum: Chordata
Class: Aves

Order: Charadriiformes
Family: Laridae

Description: The smallest of the terns. See Robbins *et al.* (1966).

Present Range: Breeds on all continents, except Antarctica, and in parts of the West Indies and East Indies. There are three subspecies in North America. *Sterna albifrons browni* (Mearns) occurs on the Pacific Coast. *Sterna albifrons athalassos* (Burleigh and Lowery) breeds along some of the major river systems of the interior -- especially the Mississippi. *Sterna albifrons antillarum* (Lesson) ranges along the Atlantic and Gulf coasts from Massachusetts to Texas.

Distribution in Virginia: Small scattered colonies occur on virtually all of the barrier islands of the Eastern Shore. There are a few breeding sites on the bay side of the Eastern Shore and a small colony was located on Watts Island in the Chesapeake Bay in 1975. Least terns also breed in Tidewater. The largest colonies are located at the north end of Grand View Beach in Hampton and at the U.S. Army Corps of Engineers disposal area at Craney Island in Portsmouth. Colonies formerly existed at Cape Henry and Sandbridge, but the current status of these is unknown. Least terns also formerly nested on beaches and spoil areas of the major river systems in Tidewater. The Virginia breeding population probably ranges between 600 and 800 pairs (Fig.8).

Habitat and Mode of Life: Broad, flat exposed areas are the primary nesting habitat for the least tern. Most colonies are found on beaches and over-wash areas, but some are found in spoil areas or similar locations with sandy substrate and sparse vegetation.

Reproduction: The least tern is loosely colonial. The nest is a depression scraped in the sand. It may or may not be lined with bits of shell or pebble. Clutch size ranges from 1 to 4 eggs with 2 being the average. Incubation lasts 22 days in most cases. Fledging occurs in 20 to 22 days (Akers, unpublished thesis).

Status: *Threatened*. Although this species initially staged a successful comeback after nearly being extirpated by plume hunters in the late 19th century, it has begun to decline again in recent years. The California subspecies is already *Endangered* and the eastern least tern appears to be declining throughout its range, including Virginia. The most obvious problem is the loss of nesting habitat due to extensive real estate development along beaches and coastal islands on the eastern seaboard. Even where such habitat remains, colonies are subject to serious disruption by human recreational activities. This is a greater problem for this species than for other terns because least terns often utilize sites that are more accessible to humans. Another possible problem which warrants closer examination is the threat of increasing depredation of eggs and young by burgeoning populations of certain species of gulls, such as the herring gull and great black-backed gull.

Protective Measures Proposed: Protection of remaining nesting habitat from development and disruption during the breeding season is absolutely essential.

Author: J. William Akers.

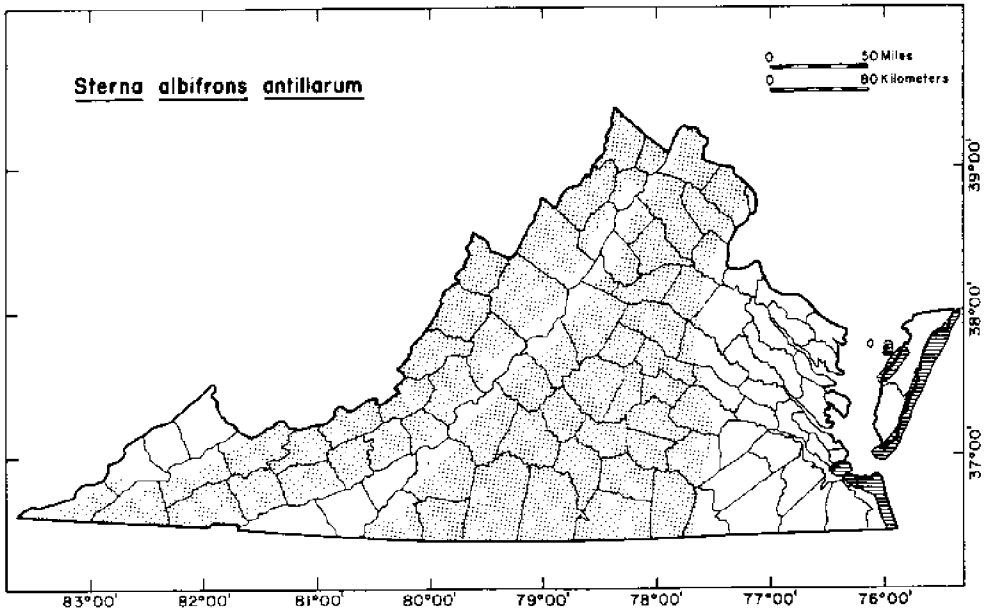


Figure 8. Distribution of Least Tern (*Sterna albifrons antillarum*) in Virginia

9. BEWICK'S WREN

Thryomanes bewickii altus Aldrich

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Troglodytidae

Description: Brown above, with faint darker brown barring on wings. Head dark brown with conspicuous white line above eye. Entirely dingy white below, without markings, except on crissum. Tail longest of our Virginia wrens, with white terminal edges. See pages 222-223 in Robbins *et al.* (1966).

Present Range: The species breeds from southwestern British Columbia, central Washington, southeastern Nebraska, southern Wisconsin, southern Michigan, southern Ontario, central Pennsylvania and Virginia, south to southern Baja California, Puebla, and the northern Gulf states. Winters south to southern Florida and the Gulf Coast.

Distribution in Virginia: Bewick's wren breeds mainly in the mountainous counties of western and southwestern Virginia. In winter its distribution is largely unknown, with only a few records from scattered localities around the state. Carroll and Hostetter (1933) considered it common at Mountain Lake, where it has seldom been reported in recent years. Since 1933, when Brown recorded 10 birds at Whitetop Mountain, the Rogers-Whitetop high country in Smyth and Grayson counties has produced more observations than anywhere else in the state (Brown, 1933; J. J. Murray, 1936; Scott, 1975; personal observations by the author, 1976-78 at Elk Gardens). The species has also been reported in summer in Montgomery County (Conner, Adkisson and Lucid, 1975) and in Prince William County (Ake and Scott, 1975). Other summer reports come from Highland, Madison, Nelson and Washington counties (Stevens, 1976) (Figure 9).

Habitat and Mode of Life: The species occurs in farmyards, fencerows, and brushy habitats. In the high mountains it is often found in clearings with some second growth, as is typical of much mountain pastureland. Occasionally it is found around extensive rock outcroppings in the middle of extensive stands of forest (Stevens, 1976). It nests in cavities in logs, fence posts, around old buildings, or in a bird box. There is some evidence that the species suffers from interspecific competition for nest sites with Carolina (*Thryothorus ludovicianus*) and house (*Troglodytes troglodytes*) wrens (Bent, 1948).

Reproduction: The breeding season in Virginia is probably from May through July. Fresh eggs were found at Blacksburg on 18 May 1974 (Conner, Adkisson, and Lucid, 1975). The normal clutch size is 5 to 7 eggs (Bent, 1948). Incubation lasts about 2 weeks, and the young fledge after 2 weeks more. Two broods may be raised, three in the deep South and Southwest (Bent, 1948).

Number in Captivity: Unknown.

Status: *Threatened.* Throughout the eastern states this species is markedly less abundant than formerly and, consequently, is presently on the *American Birds* "Blue List" (Arbib, 1976), even though there is no indication of trouble with the western populations. We know that the bird is less abundant than formerly (Arbib, 1976; J. W. Murray, 1974) and even though man may not be blamed for the species' decline, intensive observation in the future is justified.

Protective Measures Proposed: At this time, there are no known means of increasing size of populations of this species.

Author: Curtis S. Adkisson.

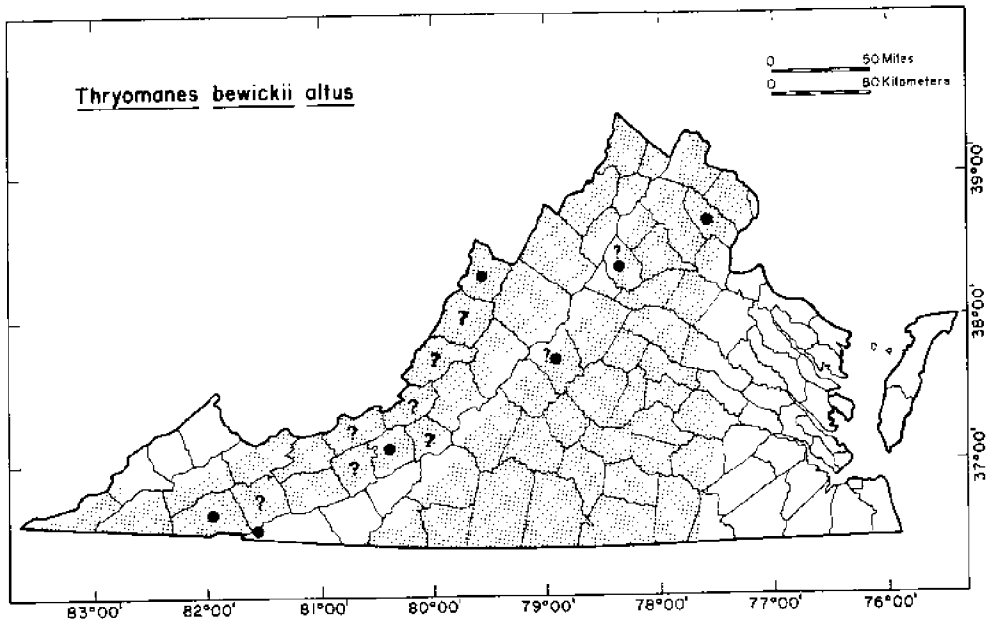


Figure 9. Distribution of Bewick's Wren (*Thryomanes bewickii altus*) in Virginia

10. LOGGERHEAD SHRIKE

Lanius ludovicianus ludovicianus (Linnaeus)
Lanius ludovicianus migrans (Palmer)

Phylum: Chordata
 Class: Aves

Order: Passeriformes
 Family: Laniidae

Description: One of two North American members of the shrike family. This species is smaller than a robin and is gray above and white below. There is a prominent black stripe through the eye. The wings are black with a white patch in the middle of each. The tail is black with most of the feathers tipped in white.

Present Range: From southern British Columbia east to southern Quebec and south-central Maine; south to Baja California, Oaxaca, Mexico, the Gulf Coast and southern Florida.

Distribution in Virginia: The northern subspecies, the migrant shrike (*Lanius ludovicianus migrans*) reaches its southern distributional limit in northern Virginia and Maryland, but extends south along the Appalachians to western North Carolina. An uncommon resident in the mountains and valleys (Pearson *et al.*, 1942). The southern subspecies, the loggerhead shrike (*Lanius ludovicianus ludovicianus*) reaches its northernmost distributional limit in central (Charlottesville) and eastern Virginia. It is a fairly common species in south-central and southeastern Virginia (Figure 10).

Habitat and Mode of Life: This species is associated with open areas where there is scattered brush. Therefore, it frequents such areas as hedgerows, the margins of woods, roadsides, or other edge types in agricultural areas. It typically sits on exposed perches such as telephone wires, fences, poles and treetops, where it scans the ground for prey. Its diet consists of 68% insects, the majority of which are orthopterans and coleopterans (Bent, 1950). The remainder of the diet consists of spiders (4%) and vertebrates (28%), which often include mice, frogs, small birds and fish. Shrikes dispatch their prey by repeated blows to the head with their strong bills. This species reportedly can carry in flight items greater than its own body weight. Because its feet are not raptorial, the shrike impales its prey on thorns, barbed wire or other sharp objects to facilitate handling. This name has given the bird the local name of "butcher bird." A thorough account of the biology of this species may be found in Miller (1931) and Bent (1950).

Reproduction: Both subspecies of the loggerhead shrike nest from early to mid-May in Virginia. They construct their nests in areas of dense twig growth. A clutch of eggs contains 4 to 6 eggs, with 4 or 5 being the average. Incubation lasts 10 to 12 days and is performed by both parents. Both subspecies probably raise two broods a year in Virginia.

Status: *Threatened*. The northern subspecies (*Lanius ludovicianus migrans*) is reported rare in eastern West Virginia and uncommon in the Appalachians of western Virginia and western North Carolina (Bent, 1950; Pearson *et al.*, 1942). Stewart and Robbins (1958) report that Alexander Wetmore felt that this species had appreciably declined in Maryland in the last 15 years. Both subspecies of the loggerhead shrike have been on the National Audubon Society Blue List of Threatened Species for the past two years (Arbib, 1977; 1978). Several reporters for the 1978 Blue List stated that this is the most critically declining species east of the Mississippi. The 1978 Blue List also reported the findings of the Breeding Bird Survey which showed a 4% annual rate of decline for the loggerhead shrike. Observers throughout the state of Virginia agree that this is a *Threatened* species.

Protective Measures Proposed: The decline of this species is currently unexplained, and to attribute this decline to such factors as persistent pesticides or habitat destruction is unwarranted in light of current information. Therefore, intensive research is needed immediately to determine reasons for this population decline. Such research would then establish guidelines for the management of the species.

Author: Jerry W. Via.

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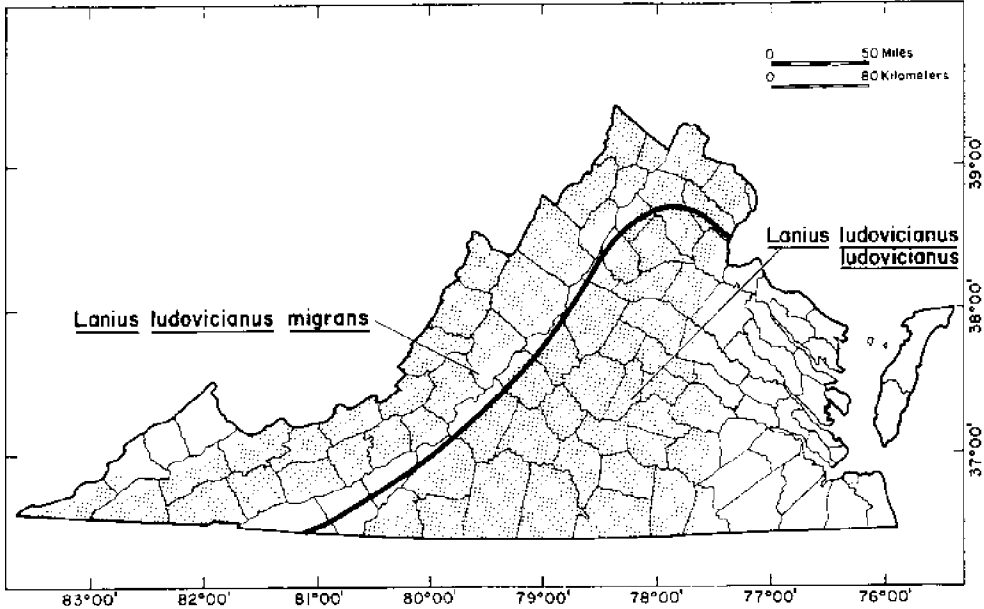


Figure 10. Distribution of Loggerhead Shrike (*Lanius ludovicianus ludovicianus*; *Lanius ludovicianus migrans*) in Virginia

11. HENSLOW'S SPARROW

Ammodrammus henslowii susurrans
Brewster

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Fringillidae

Description: This nondescript little sparrow is one of the more difficult ones to identify by sight. See Robbins *et al.* (1966) for details on identification.

Present Range: Breeds generally over the eastern half of the country south to North Carolina, Kentucky, Missouri and Kansas. Winters generally in the Gulf states and on the east coast to South Carolina.

Distribution in Virginia: Currently known as a breeding bird in small colonies only in Loudoun County on the upper Piedmont and in northern Accomack County on the Coastal Plain (Figure 11).

Habitat and Mode of Life: Open grasslands and sedge meadows are the preferred habitat of this bird.

Reproduction: This species' ground nest is often partly domed over. Four eggs are the normal clutch. Most egg dates are in late May or early June, and fledged young have been found as late as July 12 (J. J. Murray, 1952).

Status: *Threatened*. Formerly fairly common, if local, as a summer resident over much of Virginia's Coastal Plain, Piedmont, and probably the lower Shenandoah Valley. This bird's decline has been dramatic. Although transients and an occasional June bird have been reported in recent years, there are now only two localities in the state where they are known to occur regularly in summer. Although much that was said about the grasshopper sparrow applies also to this species, there are obviously other unknown factors involved in its decline. The species is clearly in danger of being extirpated in Virginia.

Author: F. R. Scott.

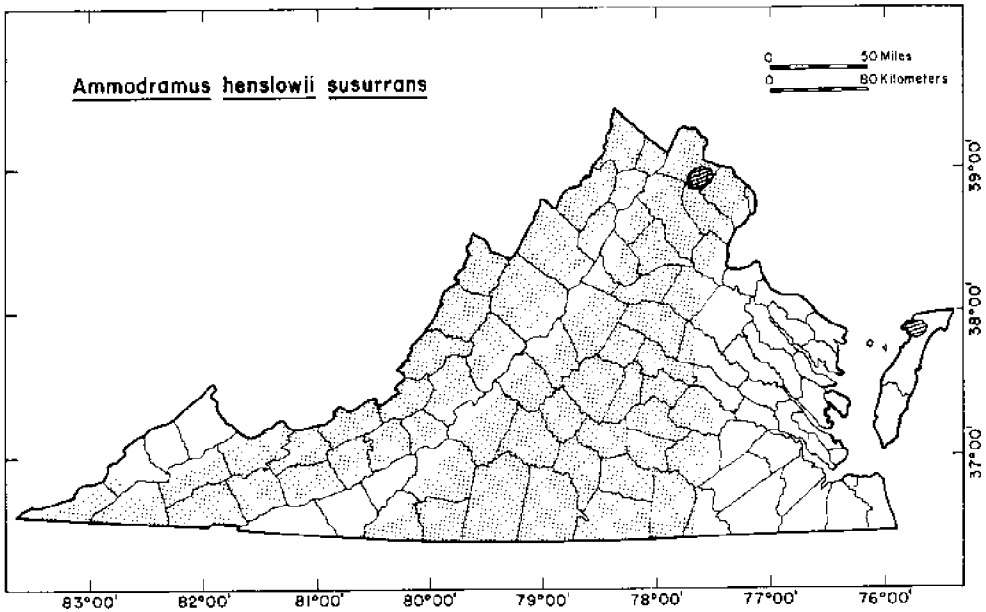


Figure 11. Distribution of Henslow's Sparrow (*Ammodramus henslowii susurrans*) in Virginia

SPECIAL CONCERN (15)

1. GREAT BLUE HERON

Ardea herodias herodias Linnaeus

Phylum: Chordata
 Class: Aves

Order: Ciconiiformes
 Family: Ardeidae

Description: "The largest of the dark herons" as described by Robbins *et al.* 1966.

Present Range: The great blue heron's present range covers all of North America (Robbins *et al.*, 1966) to southern Canada. It winters south into Mexico.

Distribution in Virginia: This species is a common permanent resident in the Atlantic Coastal Plain, breeding throughout the Tidewater area. It is an uncommon resident of the Piedmont, and considered uncommon to rare throughout the mountains and valleys. (Revised *Check-list of Birds of Virginia* in preparation.) (Figure 12).

Habitat and Mode of Life: This heron prefers both freshwater and saltwater habitats, feeding throughout the daylight hours from pre-dawn to evening. It feeds by stalking in shallow water. Foods include minnows, frogs and small fish. Great blue herons are solitary except during the breeding season when they become gregarious nesters.

Reproduction: The great blue heron breeds in isolated colonies throughout the Tidewater area of the Atlantic Coastal Plain in Virginia. Nesting may commence as early as March 10, and continues throughout June. Three to 6 eggs are laid. Incubation approximately 28 days (Bent, 1926), and young remain in the nest approximately 1 month. These birds normally nest in stands of large dead trees or large pine stands.

Status: *Special Concern*. Since this largest heron requires quite specific estuarine-type localities for its nesting habitats, it is coming, increasingly, in conflict with development of such areas for human habitation or landfill. Even local destruction or disturbance of land near the nesting areas may cause this species to abandon breeding sites. Prospects of locating similar areas after abandoning sites are becoming less successful.

Protective Measures Proposed: All great blue heron colonies should be located and designated, where possible, as protected areas, especially during the breeding season. Prospective nesting areas should also be located and preserved. Continued efforts to control pesticide use should be taken.

Remarks: The great blue heron is also called "crane" or "blue crane."

Author: Bill Williams.

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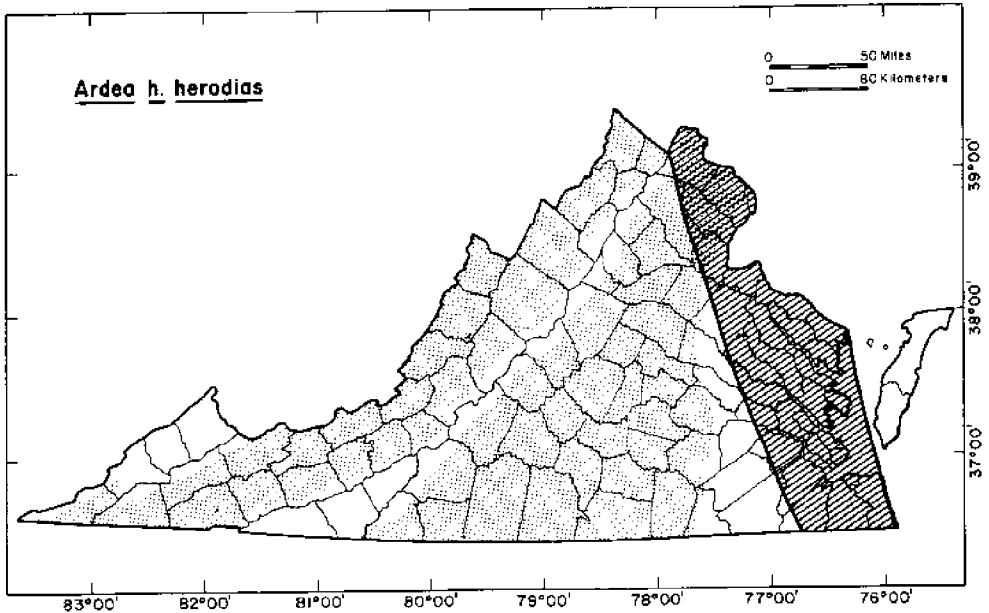


Figure 12. Distribution of Great Blue Heron (*Ardea herodias herodias*) in Virginia

2. LITTLE BLUE HERON

Florida caerulea caerulea (Linnaeus)

Phylum: Chordata
Class: Aves

Order: Ciconiiformes
Family: Ardeidae

Description: A small, dark heron. Immatures are often confused with egrets.
See Robbins *et al.* (1966).

Present Range: Breeds in North America in both freshwater and saltwater. Occurs from Massachusetts south to Florida; west along the Gulf Coast to Texas; and inland from the Gulf of Mexico to Arkansas and Missouri. Also breeds in Central America and northern South America and the Caribbean (*Check-list of North American Birds*).

Distribution in Virginia: With the exception of Watts Island and possibly Back Bay, the little blue heron breeds exclusively on the Eastern Shore (Figure 13). Heronries are most often found on the barrier islands or in nearby marshes. This species nests in mixed colonies with other herons, egrets, and ibises. An extensive survey in 1975 estimated 636 pairs of little blue herons in Virginia.

Habitat and Mode of Life: Colonies are found in a variety of vegetation and at a variety of heights. Most Virginia colonies are located in low shrubs, usually *Iva frutescens*.

Reproduction: Nests are flimsy platforms of twigs which are placed in trees, shrubs, or on the ground. Clutch size ranges from 3 to 6, with 4 or 5 being the most common. See Bent, 1926.

Status: *Special Concern.* The little blue heron is the least common of the intermediate-sized herons that occur in Virginia and does not appear to be doing as well as such species as the snowy egret and the Louisiana heron.

Protective Measures Proposed: Preservation of nesting and feeding habitat is essential.

Author: J. William Akers.

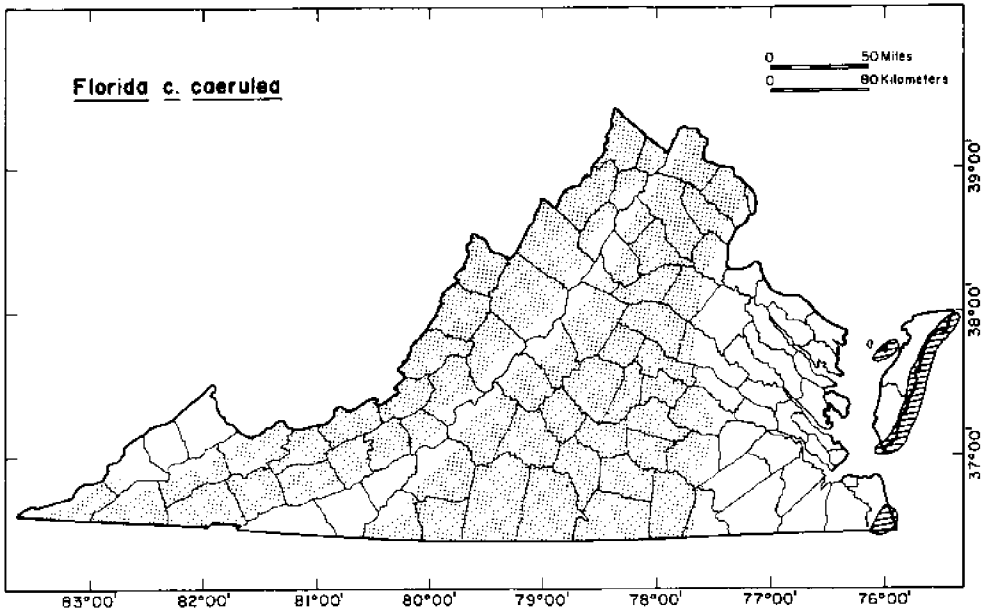


Figure 13. Distribution of Little Blue Heron (*Florida caerulea caerulea*) in Virginia

3. GREAT EGRET

Casmerodius albus egretta (Gmelin)

Phylum: Chordata
Class: Aves

Order: Ciconiiformes
Family: Ardeidae

Description: The only large white heron with a yellow-orange bill and black legs (Robbins *et al.*, 1966; Bent, 1926).

Present Range: Coastal states from Maine to Oregon and throughout the Midwest (Robbins *et al.*, 1966). Winters throughout South and Central America and parts of the Caribbean Sea.

Distribution in Virginia: The great egret is a common summer resident of the Coastal Plain. It breeds in mixed heron colonies along the barrier and Bay islands of the Eastern Shore (Figure 14). It is common during spring and fall as a transient and becomes uncommon in winter. It is uncommon to rare throughout the Piedmont and the mountains and valleys.

Habitat and Mode of Life: The great egret is a diurnal wading bird of freshwater and saltwater estuaries, small ponds, and coastal marshes. It feeds by slowly stalking the minnows, crabs and frogs available in these habitats. Although it is solitary by day, it prefers gregarious roosts in treetops by night. In most instances the herons become quite attached to these roosting sites and return to them every evening (Bent, 1927).

Reproduction: In Virginia the great egret prefers to nest as part of large mixed heron and ibis colonies. Generally, the nests are situated 3 to 4 feet above the ground, but they may be placed in treetops when associating with great blue herons. Nesting season lasts from mid-May through July. Normal clutch size is 3 eggs which will be incubated 23 to 24 days. The young fledge at approximately 4 weeks of age. Normally only one brood per nesting season will be produced.

Status: *Special Concern.* The great egret merits *Special Concern* status due to its limited and easily destroyed nesting habitat. The bulk of the breeding population is concentrated in the several heronries on the Virginia barrier islands. These islands and the waters about them are quite fragile physical features. The vegetation covering them, which the herons prefer for nesting sites, can be easily destroyed without proper protection. Further, any disruption of food availability for these birds will certainly alter their breeding status in the state.

Protective Measures Proposed: The Virginia barrier islands are for the most part under the protective influence of the Nature Conservancy. Every effort should be made to continue monitoring the breeding sites for these birds and their relative numbers on a yearly basis. A habitat analysis for nesting site preference is needed. In those areas where nesting does occur, the site should be marked as a colonial bird nesting area to be avoided during the breeding season and to be protected from habitat damage between breeding seasons

Author: Bill Williams.

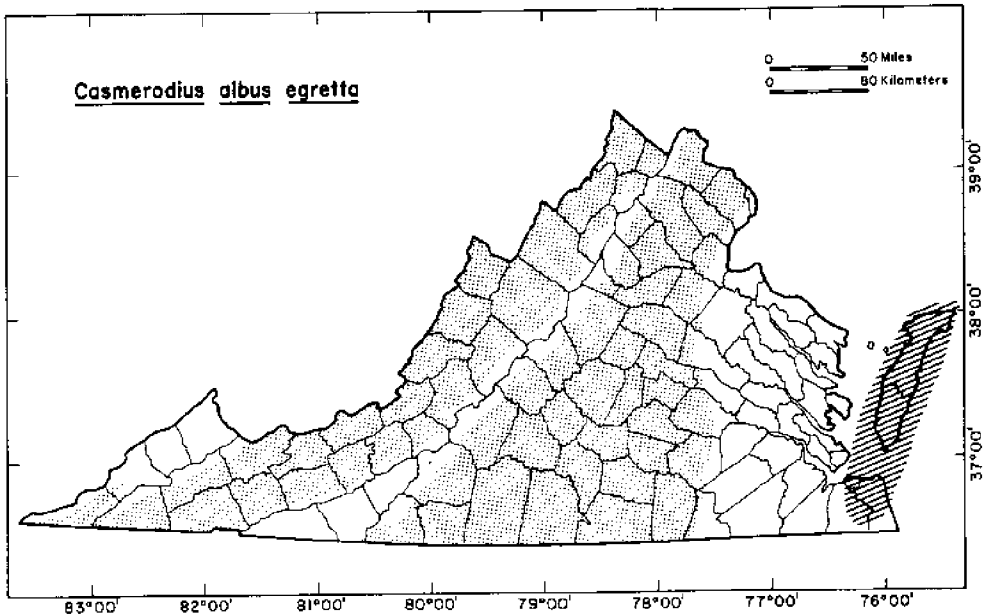


Figure 14. Distribution of Great Egret (*Casmerodius albus egretta*) in Virginia

4. BLACK-CROWNED NIGHT HERON

Nycticorax nycticorax hoactli
(Gmelin)

Phylum: Chordata
Class: Aves

Order: Ciconiiformes
Family: Ardeidae

Description: A medium-sized heron characterized by a heavy body and short, thick neck. The adult is dark black on the head and back and all white below (Robbins *et al.*, 1966; Bent, 1926).

Present Range: South and Central America and North America to southern Canada (Bent, 1926).

Distribution in Virginia: The black-crowned night heron is a common summer resident along the Virginia coast, nesting on the Eastern Shore. It is uncommon inland during the summer for the Coastal Plain and Piedmont and rare in the mountains and valleys in all seasons. During the winter months it is locally common along the coast and rare throughout the rest of the state (Figure 15).

Habitat and Mode of Life: The name implies the black-crowned night heron prefers to lead a nocturnal existence. It prefers to forage in shallow, weedy creeks, pond margins, and marshes from the evening to early morning. However, it can

often be found abroad diurnally, especially during the breeding season. By foraging at night it avoids competition with other herons for fish, its primary food source (Bent, 1926).

Reproduction: This heron prefers to nest in mixed heron and ibis colonies from late April through July, often choosing nest sites somewhat on the periphery of the main colony. Normally it builds its nest close to or on the ground in low vegetation, although it will nest in trees. Clutch size ranges from 2 to 5 eggs which will hatch in 24 to 26 days. The young are cared for by both parents until fledging at about 1 month of age.

Status: *Special Concern.* This status is necessary because of the limited and fragile nesting locations of this species. As with almost all of Virginia's heron species, their main breeding locations are on the Virginia barrier islands and their marshes. Habitat destruction in this area can be simply and quickly administered through dredging, oil spills, or recreational misuse.

Protective Measures Proposed: These marshes and spoil islands should be protected from human encroachment. The nesting colonies should continue to be monitored and relative numbers charted on a yearly basis. Colonial bird nest sites should be designated protected areas throughout the breeding season and carefully watched between breeding seasons for habitat disruption.

Remarks: Also known as "quawk."

Author: Bill Williams.

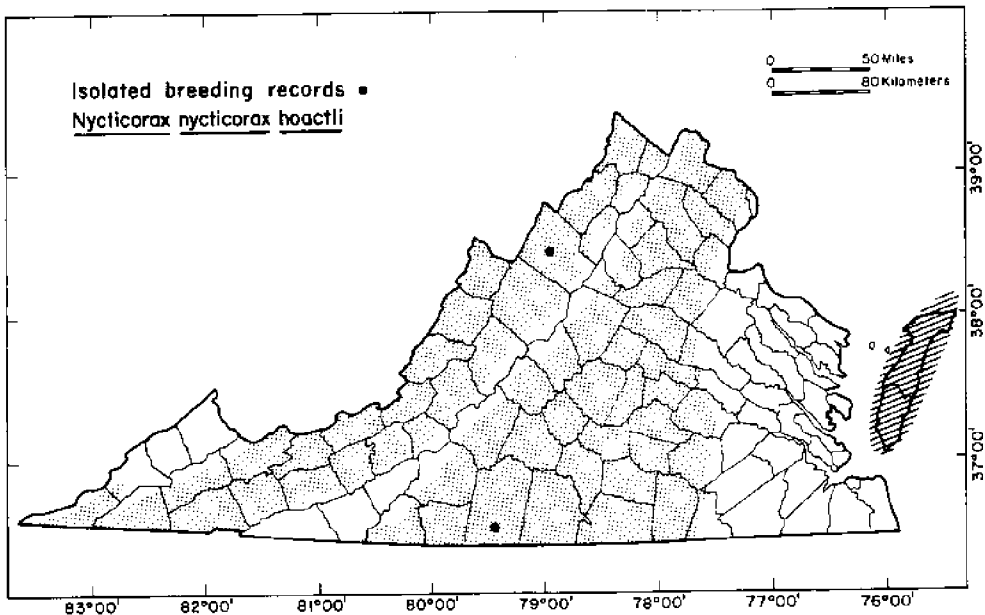


Figure 15. Distribution of Black-Crowned Night Heron (*Nycticorax nycticorax hoactli*) in Virginia

5. GLOSSY IBIS

Plegadis falcinellus falcinellus
(Linnaeus)

Phylum: Chordata
Class: Aves

Order: Ciconiiformes
Family: Threskiornithidae

Description: This is a medium-sized wading bird, 22 to 25 inches in total length. The bill is long, decurved and slender; upper mandible ridged and lower grooved; very small slitlike nostrils; part of facial area bare. Head and neck feathers rounded at tip, blackish chestnut with whitish edging. Back, tail and wing feathers dark, glossy, violet, green. Wing primaries, primary coverts, axillars, under wing coverts dark glossy green; outer secondaries glossed nearer bronze; lesser coverts dark brownish red.

Present Range: This species has invaded North America in recent years. Its range (A.O.U., 1957) is given as Eagle Lake (Colorado County) Texas; in Alachua, Brevard, Indian River and Monroe counties, Florida; Charleston County, South Carolina; Chincoteague Bay, Maryland; New Jersey (Stone Harbor); Cuba; Hispaniola; and Puerto Rico. The species winters, at least casually, north to coastal Texas, southern Louisiana, and southern Florida. Because of a range expansion in the past twenty years, the species now breeds as far north as Maine, where 494 pairs were nesting in 1975 (Custer and Osborn, 1977) and where the total estimated coastal population was 6,769 pairs. Extension of the range has been reviewed adequately by Stewart (1957) and Hailman (1959) who indicate the progressive northward movement.

Distribution in Virginia: The glossy ibis was first recorded breeding in Virginia in 1956 (Bock and Terborgh, 1957) on Hog Island on the Eastern Shore. It now breeds in colonies on the ocean side of the Eastern Shore from Fishermans Island to Chincoteague Bay, in one colony on the Chesapeake Bay side of the Eastern Shore, and on Watts Island in Chesapeake Bay (Figure 16).

Habitat and Mode of Life: This species nests in mixed colonies comprised of several species of herons. It nests largely in shrubby vegetation comprised of *Baccharis*, *Iva*, and *Myrica*. Williams (1973) showed that the glossy ibis nests lower in the vegetation than do the native heron species with which it occurs. Some individuals nest on the ground. This species feeds in marshes and shallow water areas, apparently not competing with herons for food, as Williams (1973) suggested that insect larvae and crustaceans predominated in regurgitated food samples.

Reproduction: Nesting begins on the Virginia Eastern Shore on May 6 (Warren, 1977). Incubation period is 21 days (Palmer, 1962) and clutch size is reported by him to be 3 or 4 eggs. Williams (1973) reported a fledging rate in a colony near Wachapreague, Virginia, to be 34 percent, but suggested it might normally be as high as 70 percent.

Status: *Special Concern.* The glossy ibis underwent a spectacular population expansion in Virginia between 1956 and 1973. One colony near Chincoteague, Virginia, contained approximately 600 breeding pairs in 1972 (Byrd, personal observation). The glossy ibis population in coastal Virginia and Maryland was down substantially during the breeding season of 1975 (Byrd, personal observation), whereas great numbers of ibises were reported in Massachusetts (R. M. Erwin, personal communication). The ibis breeding population appeared to be most concentrated between Virginia and New Jersey during the 1975 breeding season (Custer and Osborn, 1977). It appears likely that the breeding range of this species is shifting farther to the north on the Atlantic Coast (Byrd, 1978a).

Protective Measures Proposed: The breeding population of this species should be monitored on an annual basis. Every effort should be made to determine whether numbers continue to decline and whether this represents only a shift in the major breeding range. This species nests primarily in colonies on islands and dredge spoil islands. It is essential that these areas be protected as they represent a minimal amount of breeding habitat for this and associated species. Steps should be taken to coordinate efforts with the Army Corps of Engineers in the management of spoil areas to maintain suitable conditions for the bird species which utilize them.

Author: Mitchell A. Byrd.

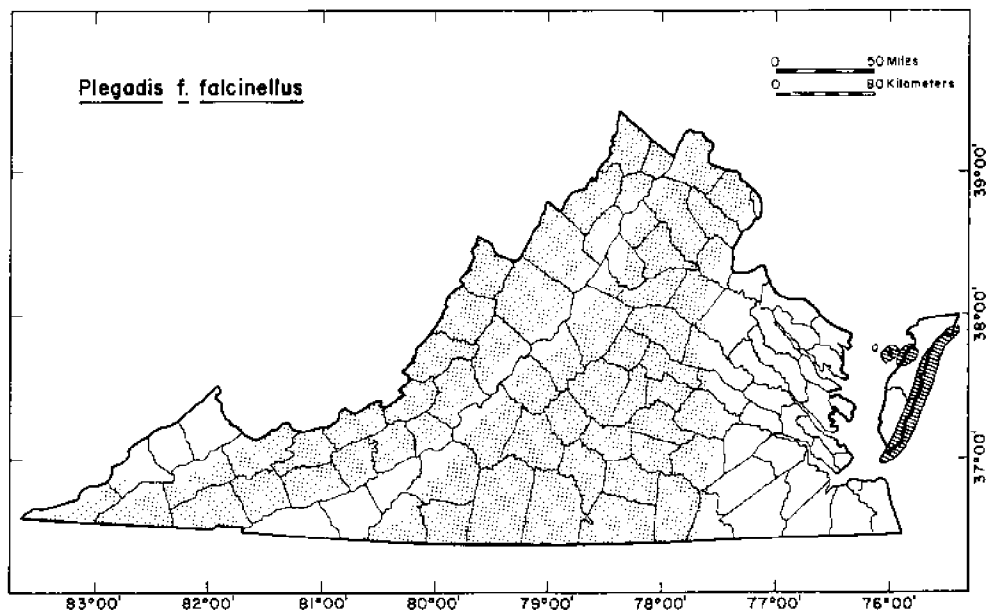


Figure 16. Distribution of Glossy Ibis (*Plegadis falcinellus falcinellus*) in Virginia

6. RED-SHOULDERED HAWK

Buteo lineatus lineatus (Gmelin)

Phylum: Chordata
Class: Aves

Order: Falconiformes
Family: Accipitridae

Description: This is a medium-sized soaring hawk which is approximately 16 inches in length with a wingspread of 40 inches. In the adult plumage, this species has a rusty red breast with rusty shoulder patches. In flight, the red-shouldered hawk is identified by light patches (windows) in the wings at the bases of the primaries (Brown and Amadon, 1968).

Present Range: This species breeds as far west as the eastern Plains states, north through southern Ontario and Gaspé, and south along the Atlantic coast through Florida, the Gulf coast and northern Tamaulipas, Mexico.

Distribution in Virginia: This bird is a breeding species throughout the state (Bailey, 1913). It is more numerous in the Piedmont and Coastal Plain than it is in the mountain and valley regions.

Habitat and Mode of Life: This species prefers moist mixed or deciduous woodlands with adjacent open country (Bent, 1937). It also has a strong affinity for wooded swamps or woods adjacent to standing water. It is unusual to find these birds in dry or coniferous woods. It is a diurnal predator with approximately 65% of its diet consisting of small mammals. The diet is varied and also includes snakes, lizards, turtles, frogs and small birds. It is a migratory species in the north but some birds winter in Virginia. This species is rarely syntopic with the larger red-tailed hawk.

Reproduction: The red-shouldered hawk builds a large nest of twigs and sticks in a large tree within the territory. The nest is usually used for only one season. The eggs are laid between late March and mid-April. Most clutches consist of 3 eggs, but some may have 4 eggs. The eggs are incubated by both parents for 28 days. Since incubation begins with the first egg, there is asynchronous hatching and development of the young. The young birds fledge from the nest about 6 weeks after hatching. The young retain a juvenile plumage for 18 months; thus, breeding is delayed until the birds are 2 years of age. Stewart (1949) found that a healthy population of this species in Maryland had a density of 51 pairs per 42 square miles. This same population produced an average of 1.8 young per active nest over a two-year period.

Status: *Special Concern.* This is a declining species over much of its range. Bailey found in 1913 that this was the most common raptor in Virginia. However, recent population estimates are not as good. Brown (1971) analyzed winter population trends of red-shouldered hawks for the period 1950-1969, and found a declining population in all but two states. He reported a 35% to 44% decline in populations of this species from Virginia during this period. This species was also retained on the "Blue List" (Arbib, 1976) of potentially endangered species for 1977, since 60% of the bird population experts across the country favored retention. There is some sentiment that this subspecies is continuing to decline in North Carolina, as reported by *American Birds*.

Protective Measures Proposed: Intensive research must be done to establish the reasons for these population declines. These declines are probably not related to habitat destruction, but until this species is studied further, perhaps wooded areas close to water should be preserved as much as possible to provide adequate habitat for this species.

Remarks: The decline of the red-shouldered hawk is very puzzling since similar species such as the red-tailed hawk have not shown these drastic declines.

It is unlikely that pesticides are involved since the diet is largely rodents, which are relatively free of pesticide contamination. These declines are probably not related to loss of suitable habitat since the rate of decline is so pronounced.

Author: Jerry W. Via.

* * * * *

7. FORSTER'S TERN

Sterna forsteri (Nuttall)

Phylum: Chordata
Class: Aves

Order: Charadriiformes
Family: Laridae

Description: One of four intermediate-sized terns that are similar in appearance, the Forster's tern frequents the marshes rather than the beaches. See Robbins *et al.* (1966).

Present Range: Breeds in North America from southern Canada to Louisiana and Texas. Occurs on both Atlantic and Pacific coasts and inland on freshwater marshes. Winters from Virginia to Florida in the east, and from California to Baja and the Gulf of Mexico (*Check-list of North American Birds*).

Distribution in Virginia: Scattered colonies of this species may be found in the coastal marshes of the Eastern Shore (Northampton and Accomack counties) (Figure 17).

Habitat and Mode of Life: The Forster's tern is distinct from other species of terns in Virginia in that it is a bird of the marshes rather than the shore. See Bent (1921).

Reproduction: Forster's terns are colonial marsh breeders. Terneries of this species are usually found along the banks of small tidal creeks where mats of dead vegetation have accumulated due to tidal action. These mats serve as breeding platforms on which the nests are constructed. Colony size ranges from 10 to 40 pairs. Larger colonies have been reported. Nests are constructed of dead vegetation, usually the same as the platform mat. Clutch size usually ranges from 2 to 5 eggs, with 3 being the average (Bent, 1921).

Status: *Special Concern*. Forster's terns are of *Special Concern* primarily because of dwindling habitat (*i.e.*, destruction of wetlands) and the quality of the remaining habitat. This species presents a problem when assessing population trends because of difficulties in locating and gaining access to colonies. A serious drop in reproductive success or adult population could occur before any problem is detected.

Protective Measures Proposed: It is essential that adequate stretches of coastal marshes be preserved and their quality maintained to insure that the Forster's tern will survive as a breeder in Virginia.

Author: J. William Akers.

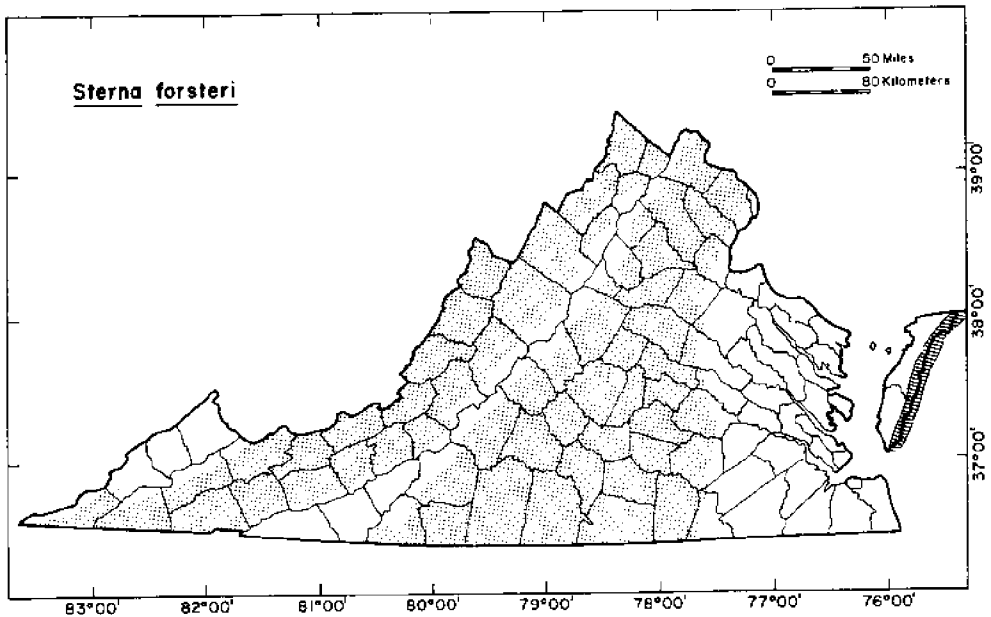


Figure 17. Distribution of Forster's Tern (*Sterna forsteri*) in Virginia

* * * * *

8. ROYAL TERN

Thalasseus maximus maximus (Boddaert)

Phylum: Chordata
Class: Aves

Order: Charadriiformes
Family: Laridae

Description: A large crested tern which breeds in dense colonies on coastal islands. See Robbins *et al.* (1966).

Present Range: Breeds from Maryland to Georgia; from southern Louisiana to southern Texas and the Bay of Campeche. Also occurs in Baja California, the West Indies and the west coast of Africa. Winters in much of the breeding range and south to South America.

Distribution in Virginia: A large colony (3500 pairs) nested on Fishermans Island and smaller aggregations were located on Metomkin Island (125 pairs) and Ship Shoal Island (150 pairs) in 1977. Although restricted to the Eastern Shore as a breeder, the royal tern ranges all along the coast and bay areas of the state. During late summer and fall they may occur as far inland as Claytor Lake in Pulaski County (Figure 18).

Habitat and Mode of Life: In Virginia, royal terns breed exclusively on coastal islands. Colonies occupy broad, flat, sandy areas with sparse to moderate vegetation. Lack (1968) states that *Thalasseus* terns require breeding sites that are isolated from access by mammalian predators.

Reproduction: Royal terns breed in dense colonies. The nests, which are only a peck reach apart, are shallow, hollowed depressions in the sand with little or no lining. Clutch size is normally 1 or 2 eggs per nest (Bent, 1921). At about 1 week of age, young terns leave the nest area to form a crèche, a dense aggregation of hundreds or thousands of chicks that apparently affords better protection against avian predators (Buckley and Buckley, 1968). The young fledge within a few weeks, but parental care lasts well into the following winter (Ashmole and Tovar, 1968).

Status: *Special Concern.* Although the royal tern population in Virginia is stable, it merits concern for at least two reasons. First, the breeding habitat is threatened by both natural (erosion and storms) and man-made (real estate development and pollution) problems. Secondly, because the royal tern population is so heavily concentrated during the breeding season, it is particularly vulnerable to a potential local disaster (e.g., severe weather, oil spill, etc.).

Protective Measures Proposed: Preservation of undisturbed nesting habitat and insurance of environmental quality are essential to maintaining the population of this species.

Author: J. William Akers.

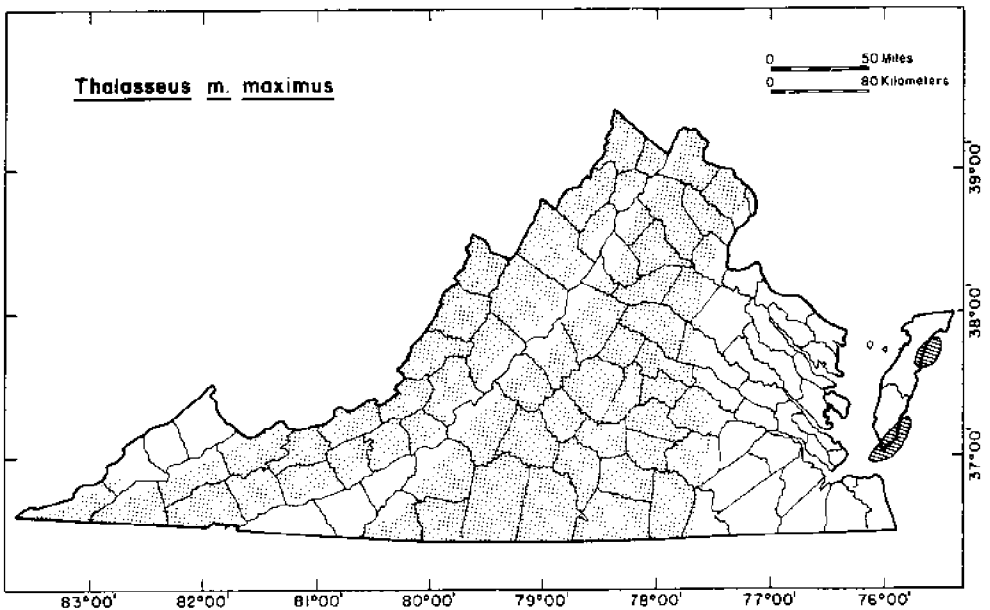


Figure 18. Distribution of Royal Tern (*Thalasseus maximus maximus*) in Virginia

9. SANDWICH TERN

Thalasseus sandvicensis (Latham)

Phylum: Chordata
 Class: Aves

Order: Charadriiformes
 Family: Laridae

Description: This species differs from the other terns by having a black bill tipped with yellow. The bill is long and slender, the legs are black, and a slight crest is present.

Present Range: The sandwich tern breeds from Virginia (Northampton County) to British Honduras (Saddle Cay), and some of the Bahamas and West Indies. It winters from the Bahamas and Florida southward through the West Indies, down the Atlantic coast of South America to southern Brazil, and from the coasts of Louisiana and Texas south along the Central American coast to Columbia. It also occurs on the Pacific coasts of Oaxaca and Guatemala (*Check-list of North American Birds*, 1957).

Distribution in Virginia: Generally, this tern is an uncommon to rare transient along the coast. The birds were first reported as extending their range into Virginia in 1912. Its nesting was confirmed 15-21 July 1967 by A. F. Nolis. The young were banded and photographed. Thirty pairs were reported on Fishermans Island, July 1973, and 50 pairs were reported on Cobb Island, 23 June 1978 (Figure 19).

Habitat and Mode of Life: This tern is generally associated with its larger relative, the royal tern. Both species prefer coastal islands. They nest together in colonies.

Reproduction: The nest of the sandwich tern is a mere scrape in the sand, generally unlined (Bent, 1921). Usually there are 1 to 2 eggs laid, average 51.1 x 36 millimeters. The eggs are oval, shell smooth, lustreless. The color ranges from pinkish to olive-buff, with a wide variety of markings ranging from small dark brown dots to bold blocks. Incubation is by both sexes for a period of 21 days. Food consists almost wholly of small fish with some shrimps and squids. It is more a sea bird than the smaller terns.

Status: *Special Concern.* The breeding population of the sandwich tern is closely correlated with the success of royal tern colonies. The number of sandwich terns in Virginia has been slowly increasing since the early 1970's.

Protective Measures Proposed: Preservation of adequate habitat is essential.

Author: R. A. Beck.

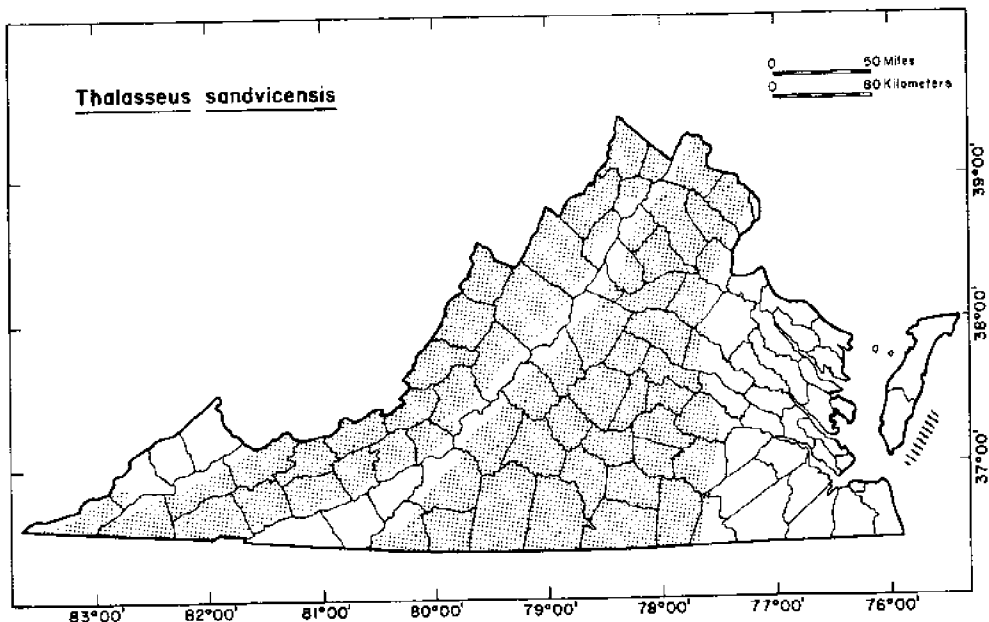


Figure 19. Distribution of Sandwich Tern (*Thalasseus sandvicensis*) in Virginia

10. CLIFF SWALLOW

Petrochelidon pyrrhonota pyrrhonota
(Vieillot)

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Hirundinidae

Description: Back bluish with longitudinal white stripes. Rump buffy. Tail dark and square, not forked. Head bluish above, with white forehead and rusty face and throat. See pages 204-205 in Robbins *et al.* (1966).

Present Range: Central Alaska, central Yukon, western Mackenzie, central Saskatchewan, southern Manitoba, central Ontario, and southern Quebec south to central Mexico, west-central Texas, central Missouri, western Kentucky, west-central Tennessee, northern Florida, and western North Carolina. Winters from southern Brazil south to central Chile and central Argentina.

Distribution in Virginia: This species apparently may be expected to occur routinely only in the vicinity of Kerr Dam in Southside Virginia (Lynch, 1974). In addition, two pairs were found nesting near Abingdon in 1965 (Scott, 1966). (See also Scott and Cutler, 1967, for Kerr Dam observations.) (Figure 20).

Habitat and Mode of Life: The cliff swallow requires open country for foraging on flying insects and, like most swallows, does best where there are large bodies of water. It originally nested only on cliff faces, and perhaps on

the sheltered sides of very large trees in western North America (Bent, 1942). The earliest American ornithologists (e.g., Alexander Wilson) never saw this bird. After eastern North America was settled, the species adapted to man-made structures, and became abundant around farms during the nineteenth century. In the latter part of that century, as the house sparrow began to be abundant, the cliff swallow declined in abundance, and during this century virtually disappeared from most of the states east of the Mississippi because of interference by house sparrows at nesting time (Bent, 1942). In western North America today this swallow regularly uses dams and highway overpasses for nesting and is an extremely common bird locally. Only recently has the species started using concrete structures in the East, and it is this relatively new habit that may account for the species' resurgence in certain eastern states, including Virginia. The critical factor is that house sparrows cannot use swallow nests where these are well removed from cities and farms.

Reproduction: The cliff swallow carries little balls of mud to the nest site, where it constructs a retort-shaped nest with usually one entrance. However, dish-shaped nests are not rare in very sheltered spots. Three to six eggs are laid and incubation takes 12 to 14 days. The young fledge in about 3 weeks. Two broods, rarely 3, may be raised (Bent, 1942).

Status: *Special Concern.* This species is on the *American Birds* "Blue List," primarily on the rarity of the bird east of the Mississippi River (Arbib, 1976). At this time there is every indication of continued prosperity in the Kerr Dam area, and attention should be focused on possible expansion into other parts of the state. Consequently, this species should be marked for *Special Concern.*

Author: Curtis S. Adkisson.

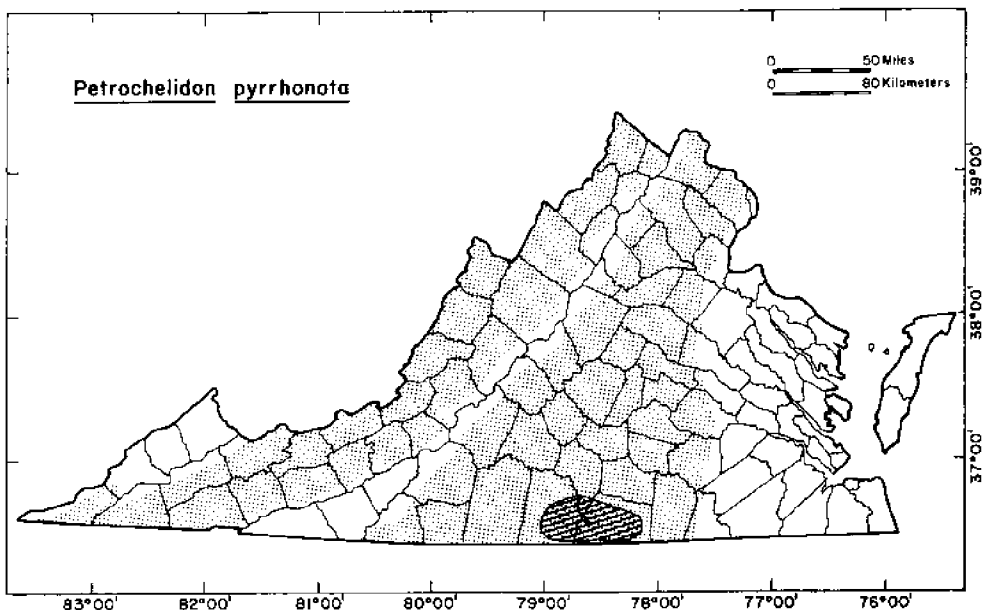


Figure 20. Distribution of Cliff Swallow (*Petrochelidon pyrrhonota pyrrhonota*) in Virginia

11. SHORT-BILLED MARSH WREN

Cistothorus platensis (Naumann)

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Troglodytidae

Description: This species has a streaked crown and back, buffy underparts, short slim bill, cocked tail, and an obscure buffy stripe over the eye.

Present Range: Breeds north to southeastern Saskatchewan, southern Manitoba, central Ontario, southern Quebec and central Maine; east to central Indiana and central Missouri; and west to western Missouri, eastern Nebraska and eastern North Dakota (*Check-List of North American Birds*, 1957).

Distribution in Virginia: Uncommon to common. Transient and winter resident along the coast. Rare west of the Chesapeake Bay. It is a rare to local summer resident at Virginia Beach and Saxis, Virginia. During the 1974 Back Bay Christmas Count, 88 birds were recorded in December. Ten birds were recorded in Saxis on 11 August 1974. It is a rare and irregular transient throughout the Piedmont region (Figure 21).

Habitat and Mode of Life: This species prefers wet meadows, grass and sedge marshes, and hay fields. It prefers drier areas than the long-billed marsh wren and generally avoids cattail marshes. No extensive study of food has been made. They are normally insectivorous (Bent, 1948).

Reproduction: The nests are sometimes single, but where conditions are favorable, this species nests in colonies. The structure of the nest itself is globular, consisting of dried or green sedges with entrance 2.5 centimeters, barely discernible on the side. It is well hidden and woven into growing vegetation about 6-9 millimeters above the ground. The nest is lined with feathers, fur, and soft plant down. The male builds numerous unlined dummy nests. There are 4 to 8 white eggs per clutch. The 14- to 16-day incubation period is carried out by the female alone. Typically there are 2 broods per breeding season (Bent, 1948).

Number in Captivity: None.

Status: *Special Concern.* An evaluation of the current population status should be made. There has been no breeding record reported in Virginia.

Protective Measures Proposed: None at this time.

Author: R. A. Beck.

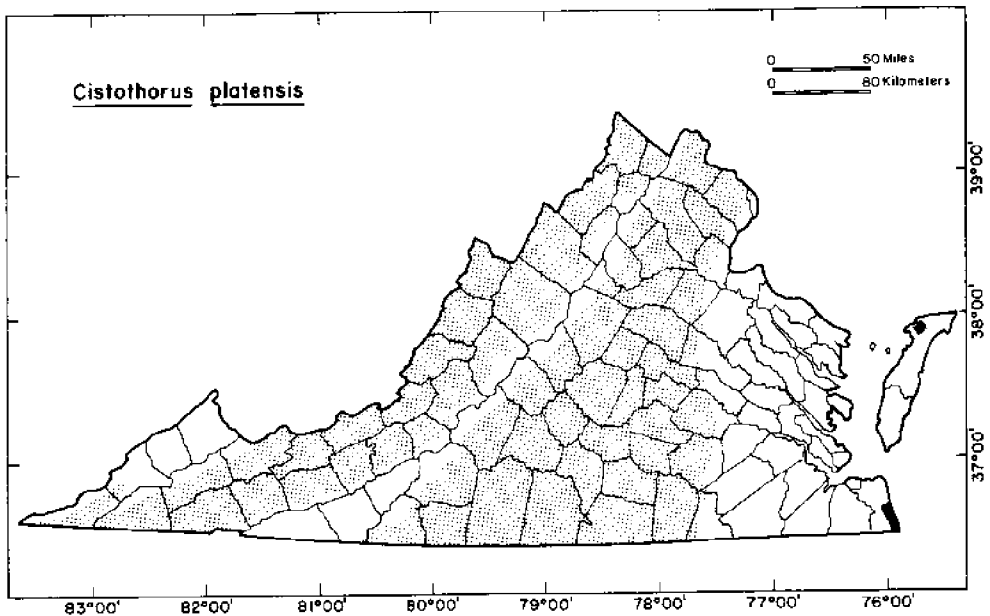


Figure 21. Distribution of Short-Billed Marsh Wren
(*Cistothorus platensis*) in Virginia

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12. EASTERN BLUEBIRD

Sialia sialis sialis (Linnaeus)

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Turdidae

Description: The male of the species has a bright blue back and a rusty throat and breast. The female and immature have a definite eye ring, and blue in the wings and tail. The juvenile has the typical spotting of the thrushes.

Present Range: The eastern bluebird occupies the range east of the Rocky Mountains, except Florida and southern Texas.

Distribution in Virginia: In all regions of the state this species is an uncommon to locally common permanent resident. The peak numbers for the Coastal Plain were a wintering record of 194 birds in Mathews, January 2, 1977. In the summer, 103 pairs were observed in Newport News, July, 1976. In the Piedmont, the high winter record is 316 on December 18, 1965 by the Lynchburg Bird Club. A summer high of 136 was recorded on June 7, 1975 in Lynchburg. For the mountains and valley, 161 were observed in December, 1976, and 21 pairs were reported in June, 1976.

Habitat and Mode of Life: The eastern bluebird occurs on farmlands, roadside fence lines, open woods, swamps and gardens. This species is a cavity nester and is primarily insectivorous in its feeding habits.

Reproduction: The nest of this species is rather carelessly arranged in a natural cavity in a tree, in an abandoned woodpecker hole or in one of the thousands of bluebird houses available in suitable locations throughout the bird's range. The nest is a loose cup of grasses and weed stalks. The female builds the nest in 4 to 5 days. The male may carry some material. The outside diameter varies with the cavity; the inside diameter averages 6.4 x 7.6 centimeters, with a depth of about 5.1 centimeters. There are from 3 to 6 unmarked pale-blue to whitish eggs. Incubation is solely by the female and continues for 13 to 15 days. Two broods are common.

Number in Captivity: None.

Status: *Special Concern.* The bluebird population appears to be increasing after a serious decline. Much of this success may be attributed to the educational programs and the establishment of the bluebird trails, and availability of bluebird houses throughout the state. Although concern for the species has lessened with the success of the promotional campaign, the availability of artificial nest sites is critical to its success.

Protective Measures Proposed: Continuation of educational and promotional programs for trails and artificial nest sites.

Author: R. A. Beck.

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13. WARBLING VIREO

Vireo gilvus gilvus Vieillot

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Vireonidae

Description: A small warbler-sized bird with a uniform mantle of light greenish gray. Underneath parts are somewhat paler and there is a faint eye stripe. Wings and tail are somewhat darker. There are no wing bars.

Present Range: Breeds from northern British Columbia and central Saskatchewan east to southern Nova Scotia and south to Baja California, northern Mexico, southern Louisiana, northern Alabama, western North Carolina and the Coastal Plain of Virginia.

Distribution in Virginia: The warbling vireo occurs throughout the state of Virginia. It is locally common in the mountain and valley provinces, uncommon to rare in the Piedmont and Coastal Plain of Virginia. This species reaches the limit of its southeastern distribution in Virginia.

Habitat and Mode of Life: The warbling vireo selects areas of open stands of shade trees or open-growth flood-plain forests. In Virginia the typical habitat consists of stands of sycamores along streams and rivers. The bird usually builds its nest at the end of a branch typically over water. This species spends most of its time foraging in the upper portions of the tree at the ends of the branches (Bent, 1950). James (1976) found that the warbling vireo forages by hovering and picking insects off living foliage

at the outer portions of the tree. The diet of this species consists mostly of insects, 77 percent of which are lepidopterous larvae (Bent, 1950).

Reproduction: The nesting season for this species is from mid-May to mid-July. The warbling vireo lays from 3 to 5 eggs, usually 4. These eggs are incubated for 12 days with both male and female performing incubation duties. Nests are located fairly easily since the male often sings while incubating. After hatching, the young remain in the nest for about 16 days before fledging. The warbling vireo is a frequent host for the eggs of the brown-headed cowbird, a brood parasite.

Status: *Special Concern.* This species is termed common in the Ridge and Valley Province of Maryland (Stewart and Robbins, 1958), but it is presently not a common bird in the northern and western part of Virginia. Smyth (1912) listed the bird as a common species in Montgomery County in southwest Virginia, but it is a species of local distribution today. This species was placed on the Blue List of Threatened Birds by the editors of *American Birds* for the years of 1978 and 1979 (Arbib, 1977; 1978). The Appalachian region was one of the supporters for this status. The 1978 Blue List reported the findings of the breeding bird surveys which showed a 3 percent annual rate of decline for this species in the East.

Protective Measures Proposed: A statewide census of this species is first needed to determine the rate of decline. Such a study should also investigate causative factors for the population declines, and suggest potential management strategies. In Virginia, a restriction on the alteration of the remaining riparian habitats would preserve the preferred breeding habitat for the species.

Author: Jerry W. Via.

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14. WAYNE'S BLACK-THROATED GREEN WARBLER

Dendroica virens waynei Bangs

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Parulidae

Description: A small member of the wood warbler family with an olive-green back and wings, a broad golden cheek patch, a black throat, and an upper breast. This subspecies is similar to the nominant form (*Dendroica virens virens*) except for its smaller bill and smaller body size. It was first described by Bangs in 1918.

Present Range: Breeds along the Atlantic Coastal Plain of southeastern Virginia, eastern North Carolina and eastern South Carolina.

Distribution in Virginia: This subspecies breeds only in the Great Dismal Swamp and immediate areas (Figure 22).

Habitat and Mode of Life: This species is restricted to the cypress swamps along the eastern Atlantic coast from Virginia to South Carolina (Bent, 1953). It forages between 20 and 40 feet high in the branches of cypress and other swamp trees, in a gleaning fashion, much like other members of this family. Unlike the nominant form, this form is very active and elusive. This, along with the dense foliage in many swamps, makes detailed observations next to impossible. Wayne's description of the habitat of this form is one of virgin cypress swamps with huge trees and unbroken canopy. This is quite different

from the vegetation of the Dismal Swamp today, since the area has been intensively managed for timber in the recent past. Therefore, this form is probably adaptable in its habitat preferences (Meanley, 1968; 1969; 1970; 1972).

Reproduction: This form is one of the earliest nesters in the swamp with egg dates as early as April 4. The average egg date would be approximately April 20. Most nests contain 4 eggs, but some may have as many as 5 eggs. The young are altricial and are raised in the nest by both parents.

Status: *Special Concern.* This subspecies represents a unique disjunct population. At the closest points, this subspecies is 300 miles from any populations of the nominant form. Its preference for densely wooded swamps may result in limited habitat and population declines, since historical accounts of this species relate the disappearance of this form in areas which have been lumbered. This has not been the case in the Dismal Swamp since this form is considered to be a common bird.

Protective Measures Proposed: The establishment of the Dismal Swamp National Wildlife Refuge in 1975 will hopefully allow the Virginia population of this form to flourish since timber removal operations have ceased. However, any management or development of the refuge should be evaluated with regard to this species before being enacted.

Remarks: Little information is available on the habitat requirements of this form. Such information is important for the development of a management plan. Several authors note the lack of singing birds in early July. While some of the authors think the birds leave the swamp in late June, Meanley believes the birds simply quit singing in late June and remain unnoticed in the swamp.

Author: Jerry W. Via.

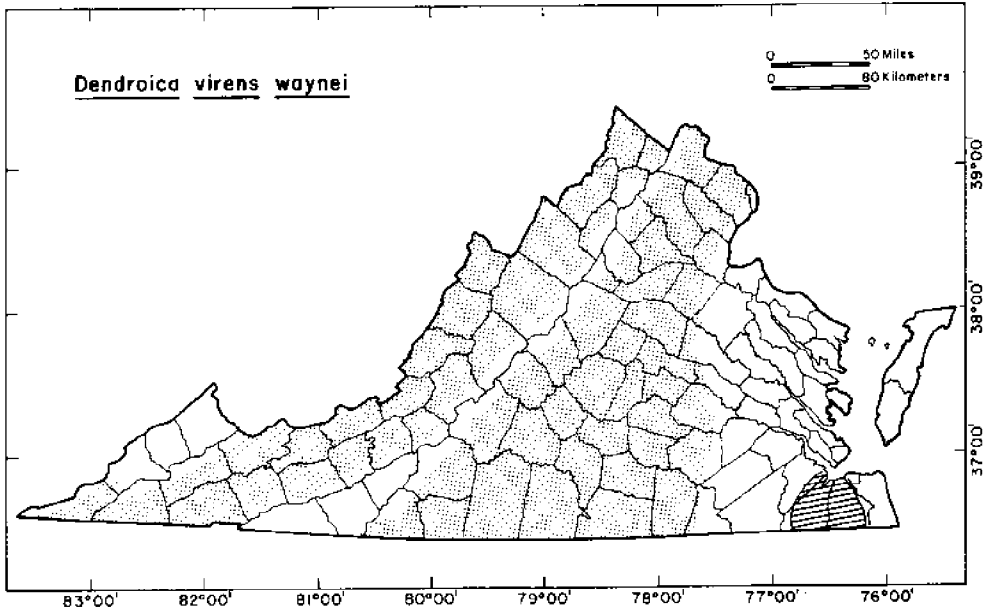


Figure 22. Distribution of Wayne's Black-Throated Green Warbler (*Dendroica virens waynei*) in Virginia

15. GRASSHOPPER SPARROW

Ammodramus savannarum pratensis
(Vieillot)Phylum: Chordata
Class: AvesOrder: Passeriformes
Family: Fringillidae

Description: This short-tailed sparrow of the grasslands has a distinctive song. See Robbins *et al.* (1966) for a detailed description and illustration.

Present Range: Breeds across much of the northern and central United States and southern Canada south in the east to Florida. Isolated populations also occur in Central America, northern South America, and the West Indies. The northern races winter north to central California, Oklahoma, Tennessee, and North Carolina.

Distribution in Virginia: A locally common summer resident over most of the state, though uncommon in extreme southeastern Virginia.

Habitat and Mode of Life: The preferred habitat in Virginia seems to be hay fields and abandoned farmland grown up in weeds, but to a lesser extent it also occurs in some grain fields.

Reproduction: This species lays 4 or 5 eggs in a nest on the ground in a depression or in a clump of vegetation. Eggs as early as May 20 and young in the nest from May 26 to July 22 (J. J. Murray, 1952).

Status: *Special Concern.* Changing land use has put considerable pressure on this bird, and although it is still locally common, it has become rare or disappeared from many of its former haunts. Increasing suburban development, and especially the virtual disappearance of hay fields from many areas of Virginia, are having a devastating effect on this bird's breeding habitat. Intensive cultivation of corn and soybean, habitats which do not appeal to this bird, is also reducing the areas available to it.

Author: F. R. Scott.

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STATUS UNDETERMINED (10)

1. YELLOW-CROWNED NIGHT HERON

Nyctanassa violacea violacea
(Linnaeus)Phylum: Chordata
Class: AvesOrder: Ciconiiformes
Family: Ardeidae

Description: Similar to the black-crowned night heron in body form. Adults of the two species may be separated by sight since the yellow-crowned night heron has black and white facial markings, no black on the back, and is gray underneath as opposed to white (Robbins *et al.*, 1966; Bent, 1926).

Present Range: Southeastern United States, Central America and the northern half of South America (Bent, 1926).

Distribution in Virginia: The yellow-crowned night heron is an uncommon summer resident of the Coastal Plain. It is rare inland. It breeds on the Eastern Shore and at Hampton and Norfolk. It is rare along the coast in winter. This species is considered rare throughout the year in the Piedmont and rare in the mountains and valleys where there are two summer breeding records (Bridgewater, 1951 and Radford, 1970) (Figure 23).

Habitat and Mode of Life: This heron prefers to feed in fresh and salt marshes primarily in the late evening and early mornings, though it can often be found abroad during daylight hours. The yellow-crown is less gregarious than many other herons and most often is found entirely alone. Its main food items consist of crustaceans and some small fish.

Reproduction: The yellow-crowned night heron, unlike many other herons, chooses to nest in small groups away from large mixed colonies. They prefer to nest in evergreen trees 15 to 20 feet above the ground. Clutch size averages 3 to 4 eggs with incubation lasting slightly more than three weeks. Nesting begins by mid-May and may continue through mid-July. One brood per season is normal.

Status: *Undetermined.* Since this species is relatively uncommon over its range in Virginia, with scattered breeding reports state-wide, it should be considered as *Status Undetermined.* Much work needs to be done to delineate the nesting and feeding habitats this heron most prefers within Virginia. In short, there is little pertinent ecological data on yellow-crowned night herons that would help explain its rather puzzling breeding distribution. (Revised *Check-list of Birds of Virginia* in preparation).

Protective Measures Proposed: Quite simply, much field work needs to be done to find out where and how many members of this species exist throughout Virginia. Habitat preferences for feeding and nesting need to be analyzed, and areas which the yellow-crown now occupy need to be protected from human encroachment.

Author: Bill Williams.

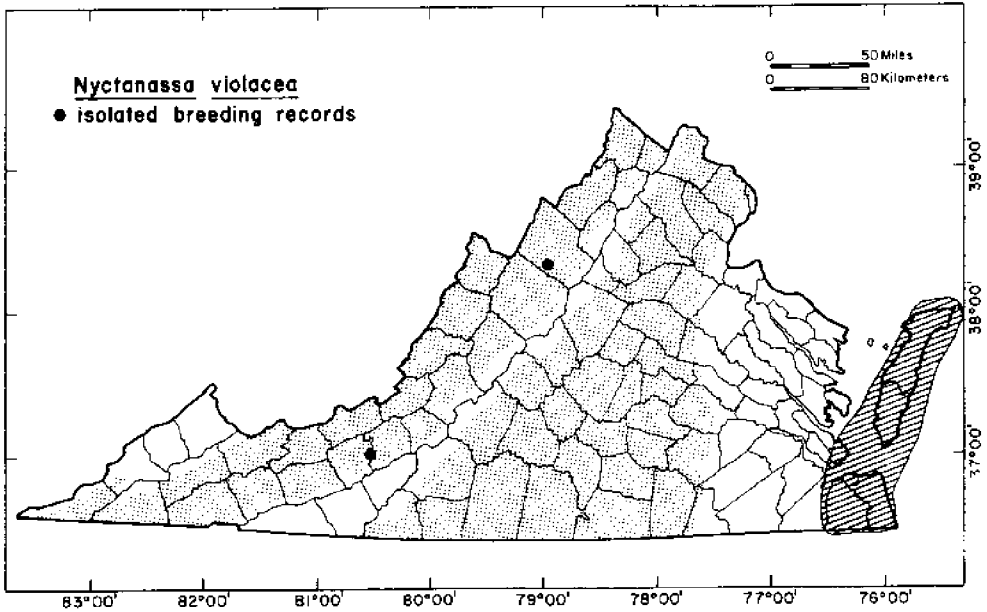


Figure 23. Distribution of Yellow-Crowned Night Heron (*Nyctanassa violacea violacea*) in Virginia

2. LEAST BITTERN

Ixobrychus exilis exilis (Gmelin)

Phylum: Chordata
 Class: Aves

Order: Ciconiiformes
 Family: Ardeidae

Description: This smallest of our herons is very shy and rarely flies far when flushed. See Robbins *et al.* (1966) for description and illustration.

Present Range: Breeds over most of North America below Canada south to Paraguay and Brazil, including the Bahamas and the Greater Antilles.

Distribution in Virginia: Transient and summer resident, locally common on the Coastal Plain and rare and very local farther inland (Figure 24).

Habitat and Mode of Life: Marshes of all types attract this bird, but its preference is for freshwater to brackish marshes, especially narrow-leaved cat-tails. It is less common in salt marshes.

Reproduction: This bird builds a small platform nest usually in marsh vegetation a foot or so above the water level. Occasionally the nest is in a shrub. Normally 4 to 5 eggs are laid. Available nesting records in Virginia are incomplete but give egg dates of May 22 to July 9. Unfledged young have been found as late as August 17.

Status: *Undetermined.* No doubt some of this concern is due to the difficulty of getting information on the breeding population of such an exceedingly shy bird. However, destruction of this bird's habitat has been a major factor in its decline in past years and is clearly continuing, if at a slower rate. Although tidal marshes are now offered some protection under the law, non-tidal marshes are under no such restrictions and are being drained and destroyed whenever this is considered "desirable."

Author: F. R. Scott.

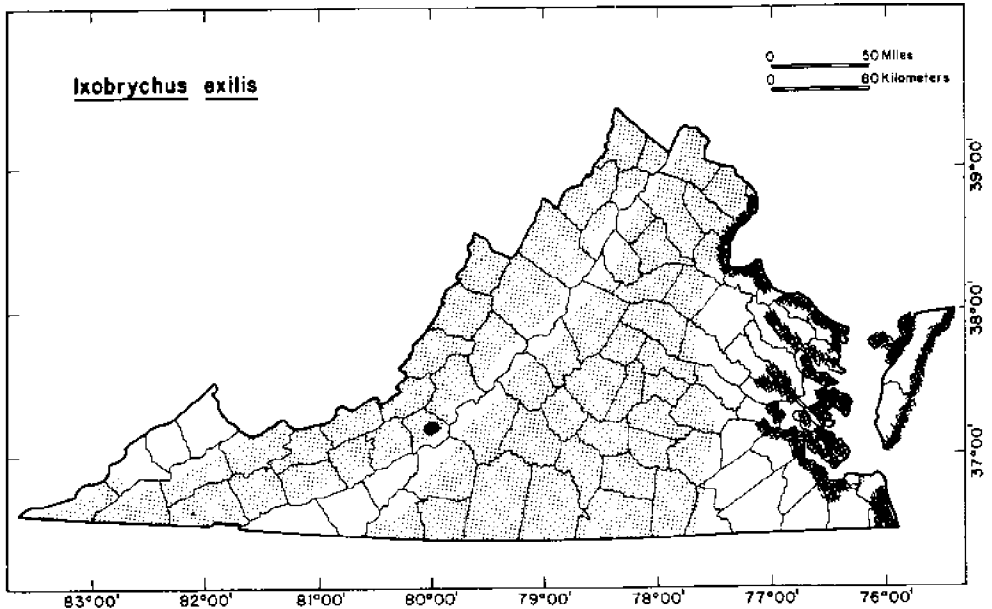


Figure 24. Distribution of Least Bittern (*Ixobrychus exilis exilis*) in Virginia

3. AMERICAN BITTERN

Botaurus lentiginosus (Montagu)

Phylum: Chordata
 Class: Aves

Order: Ciconiiformes
 Family: Ardeidae

Description: This species may be recognized in the field by its black whisker mark and white chin area. In flight the black primaries are diagnostic (Robbins *et al.*, 1966; Bent, 1926).

Present Range: North America throughout central Canada; also South and Central America.

Distribution in Virginia: Throughout the state the American bittern is considered uncommon during the spring, summer, and fall; uncommon to rare in the winter. There is only one breeding record for the state from Back Bay, May 1968 (revised *Check-list of Birds of Virginia* in preparation) (Figure 25).

Habitat and Mode of Life: This is one of the most solitary of the herons. It prefers secluded swamps and marshes where it feeds on frogs and small fish. Its secretive habits make this species difficult to locate, especially for study purposes.

Reproduction: The American bittern breeds from mid-May through July. Three to 7 eggs comprise a clutch. Incubation of its single yearly brood lasts for 28 days. Young bitterns remain in the nest for 2 weeks and fledge 2 to 3 weeks later. During the pre-fledge and brooding period both parents care for the young.

Status: *Undetermined.* There is very little information on this species in the state. Although its habitats are well-known, there is virtually no indication of how often, when, or where this heron breeds in Virginia.

Protective Measures Proposed: Initially, a concerted effort must be made to establish the reproductive status of the American bittern in Virginia. This will require extensive field work. From the information derived from field data an inventory of used and potentially usable areas for bittern breeding can be established. These areas may then be protected and monitored for bittern use on a yearly basis.

Author: Bill Williams.

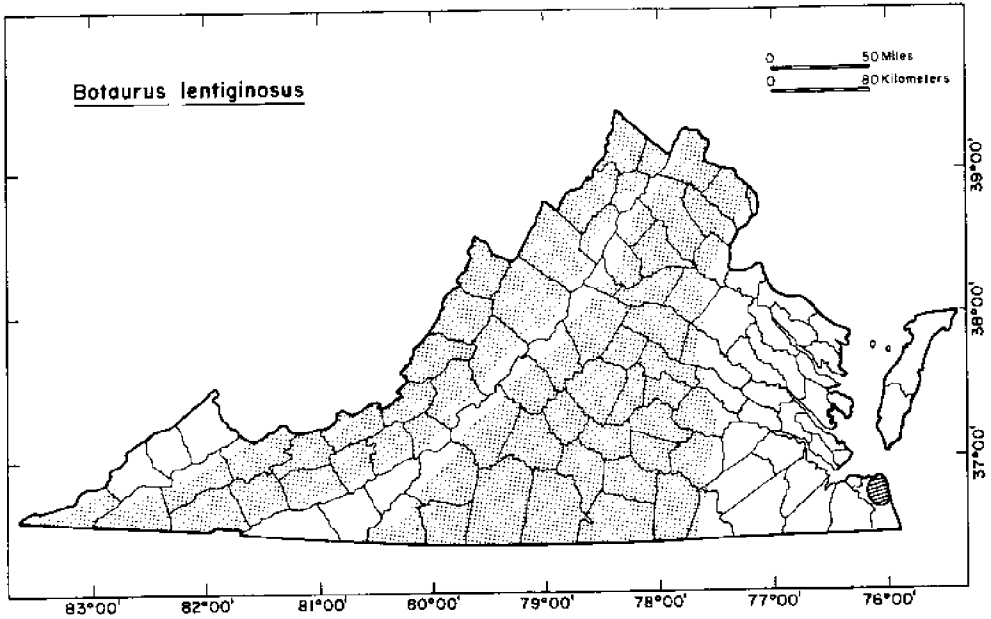


Figure 25. Distribution of American Bittern (*Botaurus lentiginosus*) in Virginia

4. COOPER'S HAWK

Accipiter cooperii (Bonaparte)

Phylum: Chordata
Class: Aves

Order: Falconiformes
Family: Accipitridae

Description: Bluish-gray above, with gray and dark-gray banding on tail. Front basically white with rufous barring throughout, including on legs. Cap dark. Best distinguished from similar sharp-shinned hawk by rounded tail. This hawk has the short, rounded wings characteristic of its genus. See pages 68-69 in Robbins *et al.* (1966).

Present Range: The species breeds from southern British Columbia and central Alberta through eastern North Dakota, southern Minnesota, to southern Maine, northern New Brunswick and Nova Scotia; south to Baja California, Chihuahua, south-central Texas, central Mississippi, Alabama and central Florida. It winters from Washington, Colorado, Iowa, southern Wisconsin, southern Michigan, southern Ontario and southern Maine south through the southern United States and Mexico to Costa Rica.

Distribution in Virginia: Extremely scarce. Not known to nest in Virginia today. Based on 30 years' observations, J. W. Murray (1974) considered it a rare summer resident. It was not mentioned by Carroll and Hostetter (1933) for Mountain Lake. However, recent sightings (1978) on Potts Mountain in Craig County, and on Mount Rogers in Smyth County, may indicate nesting activity yet to be verified (James Hill, pers. comm.).

Habitat and Mode of Life: Occupies open woodlands, especially along woodland margins as well as in woodlots. In New England, white pine groves were favored for breeding (Bent, 1937). This species eats medium-sized birds and mammals, from some of which it presumably acquired a considerable pesticide load over the last three decades, leading to its demise over much of its range.

Reproduction: The nest is placed in a conifer, less commonly in a deciduous tree, from 6 to 25 meters above ground. The normal clutch size is 4 or 5 eggs. Incubation usually begins after most of the eggs have been laid and lasts about 24 days. The young probably fledge 5 weeks later (Bent, 1937).

Number in Captivity: Unknown. Most captives would be held by falconers, legally or otherwise. Some wounded birds may be held by zoos.

Status: *Undetermined*. The Cooper's hawk was once regarded as one of our commonest hawks over the United States (Bent, 1937). However abundant it may once have been, it is now virtually extirpated in Virginia. It is on the *American Birds* "Blue List" (Arbib, 1977) because of the depleted eastern populations. A recent significant increase in number of sightings during fall migrations (1971-74) (U.S. Department of Interior, 1976) is cause for optimism.

Protective Measures Proposed: At this time, minimum measures should include a ban on all use of this species in falconry, and a ban on certain pesticides (*e.g.*, DDT) throughout its range.

Author: Curtis S. Adkisson.

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5. COMMON GALLINULE

Gallinula chloropus caohimans
(Bangs)

Phylum: Chordata
Class: Aves

Order: Gruiformes
Family: Rallidae

Description: This species is only slightly smaller than the American coot which it resembles. This bird has a dark charcoal-gray head and breast, with dark olive-brown back and wings. The head is distinctively marked with a red frontal shield and a red chicken-like bill which is tipped with yellow.

Present Range: Breeds along the east coast from Florida to southern Maine, north through the Great Lakes, west through central Nebraska and south through eastern Texas. There are also populations of this species along the California coast.

Distribution in Virginia: This species is an uncommon breeding bird along the Eastern Shore and Chesapeake Bay of Virginia. There are few records for the Piedmont and mountains of Virginia (Figure 26).

Habitat and Mode of Life: The gallinule has long toes that enable it to walk on floating or partially submerged vegetation. It swims well and may often dive. It usually forages on the shores of lakes and marshes where it turns over vegetation to secure food. The diet of this species consists of 96 percent vegetable matter made up of seeds, roots and soft parts of succulent plants (Bent, 1926). The remainder of the diet consists of molluscs and insects. Even though it is a migratory species, it seems to be a very poor flyer on the breeding grounds.

Reproduction: The bird may nest from mid-May to late July, but only one brood is raised annually. The gallinule may lay from 6 to 16 eggs but the average clutch size is 10. The precocial young are jet black with orange legs, and leave the nest soon after hatching.

Status: *Undetermined.* Apparently this has always been an uncommon species in Virginia. Grey (1950) called this species rare as a breeding bird in the Cape Henry region. Meanley (1975) reports that it is also uncommon on the Eastern Shore of Virginia. Due to the rather secretive nature of the species, an intensive census is needed. The destruction of many coastal wetlands has probably contributed to the decline of this species in recent years, but a census is needed to determine this fact.

Protective Measures Proposed: Once coastal wetlands are censused to establish population estimates, areas where the species thrives could potentially be managed to increase gallinule populations. Wetlands could be potentially generated by creating impoundments that may be attractive to the species.

Author: Jerry W. Via.

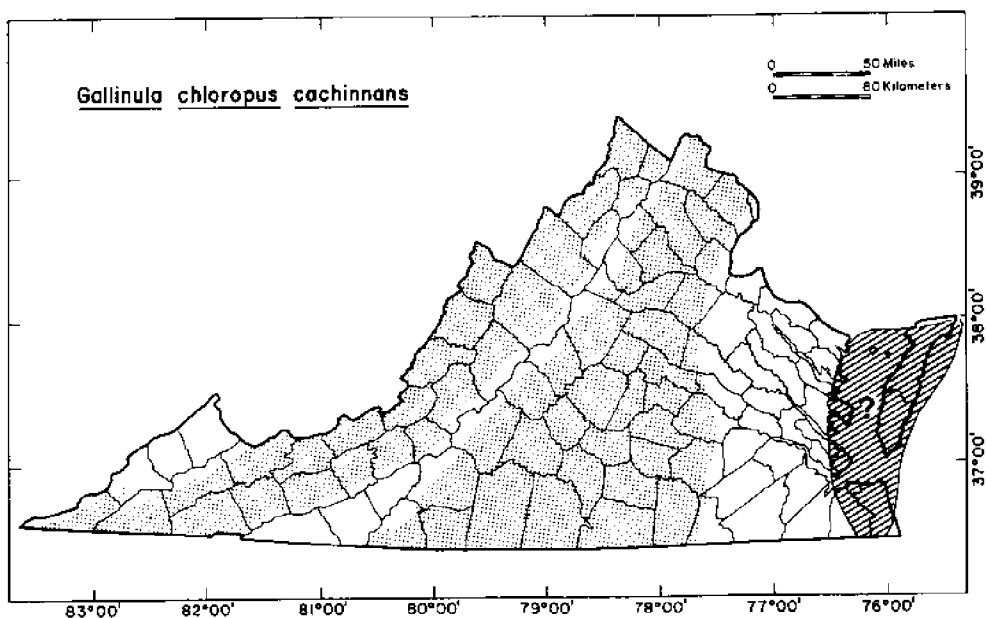


Figure 26. Distribution of Common Gallinule (*Gallinula chloropus cachinnans*) in Virginia

6. BLACK-BILLED CUCKOO

Coccyzus erythrophthalmus
(Wilson)Phylum: Chordata
Class: AvesOrder: Cuculiformes
Family: Cuculidae

Description: A slender, long-tailed bird with brown above, striking white below, and indistinct tailspots. Bill is all black, and there is a red eye ring. See pages 158-159 in Robbins *et al.* (1966).

Present Range: Breeds from southern Saskatchewan and northern Minnesota to southern Quebec and Nova Scotia on the north, south to southeastern Wyoming, Nebraska, northwestern Arkansas, and central North Carolina and South Carolina on the south. Western limit imprecisely known, but may extend to Alberta and Colorado. Winters in northwestern South America to the equator.

Distribution in Virginia: Apparently restricted to higher mountains today. This species apparently was more common in western Virginia earlier this century than it is today (Bailey, 1913; J. W. Murray, 1974). There have been few sightings in recent years, and no nests have been reported. The most heavily watched montane area in the state, the vicinity of Mountain Lake in Giles County, has produced little information on the species' occurrence (Fig. 27).

Habitat and Mode of Life: The black-billed cuckoo probably occurs mostly in high altitude hardwoods, especially at the forest edge, and in clearings and in second-growth woods. This species and its more abundant relative feed primarily on lepidopterous larvae, especially on "tent" caterpillars, and at least one past range expansion into Alberta was associated with an outbreak of these insects (Bent, 1940).

Reproduction: The breeding season in Virginia is not known, but probably lasts from late May to late July. A flimsy nest of twigs built from a few centimeters to 2 or 3 meters above ground in a sapling or shrub is characteristic of the species elsewhere. Two or 3 eggs are laid. There are reports that this species lays its eggs in the nests of other species occasionally (Bent, 1940). Incubation lasts about 14 days, and the young fledged in another 8 or 9 days.

Number in Captivity: Unknown. It is presumably difficult or impossible to maintain in captivity.

Status: *Undetermined.* This species was not mentioned in the latest *American Birds* "Blue List" (1976), indicating that it is not in any danger outside Virginia. There is no explanation for the consensus that it was more common in Virginia 50 years ago.

Protective Measures Proposed: None advised at this time.

Author: Curtis S. Adkisson.

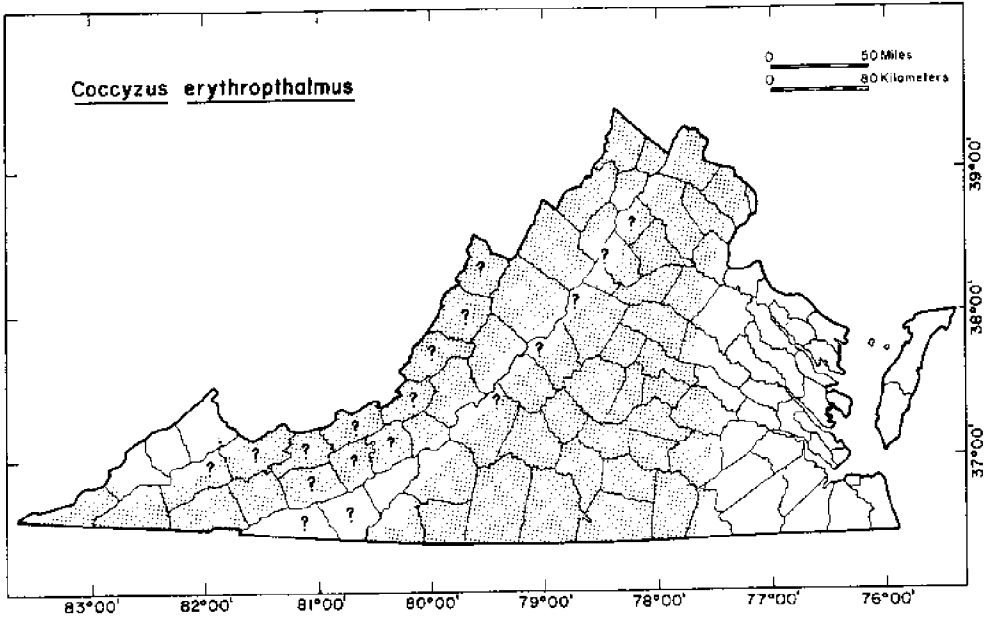


Figure 27. Distribution of Black-Billed Cuckoo (*Coccyzus erythrophthalmus*) in Virginia

7. BARN OWL

Tyto alba (Scopoli)

Phylum: Chordata
Class: Aves

Order: Strigiformes
Family: Tytonidae

Description: A large light-colored uncommon owl with a heart-shaped facial disk. Another distinguishing characteristic is its long legs, which are longer than the tail and completely feathered down to the feet. It also has small dark eyes.

Present Range: This species is nearly cosmopolitan. Ranging from the British Isles, the Baltic area and southern Russia, south through Africa to Madagascar and the Cape district; India, northern Burma, Palestine and Iraq to Arabia; Indochina, Java, New Guinea and the Society Islands south to Australia. In North America the barn owl breeds from British Columbia, North Dakota, southern Michigan, southern Ontario and southern New England south through the West Indies. Its range extends southward through Central and South America to Tierra del Fuego (*Check-list of North American Birds*, 1957).

Distribution in Virginia: In the Coastal Plain region, this species is an uncommon, local permanent resident. It is an uncommon, rare, permanent resident in the Piedmont, mountains and valleys.

Habitat and Mode of Life: The barn owl may be found almost anywhere. Its natural nesting sites are hollow trees, cliffs, or old hawk nests. It now nests most often in buildings (especially abandoned ones), barns, church steeples, duck blinds and other artificial sites.

Reproduction: No nest is built. Old pellets are frequently used to form a base for the eggs. There are 3 to 11 (generally 5 to 7) eggs laid at 2- or 3-day intervals. The average size is 43.1 x 33 millimeters. The eggs are pure white. Incubation is generally done by the female with the male feeding the incubating female regularly. The incubation period is reported as 32 to 34 days or 21 to 24 days, and starts with the laying of the first egg. This variation in reported incubation period is probably due to different methods of determination. The shorter period suggests hatching time of a single egg; the longer period, the total time to incubate the entire clutch. The first owlet hatched can be two weeks old when the last egg hatches. This species may breed throughout the year. Eggs have been reported in the Coastal Plain from January 24 to September 25. Rodents serve as the main source of prey and the owls' available food supply acts as one of the controlling factors in survival of the last hatchings.

Status: *Undetermined*. Since this species is uncommon over its range in Virginia, with scattered breeding records statewide, it should be considered as *Status Undetermined*.

Protective Measures Proposed: Field work is needed to determine the abundance and distribution of this species in Virginia.

Author: R. A. Beck.

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8. YELLOW-BELLIED SAPSUCKER

Sphyrapicus varius appalachiensis
Ganier

Phylum: Chordata
Class: Aves

Order: Piciformes
Family: Picidae

Description: Black and white barred above, yellowish below, with variable barring on sides. Forehead and throat red (throat white in female) with black lower border of throat; face white with black line through eye and down the side of head. Conspicuous white patch on black and white barred wings. - See pages 184-185 in Robbins *et al.* (1966).

Present Range: Breeds from southeastern Alaska, southern Mackenzie, northern Manitoba, northern Ontario, southern Quebec, and southern Labrador to Newfoundland, south to the mountains of central California, central Arizona, northern Indiana, northern Ohio, western Pennsylvania, northern New York, and central New England southward in the Allegheny mountains to northern Georgia. Winters south to northern Baja California, western Panama, the Gulf Coast states and Florida.

Distribution in Virginia: Most reports of this bird come from the winter period. The few summer reports indicate that this species breeds sparingly in the hardwood forests of the higher mountains. Brown (1933) reported seeing 19 on

Whitetop Mountain in Grayson County in May. J. J. Murray (1936) reported apparent nesting birds on Cold Mountain in Amherst County and in Highland County. Stevens (1976) reported sapsuckers in summer on Shenandoah Mountain in Highland County and on nearby Paddy Knob, as well as on Hurricane Mountain in Grayson County. These reports indicate that sapsuckers should be expected only above 3500 feet elevation (Figure 28).

Habitat and Mode of Life: Throughout its range in eastern North America, the sapsucker favors hardwood forests. It excavates its nest cavity in live trees, often poplars (Bent, 1939). Throughout the summer the birds feed on sap procured by drilling holes in living hardwoods, often birches. The insects drawn to this sap may form the main source of protein for the young sapsuckers. Many other birds, and several mammals, use both the sap and the insects as well (Foster and Tate, 1966).

Reproduction: From 4 to 7 eggs are laid, and these hatch in about 14 days. The time required for fledging is not precisely known. Fledglings are taken to the vicinity of the feeding tree where they are soon weaned (Foster and Tate, 1966).

Number in Captivity: Unknown.

Status: *Undetermined*. There is no indication of concern for this species elsewhere in its range. The paucity of reports from Virginia may merely reflect the lack of research in high-altitude hardwood forests in western Virginia. Thus, the current status of this bird is *Undetermined*.

Author: Curtis S. Adkisson.

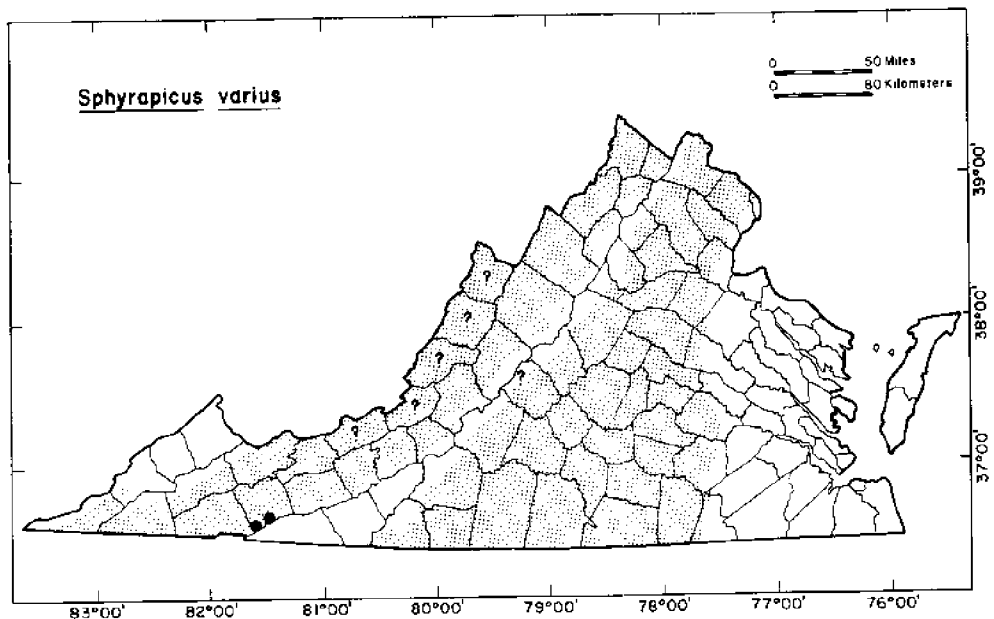


Figure 28. Distribution of Yellow-Bellied Sapsucker (*Sphyrapicus varius appalachiensis*) in Virginia

9. ALDER FLYCATCHER

Empidonax alnorum (Audubon)

Phylum: Chordata
 Class: Aves

Order: Passeriformes
 Family: Tyrannidae

Description: A small member of the tyrant flycatcher family, a family recognized for its habit of pursuing and catching flying insects. This species has a brownish-green back, wings with two white wing bars, and a light-colored throat and belly. It is most easily recognized by its distinctive three-syllable call (fee-bee-o). It was formerly considered a race of the Traill's flycatcher, but is now considered to be a separate species (Bent, 1942; Stein, 1963).

Present Range: This species breeds from central Alaska, east through the Canadian provinces to Newfoundland and south through New York. South of New York it breeds along the Appalachians to southern West Virginia (Cranberry Glades). It also breeds in the states bordering the Great Lakes.

Distribution in Virginia: A few migration records exist for this species in the eastern part of the state. It is a rare summer bird in the Mount Rogers area, where several birds were recorded in July 1978. This and other summer records indicate that the bird is a probable breeder (Figure 29).

Habitat and Mode of Life: The alder flycatcher breeds in dense alder stands, alder swamps, and similar dense woody vegetation along streams, watercourses and ponds. While the bird may sing from exposed branches protruding through the thicket, it nests within the dense tangle of vegetation. Most of the diet is insects, which are either caught in mid-air or gleaned from the vegetation (Bent, 1942).

Reproduction: There are usually 3 to 4 eggs in a clutch, which are brooded by both birds for the 12-day incubation period. The young are altricial and remain in the nest for the next two weeks after hatching. Studies on the breeding biology of the closely related willow flycatcher (*Empidonax traillii traillii*) in Ohio show that the nesting success averages 36 fledglings per 100 eggs (Holcomb, 1972). In order to maintain population stability in the willow flycatcher, between 2 and 3 young per pair must be fledged annually. Only one brood is raised annually.

Status: *Undetermined.* Since there are no breeding records for Virginia, a thorough census should be made in likely areas to ascertain the breeding status.

Protective Measures Proposed: The distribution of preferred habitat for this species in Virginia is restricted to alder swamps at high elevations (above 3500 feet). These areas should be censused. Such areas should be protected, not only for this species but other fauna and flora unique to these conditions.

Author: Jerry W. Via.

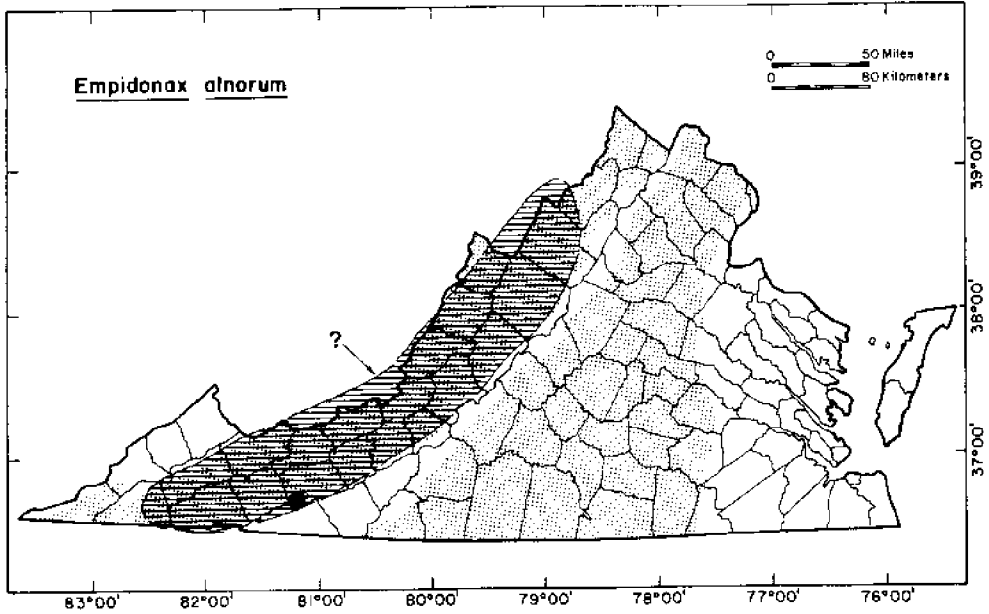


Figure 29. Distribution of Alder Flycatcher (*Empidonax alnorum*) in Virginia

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10. DICKCISSEL

Spiza americana

Phylum: Chordata
Class: Aves

Order: Passeriformes
Family: Fringillidae

Description: A small sparrow-like bird which is similar in size, bill shape and coloration to the English sparrow (*Passer domesticus*). Adult males have yellow distributed in a stripe above the eye, a spot below the eye, and a yellow breast. A heavy black band extends across the throat beneath the white chin. The rest of the body is brown to brownish-gray, with brown streaking. Females and immature birds are similar in color pattern but they lack much of the yellow and the black throat band. They closely resemble the female English sparrow.

Present Range: This is a bird of the central prairies of North America. It breeds north to southern Manitoba, central Michigan, and southern Ontario; south through western Oklahoma, southern Louisiana, central Mississippi and sporadically in the Piedmont of South Carolina and Georgia; and west to the eastern slope of the Rocky Mountains. Formerly a breeder along the Atlantic Coast states from Massachusetts to South Carolina. Winters in Central America and northern South America.

Distribution in Virginia: On the Coastal Plain, this species is a rare and irregular transient and summer resident, and a rare but regular winter visitor. In the Piedmont and mountains and valleys, it is rare and irregular in distribution during the migratory seasons. There are recent scattered breeding records in the Piedmont and mountains and valleys, but no recent breeding records for the Coastal Plain.

Habitat and Mode of Life: This species is a denizen of open fields and is particularly fond of pastures of clover and grasses for nesting. It is particularly partial to grassy fields with vegetation between 1 and 2 feet tall, and brushy fence rows or scattered shrubs for singing and foraging perches. It is particularly shy around the nest. During the nesting season, approximately 68 percent of the diet consists of seeds, most of which are of little economic importance. The rest of the diet is composed of insects. It is an important species in the prairie regions because it is common and most of the insects consumed are agricultural pests such as grasshoppers. This species displays very fluctuant populations in any one area from year to year. These fluctuations for the most part are unexplained. During the winter months most sightings are of single individuals which are observed foraging in a flock of English sparrows.

Reproduction: Nesting occurs between late May and mid-July, with the peak season occurring in late June. The nest is typically well concealed in the grasses. Grass is pulled over the top of the nest to provide camouflage. A clutch consists of 3 to 5 eggs, with 4 eggs being the usual number. The eggs hatch after an incubation period of 12-13 days. The young are fed primarily insects and some seeds. There are few natural enemies except for occasional predation by ground predators such as foxes, snakes, and feral cats. Agricultural procedures are the main destructive force on the nesting cycle of the Dickcissel. In particular, the mowing of hayfields and the elimination of hedgerows are the most severe.

Status: *Undetermined.* The lack of numerous breeding records for this species in recent years is unexplained. This may be due in part to the fluctuant populations of the species or perhaps the difficulty in locating nests. The distribution for this species in recent years has declined when compared to earlier published records for the eastern United States.

Protective Measures Proposed: Before management guidelines can be formulated, it is necessary to assess the abundance and status of the species throughout the state. This could be done by very careful censuses of the appropriate habitat to look for nesting birds. It is also possible that in areas of high agricultural pressure, special areas could be set aside as breeding areas for the Dickcissel.

Author: Jerry Via.

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MAMMALS

Charles O. Handley, Jr.

Introduction

The first Europeans who reached Virginia in the late Sixteenth Century and those who followed in the next hundred years were impressed with the numbers and variety of mammals they found in this new land. Almost unfailingly their writings extolled the richness of the fauna (Handley and Patton, 1947; Handley, in press). Indeed, it was a rich fauna. In the interval between the arrival of the Europeans and the present day, about 100 species of mammals are known to have occurred in Virginia and in its waters.

The recorded fauna is large, but the actual fauna must have been even larger. Our knowledge of it is incomplete because there were few zoologists around four hundred years ago and because destruction of the fauna began almost with the first European footstep on the beach. We can guess that a number of species disappeared following settlement, before zoologists could record them in Virginia. These may have included pine marten, lynx, rock vole; blue whale, gray whale, right whale; and several porpoises and seals. Others, such as the bison, porcupine, fisher; manatee, northern flying squirrel, water shrew, and snowshoe hare disappeared completely or were reduced to tiny remnants so early that we have only fragmentary knowledge of their occurrence in Virginia.

The decline of mammals in the state continues, and other species are now in danger of being lost from the fauna. Since the arrival of Europeans, 79 species of mammals (exclusive of seals, porpoises, and whales) are known to have occurred in Virginia. Among those 79 species are 33 whose well-being is in one way or another jeopardized today (Tables 1 and 2). In some instances it is a whole species, in others a subspecies, and in a few it is a local population that has some problem. Some are of concern throughout their ranges; others only in the Virginia portions of their ranges.

Eight of the nine orders of mammals occurring in Virginia are represented among the species in trouble. Only the order Marsupialia, with its ubiquitous and abundant Virginia opossum, has escaped the troubled label.

The one sirenian, the manatee, no longer occurs in Virginia and is *Endangered* throughout its range. Among the Cetacea, all of the large whales are *Endangered*, and some of the smaller whales and porpoises are thought to be *Rare*. All of the marine Carnivora, the seals, are *Rare*.

Although the eastern cottontail is one of the most abundant Virginia mammals, the other Lagomorpha of the state have not fared so well. In fact, one of the insular populations of the eastern cottontail is of *Undetermined Status* and has been thought to be extinct. The snowshoe hare survives in one small enclave and is *Endangered*. Whether attempts to reestablish it elsewhere have succeeded is questionable. The status of the New England cottontail is *Undetermined*, but it may be declining in competition with the eastern cottontail. The status of the introduced

black-tailed jackrabbit on the barrier islands is uncertain. The marsh rabbit occurs in such a small area in southeastern Virginia that it must be regarded with concern.

Three out of the four ungulates of Virginia are on the troubled list. The bison and elk are long gone, and even the exotic race of elk which was introduced and thrived for a time, recently has been *Extirpated* by disease. The sika deer, introduced on Assateague Island, and succeeding very well there, is regarded with concern because of its tiny range and small population. On the other hand, there is no large mammal in the East more abundant than the fourth ungulate of the state, the white-tailed deer. Undoubtedly, it is more abundant now than ever before.

Half of the terrestrial Carnivora are on the list. The gray wolf has been *Extirpated* from Virginia as well as the other eastern states. The fisher was lost, but has been reestablished in West Virginia, and may be spreading into Virginia. The river otter of the mountain counties is on the verge of *Extirpation*, and some lowland populations seem to be declining. The mountain lion is reestablished in Virginia after a lapse of almost a century, but its numbers probably are very low and it must be considered to be *Endangered*. The present rate of bobcat harvest, accelerated because of high fur prices, probably exceeds the replacement rate of the animal. Although the black bear is thriving in some parts of its range in Virginia, some of its populations may be overharvested. Most concern is for the isolated Dismal Swamp bears. Finally, the tiniest of all of the Carnivora, the least weasel, is of *Undetermined Status*. It appears to be rare and irregularly distributed in Virginia. The thriving Carnivora are the foxes, skunks, long-tailed weasel, mink, and raccoon.

Half of the species of Insectivora recorded for Virginia are troubled. These small, in some cases tiny, mammals are sensitive to changes in temperature and humidity and often do not survive habitat modifications. In some instances they survive today as relicts of climates of the past. The water shrew, with its only known Virginia locality now at the bottom of a deep lake, is *Endangered*. The lowland subspecies of the masked shrew, known in Virginia only from one locality in Fairfax County; a subspecies of the southeastern shrew, found only in the Dismal Swamp; and the southern subspecies of the star-nosed mole; are all *Threatened*. The big-tailed shrew, restricted to cool, damp rockslides and cliffs, and the pygmy shrew, the smallest North American mammal, are of *Special Concern*. The non-troubled fraction of the Insectivora includes, among others, the short-tailed shrew (one of the most abundant and widespread mammals of Virginia) and the common moles.

Recreational use of caves probably has *Extirpated* the eastern big-eared bat from southwest Virginia and has *Endangered* three other species, two of which once may have occurred in larger colonies than any other Virginia bats. Fortunately, most other bats of the state are more adaptable and may not face serious problems of survival at the moment. Also, they undoubtedly will benefit from the efforts to save the *Endangered* species.

About a quarter of the rodent fauna has problems. The porcupine disappeared before much was known about it in Virginia. The beaver was completely trapped out, so that none remained, but restocking has restored it to almost every county in the state. Lowland fox squirrels of two subspecies have been *Extirpated*, or survive in tiny populations. A small colony of one of them has been reestablished on Assateague Island. The northern flying squirrel is almost gone. The introduced and noxious black rat, one of the greatest pests of colonial America, seems to be doomed to extirpation. We classify it as *Endangered* but do not advocate its protection. The cotton mouse and lemming vole of the Dismal Swamp and adjacent lowlands, and the rock vole of the mountains are of *Undetermined Status*, but may no longer occur in Virginia. Needless to say, the status of most other rodents of the state is excellent. Such adaptable species as gray squirrel, southern flying squirrel, deer mouse, white-footed mouse, meadow vole, and muskrat remain at least as abundant as they ever have been.

The troubled species are not evenly distributed geographically in Virginia (Table 3). Most are in the mountains (16) and coastal lowlands (12), or have (or had) nearly statewide ranges (7). Only one, the Maryland race of the masked shrew, is restricted to the Piedmont.

Most of the mountain species (water shrew, snowshoe hare, northern flying squirrel, fisher, rock vole) prefer spruce-fir forests, most of which have been destroyed by logging and burning. Species which inhabit deciduous and mixed forest generally have fared much better. The *Extirpated* and *Endangered* bats are cave inhabitants which cannot tolerate the disturbance of human intrusion into their habitat. The river otter and star-nosed mole occur along streams and in swamps and marshes, and the big-tailed shrew is restricted to cool, damp talus. Among the mountain species, the porcupine, mountain lion, and New England cottontail were (or are) rather unspecific in their choice of forest habitat. The least weasel -- found in buildings, meadows, thickets and forest -- seemingly is even more ubiquitous.

All of the troubled lowland species are habitat specialists. Seven of twelve are mostly or entirely confined to the Dismal Swamp (southeastern shrew, star-nosed mole, eastern big-eared bat, marsh rabbit, cotton mouse, lemming vole and bobcat). Two are confined to islands (sika and cottontail); the manatee prefers warm-water estuaries; and the fox squirrel is seldom found far from loblolly and longleaf pine forest.

None of the species with statewide distribution was (or is) very specific in its choice of habitat. Most are large game, fur-bearing, or predatory species (elk, bison, bear, beaver, wolf) with relatively low reproductive rates. The black rat has been outcompeted by the Norway rat. The pygmy shrew is a relict of the ice ages and may have been declining long before human beings became a faunal factor.

In summary, it can be said that most of Virginia's troubled mammals are (1) habitat specialists that cannot survive alteration of their homes, (2) have small geographic ranges and thus small populations, (3) are at the edges of their ranges in Virginia, or (4) are large, slow-reproducing game, fur-bearing, or predatory species. A few kinds leave us wondering about causes of their rarity or disappearance. We simply know too little about them to understand their problems.

In this interesting age in which we live, we do not object to spending time, effort and money to become better acquainted with shrews and bats, and voles, and a legion of other little things, as well as with economically more significant species. We are willing to make sacrifices to provide them living space and an opportunity to survive, for we are anxious for them to continue to enrich our lives by their presence. Fortunately, this philosophy is supported by the stated policy of the Virginia Commission of Game and Inland Fisheries:

1. To produce and maintain balanced game populations in harmony with all other land uses.
2. To increase and stabilize the carrying capacity of game ranges by improving the habitat by such means as may be found practicable.
3. To maintain sufficient breeding stock of all game and fur-bearing species so that there will be provided a maximum surplus of game animals, game birds, and fur-bearers for annual harvest by sportsmen and trappers on a sustained yield basis.
4. To protect and preserve the aesthetic value of wild animals and birds of non-game species.
5. To give due consideration to all values of native wild animals and birds in accordance with public demand.
6. To coordinate the management of game animals, game birds, and fur-bearers with the management of all natural renewable resources.

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Table I. Check List of Mammals Extirpated, Endangered, Threatened, of Special Concern, or Status Undetermined in Virginia

INSECTIVORA: shrews and moles

Masked shrew, <i>Sorex cinereus fontinalis</i>	Threatened
Big-tailed shrew, <i>Sorex dispar dispar</i>	Special Concern
Dismal Swamp shrew, <i>Sorex longirostris fisheri</i>	Threatened
Water shrew, <i>Sorex palustris punctulatus</i>	Endangered
Pygmy shrew, <i>Microsorex hoyi winnemana</i>	Special Concern
Star-nosed mole, <i>Condylura cristata parva</i>	Threatened

CHIROPTERA: bats

Gray myotis, <i>Myotis grisescens</i>	Endangered
Social myotis, <i>Myotis sodalis</i>	Endangered
Eastern big-eared bat, <i>Plecotus rafinesquii macrotis</i>	Special Concern
Eastern big-eared bat, <i>Plecotus rafinesquii rafinesquii</i>	Status Undetermined
Western big-eared bat, <i>Plecotus townsendii virginianus</i>	Endangered

LAGOMORPHA: rabbits and hares

Eastern cottontail, <i>Sylvilagus floridanus hitchensi</i>	Status Undetermined
Marsh rabbit, <i>Sylvilagus palustris palustris</i>	Special Concern
New England cottontail, <i>Sylvilagus transitionalis</i>	Status Undetermined
Snowshoe hare, <i>Lepus americanus struthopus</i>	Special Concern
Snowshoe hare, <i>Lepus americanus virginianus</i>	Endangered

RODENTIA: squirrels, mice, rats, etc.

Fox squirrel, <i>Sciurus niger cinereus</i>	Endangered
Fox squirrel, <i>Sciurus niger niger</i>	Endangered
Northern flying squirrel, <i>Glaucomys sabrinus fuscus</i>	Endangered
Beaver, <i>Caster canadensis canadensis</i>	Extirpated
Beaver, <i>Caster canadensis carolinensis</i>	Extirpated
Cotton mouse, <i>Peromyscus gossypinus gossypinus</i>	Status Undetermined
Rock vole, <i>Microtus chrotorrhinus carolinensis</i>	Status Undetermined
Southern lemming vole, <i>Synaptomys cooperi helaletes</i>	Status Undetermined
Black rat, <i>Rattus rattus</i>	Endangered
Porcupine, <i>Erethizon dorsatum dorsatum</i>	Extirpated

CARNIVORA: dogs, cats, weasels, seals, etc.

Gray wolf, <i>Canis lupus lycaon</i>	Extirpated
Black bear, <i>Ursus americanus americanus</i>	Special Concern
Fisher, <i>Martes pennanti pennanti</i>	Endangered
Least weasel, <i>Mustela nivalis allegheniensis</i>	Status Undetermined
River otter, <i>Lutra canadensis lataxina</i>	Endangered
Mountain lion, <i>Felis concolor cougar</i>	Endangered
Bobcat, <i>Felis rufus floridanus</i>	Special Concern

SIRENIA: manatee

Manatee, <i>Trichechus manatus latirostris</i>	Extirpated
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ARTIODACTYLA: deer, cattle, etc.

Elk, <i>Cervus elaphus canadensis</i>	Extinct
Elk, <i>Cervus elaphus nelsoni</i>	Extirpated
Sika, <i>Cervus nippon</i> subsp?	Special Concern
Bison, <i>Bison bison bison</i>	Extirpated

Table 2. Classification by Status of Mammals Extirpated, Endangered, Threatened, of Special Concern, or Status Undetermined in Virginia

EXTIRPATED	beaver (two subspecies) porcupine gray wolf	manatee elk bison
ENDANGERED	water shrew gray myotis social myotis western big-eared bat snowshoe hare fox squirrel (lowland subspecies)	northern flying squirrel black rat fisher (extirpated, reestablished) river otter (mountain population) mountain lion
THREATENED	masked shrew (Maryland subspecies) Dismal Swamp shrew	star-nosed mole (southern subspecies)
SPECIAL CONCERN	big-tailed shrew pygmy shrew eastern big-eared bat marsh rabbit	black bear (certain populations) bobcat sika
STATUS UNDETERMINED	eastern cottontail (insular subspecies) New England cottontail cotton mouse	rock vole lemming vole (lowland subspecies) least weasel

Table 3. Geographical Distribution of Mammals Extirpated, Endangered, Threatened, or Status Undetermined in Virginia

	MOUNTAINS	PIEDMONT	COASTAL PLAIN	WIDESPREAD
EXTIRPATED	porcupine		manatee	beaver gray wolf elk bison
ENDANGERED	water shrew gray myotis social myotis western big-eared bat snowshoe hare northern flying squirrel fisher river otter mountain lion		fox squirrel	black rat
THREATENED	star-nosed mole	masked shrew	southeastern shrew (Dismal Swamp) star-nosed mole	
SPECIAL CONCERN	big-tailed shrew		eastern big-eared bat marsh rabbit bobcat sika	pygmy shrew black bear (several populations)
STATUS UNDETERMINED	eastern big-eared bat New England cottontail rock vole least weasel		eastern big-eared bat eastern cottontail (barrier islands) cotton mouse lemming vole	

SPECIES ACCOUNTS

Accounts of 27 species are presented in this section. The degree of threat varies from species to species. Perhaps further study will show that some may not be in trouble at all. Others may already have been extirpated from Virginia. Hopefully some will benefit from the efforts of this symposium.

ENDANGERED (11)

1. WATER SHREW

Sorex palustris punctulatus Hooper

Phylum: Chordata
Class: Mammalia

Order: Insectivora
Family: Soricidae

Description: Next to the short-tailed shrew (*Blarina brevicauda* Say), the water shrew is the largest eastern shrew. It is also one of the most handsome, with glossy gray-black dorsum, silvery-buff underparts, whitish hands and feet, and long (about half the total length), sharply bicolored tail. Its toes and the sides of its feet are fringed with stiff hairs, making its hind appendages effective paddles for swimming. Measurements (in millimeters) of the holotype and two paratypes (in parentheses) from West Virginia: total length 152 (153-155), tail vertebrae 64 (70-71), hind foot 19 (20-20) (Hooper 1942); weight 12 to 15.3 grams (McKeever, 1952). Color illustration: Burt and Grossenheider (1976, plate 1).

The water shrew cannot be readily confused with any other local mammal. It is somewhat like *Sorex dispar* in color and proportions, but is blacker and brighter dorsally, paler ventrally, has a more sharply bicolored tail, and is altogether larger, especially in the size of its hind feet (19-20 millimeters *vs.* 14-15 millimeters). It is only slightly smaller than the short-tailed shrew, *Blarina brevicauda*, but it has a much longer, bicolored tail (63-71 millimeters *vs.* 23-29 millimeters), is brighter, and has more contrast between upper and underparts.

Present Range: The water shrew occurs in the boreal forest belt from Labrador, Nova Scotia and New England across Canada and New York, northern Michigan, Wisconsin, Minnesota, and the eastern edge of the Dakotas to southeastern Alaska; and extends south in the mountains to California, Arizona, New Mexico, Tennessee, and North Carolina. The subspecies *Sorex palustris punctulatus* is found in the Southern Appalachians in southwest Pennsylvania, eastern West Virginia, and western Virginia. Specimens from an apparently isolated population in North Carolina and Tennessee have not been positively identified to subspecies, but may represent *Sorex palustris punctulatus*.

Distribution in Virginia: Probably once widespread in the mountainous portion of the state, the water shrew has been found in recent times (1972-1975) only in extreme northwestern Bath County (Figure 1). It may no longer occur there since the area has been subsequently cleared and flooded as part of a pump-storage electrical generating facility. Daily variation in water level where the shrews were caught may be as much as fifty feet (Pagels, pers. comm., 1978).

Habitat and Mode of Life: The Virginia specimens of *Sorex palustris* were taken in or near a small rocky stream in a narrow, steep-sided valley, in beech-yellow birch-sugar maple forest (Pagels and Tate, 1976). Other southern Appalachian specimens almost without exception have been closely associated with swiftly flowing, rocky-bedded streams, often with rhododendron on the banks, and with yellow birch as one of the dominant canopy trees. Other common forest trees at capture sites have been hemlock, red spruce, red maple, or yellow poplar (tulip tree).

The water shrew is aptly named, for it is seldom found far from water. Usually it has been snap-trapped on stream banks or on rocks in streams. Occasionally it has been caught in can traps dug into willow thickets near streams. Rarely may a water shrew be observed. Kellogg (1937) stated that one seen in Pocahontas County, West Virginia, dived into a stream like a little muskrat, looked like a little silver streak when it swam submerged, and attempted to hide under the banks of the stream. Dense fur and large, hair-fringed feet and toes adapt this shrew very well to swimming. Most of its food (immature stages of aquatic insects) is obtained in the water. In the southern Appalachians, Trichoptera, Plecoptera and Ephemera are often taken (Conaway and Pfitzer, 1952; Whitaker *et al.*, 1975). In turn, the water shrew is occasionally eaten by trout (Doutt *et al.*, 1966).

Reproduction: A female water shrew collected in the Nantahala Mountains in North Carolina had five embryos with a crown-rump length of 7 millimeters on 20 April 1974 (Whitaker *et al.*, 1975). Elsewhere in the range of *Sorex palustris*, pregnant or lactating females have been found between February and August. Embryos number 5 to 7 (Asdell, 1964).

Number in Captivity: No data.

Status in Virginia: *Endangered*. It seems likely that the water shrew no longer occurs at the single locality where it has been found in Virginia (eliminated by clearing and flooding). At one time water shrews were probably more numerous in the higher mountains of Virginia. It is possible that other surviving isolated populations will be found, but at best numbers must be very low. In the Appalachians south of northeastern Pennsylvania, shrews are relicts of the ice ages. Large, continuous populations may never have existed in historic times. The remnants should be jealously protected.

Protective Measures Proposed: If there are remnant populations of water shrews to be protected in Virginia, they first must be located. Then it will be necessary to protect inhabited streams from clearing, siltation, pollution (particularly with insecticides), and other destructive disturbance.

Author: Charles O. Handley, Jr.

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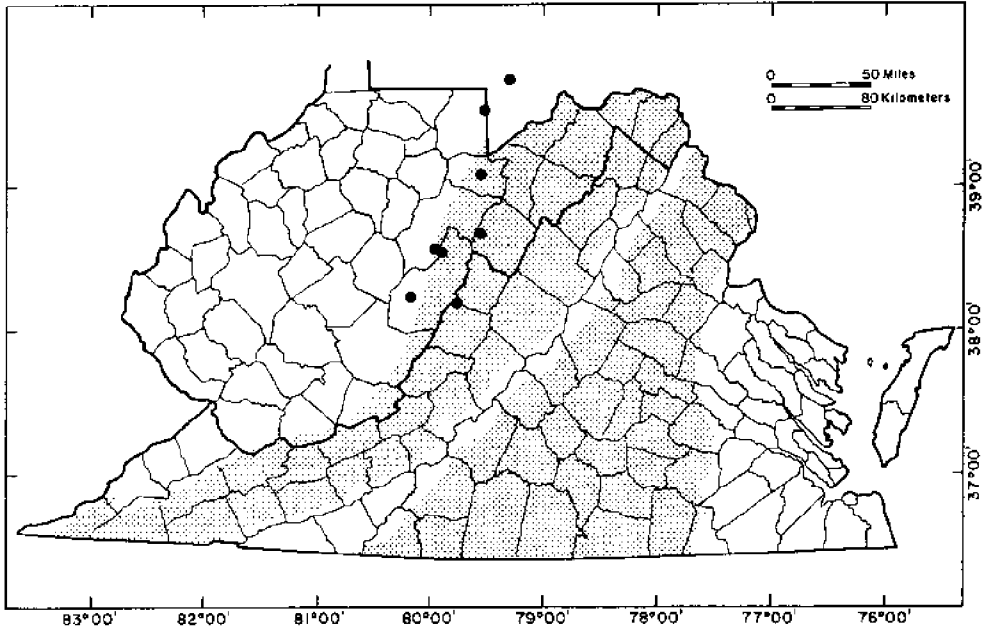


Figure 1. Distribution of the Water Shrew (*Sorex palustris*) in Virginia and West Virginia

2. GRAY MYOTIS

Myotis grisescens A. H. Howell

Phylum: Chordata
Class: Mammalia

Order: Chiroptera
Family: Vespertilionidae

Description: *Myotis grisescens* is a medium-size, mouse-eared bat. Its fur is short, soft, dusky or reddish-brown above; paler, more whitish below. Dorsal hairs are similar in color from base to tip; not sharply defined blackish at the base as they are in other small-eared eastern American bats. Foot relatively large; wing attached to metatarsus. Measurements (in millimeters) of 17 adult females (males slightly smaller): Total length 90 (86-95), tail vertebrae 40 (38-44), hind foot 10 (9-11), ear from notch 14 (13-15), forearm 43.5 (41.2 to 45.6). *Myotis grisescens* is the only bat of eastern North America with almost unicolor dorsal hairs and wing attached at the metatarsus.

Present Range: The gray myotis is found in caves, mostly in the middle Mississippi Valley, from Virginia west to Oklahoma and from Missouri, Illinois, and Indiana south to Florida. The type locality of *Myotis grisescens* is Nickajack Cave, Marion County, Tennessee.

Distribution in Virginia: *Myotis grisescens* is a true cave bat that migrates between winter cave hibernacula and summer cave maternity colonies and roosts. Only summer populations, apparently all of them bachelor colonies, are known in Virginia. This species has been reported from Grigsby Cave, Scott County

(Holsinger, 1964b); Litton Cave #1, Lee County (Holsinger, pers. comm., 1978); and Speers Ferry Cave, Scott County (Holsinger, pers. comm., 1978) (Figure 2). In August, 1977, Litton Cave #1 contained about 200 individuals, and there were about 1000 in Grigsby Cave.

Habitat and Mode of Life: During the summer, females form maternity colonies, numbering in the thousands, while males cluster in smaller groups, usually in other caves. Nightly foraging for aquatic insects and mayflies is mainly over large rivers and reservoirs. Roosts are generally located close to these aquatic foraging areas (Tuttle, 1976b).

Females are the first to migrate (in early September) to winter hibernacula. They are followed by juveniles and males around mid-October. Some whole colonies migrate as far as 300 miles. Nearly the entire population (estimated at 2,000,000) hibernates in only five caves in the southeastern United States. These caves are typically deep pits with cold air-trapping characteristics. The bats form tight clusters (sometimes layered) of up to several thousand individuals. Preferred hibernation temperatures range from 7°-10°C (45°-50°F).

Females emerge first from hibernation in early April, followed by yearlings and then males (Tuttle, 1976a).

Reproduction: Mating occurs in late fall. Females store sperm in the uterus. The young are born during late May and early June, and are volant by early-to-mid July. Only one young is produced per female each season. Females reach sexual maturity in two years.

Number in Captivity: No data.

Status: *Endangered*. The gray myotis is *Endangered* throughout its range in the United States. Since this species aggregates in only a few caves (especially in the winter), it is especially vulnerable to local catastrophes and human disturbance. Summer maternity colonies are particularly sensitive. Merely shining a light on them will cause large numbers of young to be dropped to the floor, resulting in high mortality (Tuttle, 1976b). In consequence, maternity colonies have disappeared altogether or have been forced to other caves, resulting in a lowered survival rate of the young. Tuttle (1975) estimated that only 50 percent of the young survive to reproductive maturity at two years of age. Total numbers of the species have been declining due to spelunker traffic, destruction of habitat by flooding, commercialization, and outright killings. In a 20-year period, five major hibernacula were destroyed. Each was estimated as having contained over 100,000 individuals (Tuttle, 1975). Suitable cave habitats are rare, as evidenced by the long migration distances and the fact that only a small number of caves are occupied. A large maternity colony is required for development of the young. This species is therefore very intolerant of reduction in numbers.

Protective Measures Proposed: Refer to "Bats--General."

Remarks: Other common names: gray bat, Howell's bat, and cave bat.

Authors: Ginny Tipton, Alan Tipton, and Charles O. Handley, Jr.

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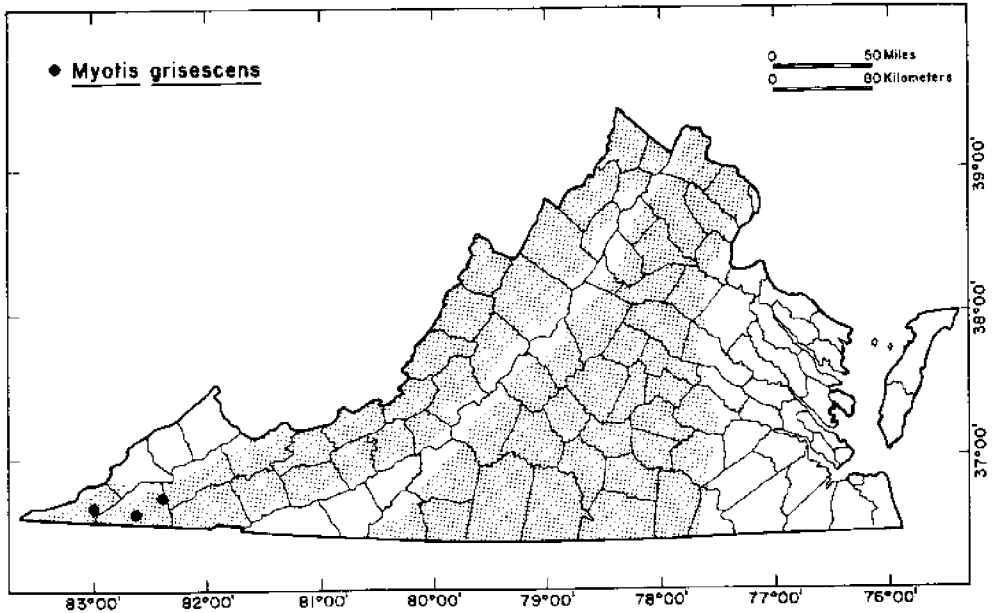


Figure 2. Distribution of Gray Myotis (*Myotis grisescens*) in Virginia

3. SOCIAL MYOTIS

Myotis sodalis Miller and G. M. Allen

Phylum: Chordata
Class: Mammalia

Order: Chiroptera
Family: Vespertilionidae

Description: *Myotis sodalis* is a small brown bat with short, mouse-like ears and plain nose. Its pelage is smooth-lying and has a rather pastel pinkish-brown hue. Measurements (in millimeters) of 20 adult females (males average slightly smaller): total length 84 (77-91), tail vertebrae 37 (33-42), hind foot 8 (7-9), ear from notch 13 (12-15), forearm 38.9 (36.2 to 40.6). From other *Myotis* that occur with it, *Myotis sodalis* can be distinguished by the combination of keeled calcar, short toe hairs (barely reaching base of claw), and short ear (not extending beyond nose when laid forward).

Present Range: The social myotis is found mostly in the middle United States, from Virginia west to Oklahoma and from Wisconsin and Michigan south to Florida. In the Appalachians it extends northeastward to New York, Vermont, and Massachusetts. The type locality of *Myotis sodalis* is Wyandotte Cave, Crawford County, Indiana.

Distribution in Virginia: During the winter *Myotis sodalis* hibernates in caves in the western part of the state (Figure 3). There are no summer records of this species in Virginia. It has been reported from:

- ? Blue Spring Cave, Alleghany County (Dyas, pers. comm., 1978)
- ? Breathing Cave, Bath County (Holsinger, 1964a)
- ? Clover Hollow Cave, Giles County (Holsinger, 1964a)
- * Cumberland Gap Saltpetre Cave, Lee County (Wallace, pers. comm., 1978)
- * Madden's Cave, Shenandoah County (Handley and Patton, 1947)
- * Nellie's Hole, Montgomery County (Handley and Patton, 1947)
- ? Newberry-Bane Cave, Bland County (Holsinger, 1964a)
- ? Peery Saltpetre Cave, Botetourt County (Holsinger, pers. comm., 1978)
- * Rocky Hollow Cave, Wise County (Tuttle, pers. comm., 1978)
- * Starr Chapel Saltpetre Cave, Bath County (Holsinger, 1964a)
- ? Stull's Cave #1, Alleghany County (Dyas, pers. comm., 1978)
- * Tawney's Cave, Giles County (Handley and Patton, 1947)
- * Witheros Cave, Bath County (Handley and Patton, 1947)

*Positive identification

?Uncertain identification

Caves not checked in 1977-78: Breathing, Madden's, Nellie's Hole, Newberry-Bane. Of those checked, Cumberland Gap Saltpetre had 150 individuals, Rocky Hollow had 500-1000, and Starr Chapel had two.

Habitat and Mode of Life: The summer range of *Myotis sodalis* seems to approximate its winter range, but summer records are few, and mostly for males. Nursery populations were unknown until 1974. It appears that this species disperses into small groups and spends its summers either in caves or under loose bark of dead trees along streams. The bats emerge at night to feed on moths, mayflies, and other insects in treetops and over streams (Humphrey *et al.*, 1977).

During autumn, the bats may migrate up to 300 miles to caves in which they spend the winter (Hall, 1962). In late August, September, and early October, they exhibit "swarming" behavior; *i.e.*, large numbers congregate at cave entrances and fly in and out from dusk to dawn. By mid-October, the bats have entered hibernation. They typically congregate in compact clusters on flat ceilings of large caves. The clusters commonly contain 500-1000 (sometimes as many as 5000) bats. Each individual bat grasps the cave ceiling, and all one normally sees in a hibernating cluster is ears, noses, and wrists. The bats occupy a rather narrow zone within the cave, usually close to an entrance. Optimum hibernating temperature is from 3°-6°C (37°-43°F), with a relative humidity preference of about 87 percent (ranging from 66 to 95 percent). The bats start emerging from hibernation in April. The females leave the hibernacula first, followed in a couple of weeks by the males. By mid-May very few bats remain in the caves (Barbour and Davis, 1969).

Reproduction: Cope and Humphrey (1977) believed that the autumn swarming behavior helps bring dispersed summer populations together for breeding. Mating occurs in the caves in early October, and sperm are stored in the uterus until spring. The only study of a nursery roost is that of Humphrey *et al.* (1977). The gestation period is not known. The young are born toward the end of June or early in July, and they are volant in 25-35 days.

Each female apparently produces a single young per season. Beginning in mid-July and continuing through mid-August, the young apparently fly and forage with their mothers.

Number in Captivity: Attempts at maintaining this and most other species of North American bats in captivity have, in general, been dismal failures. The bats do not respond well to human attention and care.

Status: *Endangered*. The social myotis is *Endangered* throughout its range in the United States. *Myotis sodalis* is considered *Endangered* because of its tendency to concentrate the hibernating population in only a few caves. During the winter, 94 percent of the known population of around 500,000 is found in 13 caves and mines in Kentucky, Missouri, West Virginia, Tennessee, and Indiana. Thus, a local catastrophe could greatly affect the total numbers of this species. The entire population has declined during recent years. According to Mohr (1972), *Myotis sodalis* has disappeared from some caves and is virtually gone from the northeastern United States. Engel *et al.* (1975) noted a 71.5 percent decline in the last 15 years in Indiana, Illinois and Kentucky. This decline has been attributed to natural disasters (such as flooding), pesticide poisoning, and human disturbance in the form of vandalism, increased spelunker traffic, cave commercialization, and scientific research (especially in the form of bat-banding, collecting, and frequent observational trips to hibernacula). This bat is readily disturbed by human activity.

Protective Measures Proposed: The only protective measure in effect in Virginia at the moment is a moratorium on traffic in caves containing colonies of *Endangered* or *Threatened* species. This is a voluntary moratorium imposed upon its members by the Virginia Region of the National Speleological Society (NSS). It is ignored by some members, and, also, non-NSS cavers are unaware of the existence of the moratorium. Refer to "Bats--General."

Remarks: Other common names: Indiana myotis, Indiana bat, social bat, and cluster bat.

Authors: Ginny Tipton, Alan Tipton, and Charles O. Handley, Jr.

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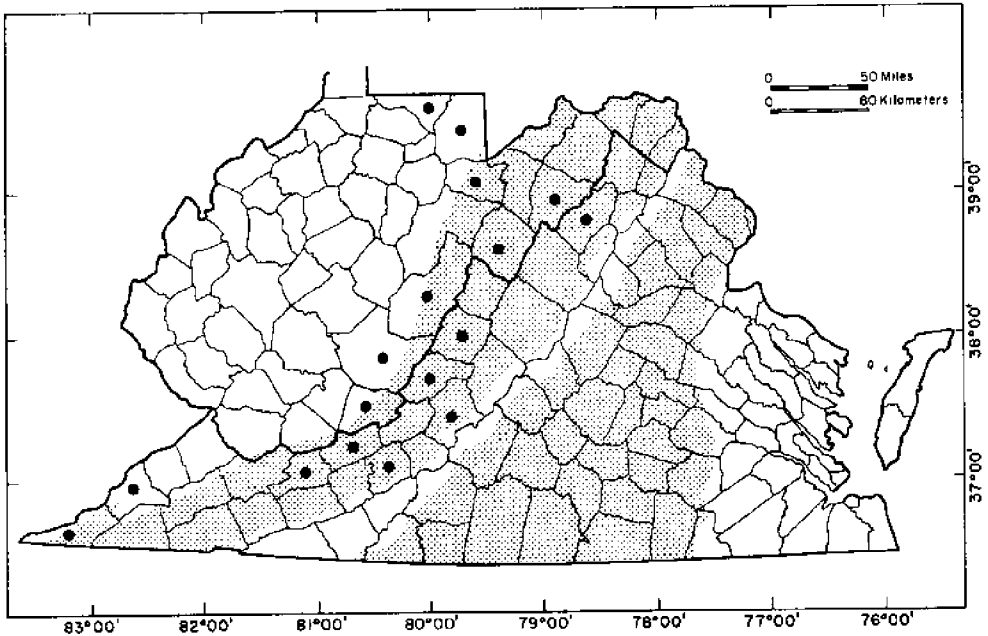


Figure 3. Distribution of Social Myotis (*Myotis sodalis*) in Virginia and West Virginia

4. WESTERN BIG-EARED BAT

Plecotus townsendii virginianus
Handley

Phylum: Chordata
Class: Mammalia

Order: Chiroptera
Family: Vespertilionidae

Description: *Plecotus townsendii virginianus* is a medium-sized bat with huge ears, connected across the forehead; mitten-shaped glandular masses on the muzzle; and elongated nostril openings. Its fur is long and lax; hairs of dorsum dark (sometimes sooty) brown at tip and pale brown at base; underparts buffy or pale cinnamon-brown, with hair bases gray-brown (Figure 4). Average measurements (in millimeters) of ten adult female *Plecotus townsendii* from West Virginia (males average slightly smaller): total length 103 (99-112), tail vertebrae 49 (46-54), hind foot 12 (11-13), ear from notch 35 (34-39), forearm 45.8 (44.6 to 47.4).

Among the bats of eastern North America only *Plecotus rafinesquii* approaches *Plecotus townsendii* in size of ears. The two big-eared bats differ in color of underparts (whitish in *Plecotus rafinesquii*; buffy or brownish in *Plecotus townsendii*) and in color of hair bases throughout (blackish in *Plecotus rafinesquii*; grayish or brownish in *Plecotus townsendii*).

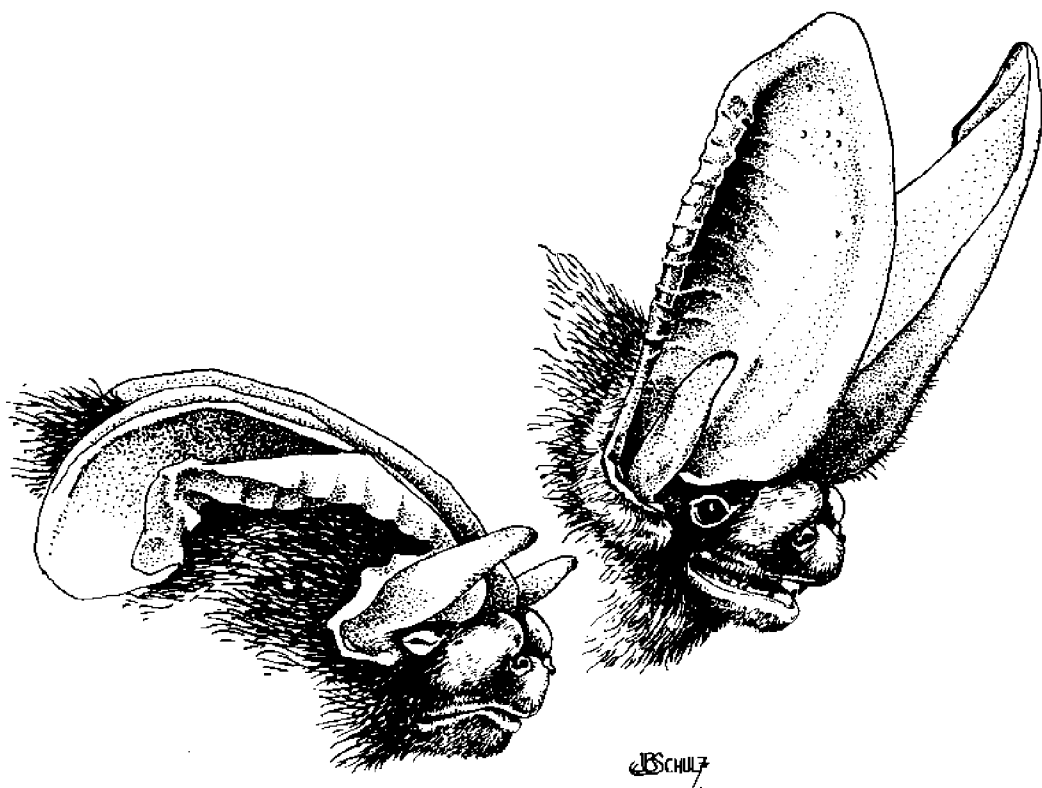


Figure 4. *Plecotus townsendii virginianus*

Present Range: The species is widespread in the western United States, extreme southwestern Canada, and the Mexican Highlands south to the Isthmus of Tehuantepec. There are small isolated populations in the Great Plains, in the Ozark Highlands, and in the central Appalachians. The range of the subspecies *Plecotus townsendii virginianus* is fragmented into several populations. Most extensive is that occupying a dozen or more caves in tributaries of the Potomac River in eastern West Virginia and in tributaries of the James River in Virginia. Isolated populations are found in Tazewell County, Virginia, and in Lee and surrounding counties in Kentucky. The type locality of *Plecotus townsendii virginianus* is Schoolhouse Cave, 4.4 miles northeast of Riverton, 2205 feet, Pendleton County, West Virginia.

Distribution in Virginia: The western big-eared bat is known in Virginia only as an inhabitant of a few caves, all above 1500 feet elevation, in Bath, Highland, Rockingham and Tazewell counties (Figure 5). Many other limestone caverns in the Shenandoah, James, New and Clinch river valleys seem to be uninhabited by this species. It has been reported in:

Better Forgotten Cave, Highland County (Conrad, 1961)
 Breathing Cave, Bath County (Conrad, 1961)
 Cassell Farm Cave #2, Tazewell County (Howell, 1909; Mohr, 1933)
 Dove Cave, Rockingham County (Mumaw, pers. comm., 1967)
 Hupman's Saltpetre Cave, Highland County (Conrad, 1961)
 Varner's Cave, Highland County (Robinson, pers. comm., 1978).

Except for Cassell Farm Cave #2 and Hupman's Saltpetre Cave, records for each of these caves were for single individuals. Cassell Farm Cave #2 and Varner's Cave were checked for bats in 1977-78. About 100 *Plecotus townsendii virginianus* were in Cassell Farm Cave #2. There were none in Varner's Cave.

Habitat and Mode of Life: *Plecotus townsendii virginianus* roosts only in caves. Summer roosts usually contain maternity colonies of females and young; males are mostly solitary at this season. Maternity colonies seem to require warm caves. In contrast, winter roost sites are often near cave entrances or in passageways where there is considerable air movement. Temperature in these sites sometimes is lower than will be tolerated by other cave bats. Apparently *Plecotus townsendii* requires unusually low temperatures for successful hibernation. Solitary individuals and small clusters are the rule in hibernating *Plecotus townsendii*, although tight clusters of up to a hundred or more individuals of both sexes are occasionally encountered. The solitary bat protects itself from air temperature variations by wrapping its wings and interfemoral membrane over its underparts, and coiling its ears against the sides of its neck. Bats in clusters fold their wings against their sides and may keep their ears extended except at very low temperatures. Although a colony may occupy the same cave throughout the year, it may have one or more alternate roosts in other caves. *Plecotus townsendii virginianus* will move from one roost to another at any season, even in cold weather, but it apparently is non-migratory. The longest recorded movement is only forty miles. Although food habits of *Plecotus townsendii virginianus* are poorly known, it is thought to subsist mostly on moths. It is nocturnal, beginning to forage after it is quite dark (Handley, 1959; Barbour and Davis, 1969; Humphrey and Kunz, 1976).

Reproduction: In California the mating season of *Plecotus townsendii* extends from early October to late February. Copulatory activity is greatest in the winter roosts when the females are more or less dormant. Ovulation occurs from February to April, and fertilization is accomplished presumably by stored sperm. Females gather from diverse hibernacula during April and May to form maternity colonies in warm caves. Parturition occurs between April and July, and the young begin to fly in about three weeks. Ordinarily, each female produces only a single young annually. Young are left in the maternity roost while their mothers forage. They probably nurse for about two months, by which time they are as large as their mothers and are skillful fliers (Handley, 1959).

Number in Captivity: No data.

Status: *Endangered.* When they petitioned the Fish and Wildlife Service to list *Plecotus townsendii virginianus* as *Endangered*, Hall and Harvey (1977) cited the following circumstances:

1. It is restricted to a very small area for reproduction and hibernation.
2. Both winter and summer populations are extremely intolerant to disturbance.

3. The total population is small. Harvey (1976) estimated 2500 individuals.
4. The population is dwindling in size.
5. Several wintering colonies have disappeared from caves.

Humphrey and Kunz (1976) hypothesized that *Plecotus townsendii* was more widespread during the last glacial interval, when favorable climatic conditions allowed it a wider choice of habitat. They believed that severe post-Pleistocene winters have extirpated the species from most of its range in the East and have forced the relict populations into a few caves which provide the climatic conditions to which *Plecotus townsendii* is physiologically adapted for reproduction and hibernation. They concluded that the small size of *Plecotus townsendii* populations, rather severe ecological limitations, and high sensitivity to disturbance, particularly in maternity colonies, make the species extremely vulnerable in the Great Plains. This conclusion seems equally applicable to the relict Appalachian populations.

Protective measures in effect are the same as those listed for *Myotis sodalis*, but the Fish and Wildlife Service has not yet acted on the petition to list *Plecotus townsendii virginianus* as *Endangered*.

Protective Measures Proposed: Refer to "Bats--General."

Remarks: Other vernacular names include western lump-nosed bat, western long-nosed bat, and Townsend's big-eared bat.

Authors: Charles O. Handley, Jr., Ginny Tipton, and Alan Tipton.

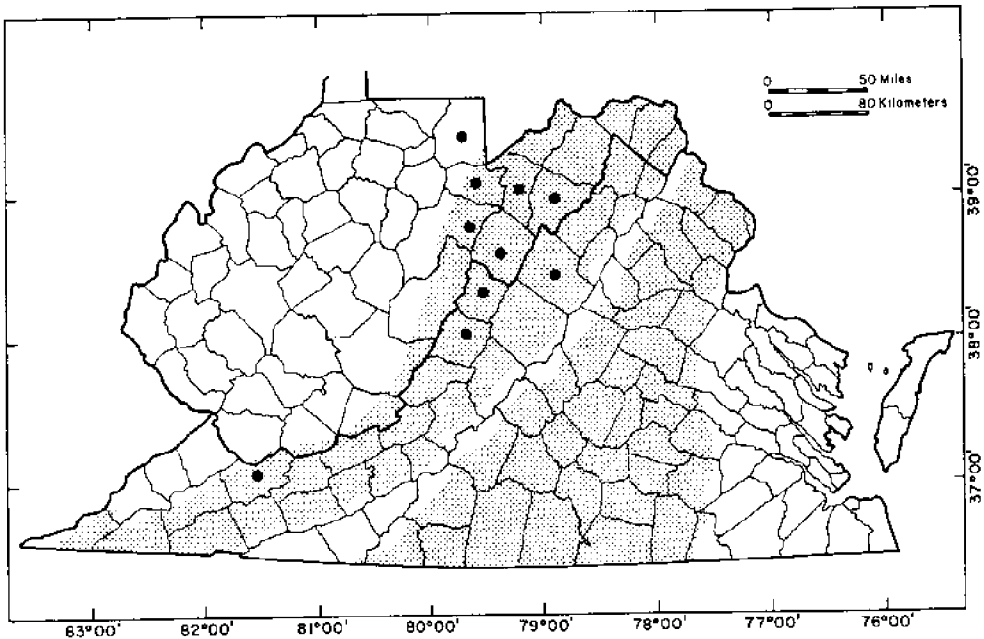


Figure 5. Distribution of Western Big-Eared Bat (*Plecotus townsendii virginianus*) in Virginia and West Virginia

BATS--GENERAL

The *Endangered* species of cave-inhabiting bats of Virginia face a common problem -- intrusion of human beings into their habitat and consequent disruption of reproduction or hibernation. All of these bats are physiologically adapted to a narrow range of ecological conditions. Even a slight alteration may prove to be disastrous.

Protective Measures Proposed: There are a number of ways to protect cave bats. Unfortunately, the bats may not survive long enough for the protective measures to become effective. Also, public relations and explanatory signs may only lead to vandalism (Humphrey, 1969; Anonymous, 1972; Mohr, 1972; Harvey, 1976, Engel *et al.*, 1975).

Restraints for the general public:

1. Educate the public through newspapers, television, popular magazines, etc.
2. Stop waste disposal in caves (like Nellie's Hole).
3. Place explanatory signs at cave entrances.
4. Stop loss of food supply by preserving open habitats and their insects.
5. Encourage concerned groups, such as The Nature Conservancy, to gain control of critical hibernating and roosting sites and to restrict entry.
6. Persuade the state and federal governments to declare and enforce moratoria on visits to bat caves during critical periods.
7. Persuade owners of caves to restrict entry during critical periods.

Restraints for the research scientist:

1. Obtain necessary permits to work with *Endangered* species.
2. Avoid lengthy disturbance of bats.
3. Stay away from nursery colonies (last week of March through the second week in October).
4. If it is necessary to handle hibernating bats, avoid arousing a population more than once per winter.
5. Monitor populations (biennial surveys). Try to locate additional colonies.
6. To determine summer population size, make photographic estimates of evening flights.
7. Speed and refine data collection in on-site studies.

Remarks: Bats are important as natural controls of insect populations. A single bat may consume from two to four grams of insects per night. They are also primary producers in fragile cave ecosystems where there is no light for growth of plants (fungi are not plants in the 5-kingdom classification scheme).

Authors: Ginny Tipton and Alan Tipton.

* * * * *

5. SNOWSHOE HARE

Lepus americanus virginianus Harlan
Lepus americanus struthopus Bangs

Phylum: Chordata
 Class: Mammalia

Order: Lagomorpha
 Family: Leporidae

Description: *Lepus americanus virginianus* is the largest and most brightly colored snowshoe hare. Summer pelage is rich rusty-brown on dorsum, throat, and limbs; whitish on chin and abdomen. Winter pelage is almost entirely white or whitish except for more or less brownish wash on feet and ears, and dusk to black at tips of ears (Figure 6). Average measurements (in millimeters) of five Pennsylvania hares: total length 513, tail vertebrae 54, hind foot 141; weight 3 to 5 pounds. Colored illustration: Burt and Grossenheider (1976, plate 20).

Lepus americanus struthopus is smaller, duller, and browner; its skull is smaller and more slender. Average measurements (in millimeters) of three hares from Nova Scotia: total length 468, tail vertebrae 29, hind foot 134.

In Virginia, only the cottontails (*Sylvilagus floridanus* and *sylvilagus transitionalis*) might be confused with the snowshoe hare. However, they are much smaller (total length averaging 427 vs. 513 millimeters, hind foot 94 vs. 141 millimeters); not as reddish in summer and not white in winter; and they have larger, more conspicuous, whiter tails. The hind foot track of a snowshoe hare in snow is almost twice the size of a New England cottontail track.



Figure 6. Snowshoe Hare (*Lepus americanus*)

Present Range: The species occurs to the northern limit of trees from Newfoundland and Labrador to Alaska, south to the Great Lakes and in the mountains to California, Nevada, Utah, New Mexico, West Virginia, and Virginia. The subspecies *Lepus americanus virginianus* is found from southern Ontario, southern Quebec, and central Maine south to the higher, wilder parts of Pennsylvania and northeastern Ohio, and a now isolated population is found in eastern West Virginia and western Virginia (Figure 7). Southward extension of range to eastern Tennessee (Kellogg, 1939; Hall and Kelson, 1959) has been doubted (Linzey and Linzey, 1971). *Lepus americanus struthopus* occurs naturally in northern Maine, southeastern Quebec, and the Maritime Provinces. It has been introduced in Newfoundland and, mostly unsuccessfully, in many parts of the former range of *Lepus americanus virginianus*.

Distribution in Virginia: *Lepus Americanus virginianus* was possibly once widespread in western Virginia in association with red spruce forest. However, the only certain record is a specimen from the head of Newman's Run, 3650 feet, Allegheny Mountain, extreme northwestern Highland County (adult female, USNM 293379, salvaged from the talons of a red-tailed hawk, 22 September 1943. There are unverified reports of snowshoe hares from a number of localities in the Blue Ridge as well as in the Alleghenies.

Habitat and Mode of Life: In Virginia and West Virginia the range of the snowshoe hare apparently coincided originally rather closely with that of red spruce. Typically the spruce was clear-cut, and after the logs were removed the remaining debris was eventually burned. The fires spread from the spruce zone to engulf whole mountains and valleys. Much of the humus was destroyed in the fires, with the result that spruce survived mainly in damp pockets, and regeneration in other areas has at best been slow. Since all spruce stands in Virginia were isolated disjunct relicts, this sequence of events probably was disastrous to associated spruce-dependent fauna such as the hare, northern flying squirrel, rock vole and fisher. The snowshoe hare survives on Allegheny Mountain in Highland County in a high, cold area of second growth yellow birch-red maple forest, with scattered spruce thickets, extensive tangles of *Rhododendron*, thick brush, patches of bog and marsh, and small openings with brambles, mountain laurel and scrubby yellow birch. Such ideal habitat persists where the white-tailed deer is not too abundant. Overbrowsing by deer has seriously reduced snowshoe hare habitat in Pennsylvania and in some parts of Virginia and West Virginia.

The hare is primarily a grazer in summer, feeding on a variety of grasses, clover, herbs, and tender parts of woody plants. In winter it is more of a browser; eating buds, twigs, young shoots, and bark of birch, alder, willow, several other hardwoods, and all of the conifers (Severaid, 1942). Like other hares, it reingests its fecal pellets (coprophagy). It forages mostly from dusk to dawn, and it usually is solitary except during the breeding season. Its numbers fluctuate dramatically in a 9- to 11-year cycle. As little as 10 percent of the population survives in cyclic lows.

The pelt becomes more or less white in winter (November-March). Snow ordinarily is no hindrance to the snowshoe hare, and deep snow may actually benefit it. It then can harvest buds, leaves and bark that otherwise would have been out of reach and, aided by its snowshoes, it is more likely to escape predators. It needs whatever advantage it can muster, for its predators are many: bobcat, fisher, foxes, large hawks and owls, dogs, and man.

The snowshoe hare seldom digs, but occasionally uses hollow logs and burrows of groundhogs or other mammals. It usually rests and hides in a "form" in thick vegetation, brush piles, or other protected areas. Permanent trails or "beats" are used to get about its 15- to 25-acre home range.

Reproduction: Between April and August the snowshoe hare produces 2 to 4 litters of 1 to 8 young (average 3). Impregnation occurs on the day of parturition. Promiscuity is the rule. The gestation period is 36 to 47 days. The young are precocial. They are fully furred and have their eyes open at birth. They can walk and hop by the time their hair dries. They soon disperse from their birth spot (the mother does not build a nest) into thick vegetation. They begin to feed on grass in 10 to 12 days and usually are weaned in 4-6 weeks, about the time the next litter is born. They are sexually mature in their second year. Longevity is about five years (Godin, 1977).

Number in Captivity: No. data.

Status: *Lepus americanus virginianus* - *Endangered*
Lepus americanus struthopus - *Special Concern*

The native subspecies, *Lepus americanus virginianus*, survives only in Highland County and must be considered *Endangered* in Virginia. Potential snowshoe hare habitat in Highland County is restricted to a 25 to 35 square mile area on Allegheny Mountain, Laurel Fork, and Middle Mountain. The Virginia population may number as few as dozens or as many as hundreds of individuals. Fortunately there is excellent snowshoe hare range in the adjacent West Virginia counties of Pocahontas, Pendleton, and Randolph where there is a substantial annual harvest of hares (Figure 7). The fact that the Virginia population is peripheral to and continuous with the larger West Virginia population is somewhat reassuring. However, even in West Virginia, *Lepus americanus virginianus* is not as widespread and abundant as it once was, and there have been efforts to augment the native population with introductions of exotic stock. According to McKeever (1942), the snowshoe hare

... probably always has been rather rare [in West Virginia] and always will be, compared to the population in more northern states ... even in peak years [it] probably will not become numerous enough to be considered abundant.

A. B. Brooks (1925) states that the varying hare must have originally lived throughout the spruce forest, an area of 732 square miles. As the forest was cut the range of the hare decreased and at present it is found only in restricted areas ... In early 1949 W. Gene Frum ... prepared [the following] report on the snowshoe hare in West Virginia, preliminary to a stocking program ...

"After about 1928, varying hares ... were restricted to Cheat Mountain, Gauley Mountain, Cold Knob--in northern Greenbrier County--and areas around the headwaters of Cherry River and Hills Creek north through Black Mountain to Tea Creek.

"During 1937-39, varying hares were released in Grant, Pendleton, and Randolph counties, mainly at Spruce Knob, Gatewood, Sinks of Gandy, Stony River Dam, and at Kumbrabow. Restocking efforts failed except in areas that contained spruce.

"Available information indicates that largest concentrations of hares are now found on Black Mountain, area around Cranberry Glades, Cheat Mountain, McGown Mountain, Spruce Mountain--north of Spruce Knob, and on Flat Rock Plains. It would also appear that hares are now present, at least in limited numbers, in all suitable habitats in West Virginia."

In West Virginia, the long-term trend of hare populations is stable or slightly increasing (Rawson, pers. comm., 1978). There is an open season in every county in which it occurs. Daily bag limit and possession limit are 2 and 8 for the hare; 5 and 20 for the cottontail. The hare is protected in state parks and there are inaccessible areas where it receives

little hunting pressure. Monongahela National Forest has cooperated with the Department of Natural Resources in designating several areas in which the snowshoe hare is the featured game species. According to a mail survey, the total harvest in West Virginia in 1975-76 was 1078 hares.

West Virginia populations of *Lepus americanus virginianus* were subjected to mixing with exotic strains at least from 1937 to 1950. Most likely the native genotype persists despite the restocking program. Specimens in the U.S. National Museum collected in West Virginia in 1936, 1954, and 1960, and one collected in Virginia in 1943, resemble in size and colorations other specimens collected in West Virginia in 1897 and 1916. All are well within the size and color range of Pennsylvania specimens of *Lepus americanus virginianus*.

In January, 1961, the Virginia Commission of Game and Inland Fisheries released on Laurel Fork, Highland County, within the residual range of *Lepus americanus virginianus*, 50 or 60 hares of undetermined subspecies, either from New Brunswick or Ontario, which it had obtained from Massachusetts in exchange for wild turkeys. Beyond the fact that 100 snowshoe hares are said to have been harvested by hunters in the Laurel Fork district in the 1973-74 hunting season, and that others have been harvested more recently, there seems to be no other information on the fate of this introduction (August, 1974; Coggin, pers. comm., 1978).

The Department of Forestry and Wildlife at Virginia Tech and the Commission of Game and Inland Fisheries cooperated in 1972 and 1974 in releases of New Brunswick *Lepus americanus struthopus* at several localities in Giles County. Shipments totalling 310 hares were imported in December, 1972 and January, 1974, but 45 died in transit. Altogether 257 hares were released at Mountain Lake, North Fork of Big Stony Creek, Dismal Creek, and No Business Creek (August, 1974). The hares are known to have dispersed from the release points as much as 4.5 miles and to have survived, at least temporarily, in all of the release areas except the North Fork of Big Stony Creek. At the present time there are thought to be few in the Dismal area, a few tracks have been seen in the No Business area, and there is a "fair" population in the Mountain Lake area (headwaters of Little Stony Creek) (Coggin, pers. comm., 1978). There is *Special Concern* for the remnants of these introductions.

Protective Measures Proposed: For the purposes of management and harvest, all species of rabbits and hares occurring in Virginia are lumped together by the Game Commission in the single category "rabbit." Thus, in the 80-day open season, a hunter could legally take 6 snowshoe hares a day, or a total of 75 during the season. Theoretically, the entire Virginia population of snowshoe hares could be wiped out in a single season by a few dedicated hunters.

Fortunately, the hares occur in habitats where rabbit hunting is difficult. There are a few snowshoe hare hunters, but probably most hares are harvested by general hunters in the forest for whatever game they can find; not out especially for rabbits or hares. Where hares occur, the open season for rabbit, squirrel, grouse and turkey are all concurrent.

The snowshoe hare is easily distinguished from the cottontail rabbit in the field. Hunters need not be deterred from harvesting cottontails in order to protect the hares. Thus, in view of the small number of hares thought to exist in Virginia, and in view of their very limited distribution in the state, the Game Commission should consider the following steps:

1. Distinguish between the snowshoe hare and the rabbits in hunting and trapping regulations.

2. Protect the snowshoe hare from hunting and trapping by a continuous closed season.
3. The snowshoe hare should be the subject of a research project in Virginia to determine precisely its distribution and numbers, habitat and food requirements, reproductive potential, and management requirements.
4. Additional restocking sites such as Clinch Mountain, Whitetop, and Mount Rogers should be sought.
5. Any further restocking should be done with the native subspecies, *Lepus americanus virginianus*. A permit could probably be obtained from the Department of Natural Resources to trap snowshoe hares in West Virginia. Such local stock should arrive at release points in better condition than animals trucked from Canada.
6. When it is thought that the populations of snowshoe hare can sustain harvest, then an open season with a reasonable bag limit should be set for it.

Remarks: Other vernacular names: white rabbit, varying hare, and snowshoe rabbit.

Author: Charles O. Handley, Jr.

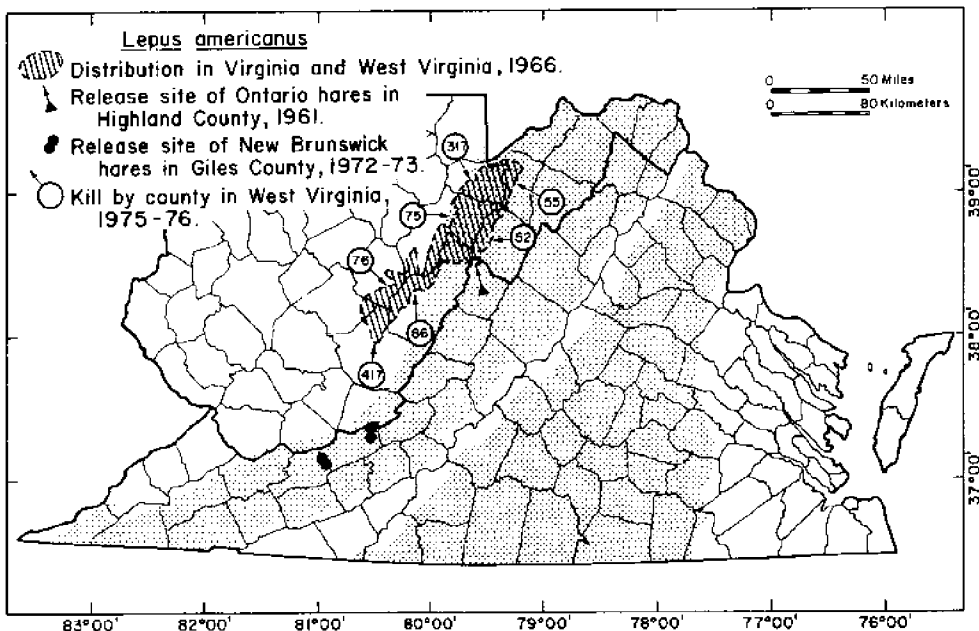


Figure 7. Distribution of Snowshoe Hare (*Lepus americanus*) in Virginia and West Virginia

6. FOX SQUIRREL

Sciurus niger cinereus Linnaeus
Sciurus niger niger Linnaeus

Phylum: Chordata
 Class: Mammalia

Order: Rodentia
 Family: Sciuridae

Description: *Sciurus niger* is a large, heavy-bodied squirrel with an unusually full, fluffy tail (to the tips of the hairs the tail is 13 to 15 inches long and can be fanned to a width of 5 to 6 inches) (Figure 8). It is geographically variable in coloration: the dorsum and tail range from gray to buff or orange, and the underparts from white to orange. Melanism is frequent in some regions. Colored illustration: Burt and Grossenheider (1976, plate 12).

In *Sciurus niger cinereus*, the upper parts are dominantly whitish-gray, occasionally with a buffy cast (summer pelage, or any worn pelage with underfur showing on the surface); underparts hands and feet are white; snout and crown often white or whitish, or colored like adjacent parts of the dorsum; cheeks whitish; ears whitish or buffy; tail black and white, with a white margin dorsally, grayish with a submarginal black band and white margin ventrally. Melanistic individuals with black head, lateral line, and fore and hind extremities, and a grizzled black and white body are rare. Average measurements (in millimeters) of 10 adult males from Dorchester County, Maryland (Poole, 1944): total length 591, tail vertebrae 284, hind foot 75. Weights of adults range from 1-3/4 to 3 pounds. See also Dozier and Hall (1944) and Barkalow (1954 and 1956).

Sciurus niger niger is similar to *sciurus niger cinereus* but is slightly larger, its snout and ears are always white, and its cheeks, face, and crown are jet black ("hooded"). Partially or completely (except for white snout and ears) melanistic individuals are frequent. Measurements (in millimeters) of 9 adults from South Carolina average: total length 607, tail vertebrae 290, hind foot 81.

Because of its white snout and ears and black hood (as well as its large size) there is no possibility of confusing *Sciurus niger niger* with any other mammal within its range. On the other hand, *Sciurus niger cinereus* somewhat resembles the gray squirrel, *Sciurus carolinensis*. However, it is much larger (total length 591 vs. 443 millimeters, tail vertebrae 284 vs. 201 millimeters, and hind foot 75 vs. 65 millimeters), its tail is much fuller, and its dorsum is uniformly colored (not darker medially).

Present Range: The species is found in the eastern United States from Minnesota, Michigan, western New York, south-central Pennsylvania, and the Eastern Shore of Maryland, south to Florida and the Gulf Coast, and west to Texas and the Great Plains. It also extends a short distance into northeastern Mexico (Coahuila) and southern Canada (Manitoba). Formerly it extended to Delaware, New Jersey, eastern New York, and western Connecticut.

The subspecies *sciurus niger niger* occupies all of the Carolinas, most of Georgia, southeastern Alabama, and most of western Florida. It once may have been found in southeastern Virginia, but it may have now been extirpated there. The type locality of *Sciurus niger niger* probably is southern South Carolina.

Sciurus niger cinereus persists naturally at several localities on the Eastern Shore of Maryland and has been introduced on Assateague Island, Virginia. Formerly it occurred throughout the Delmarva Peninsula and into southeastern Pennsylvania (G. M. Allen, 1942; Handley and Patton, 1947; Mansueti, 1952; Taylor and Flyger, 1974). If its range coincided with the northern

limit of loblolly pine, it may also have been found in southern New Jersey. The type locality of *Sciurus niger cinereus* has been restricted to Cambridge, Dorchester County, Maryland (Barkalow, 1956).

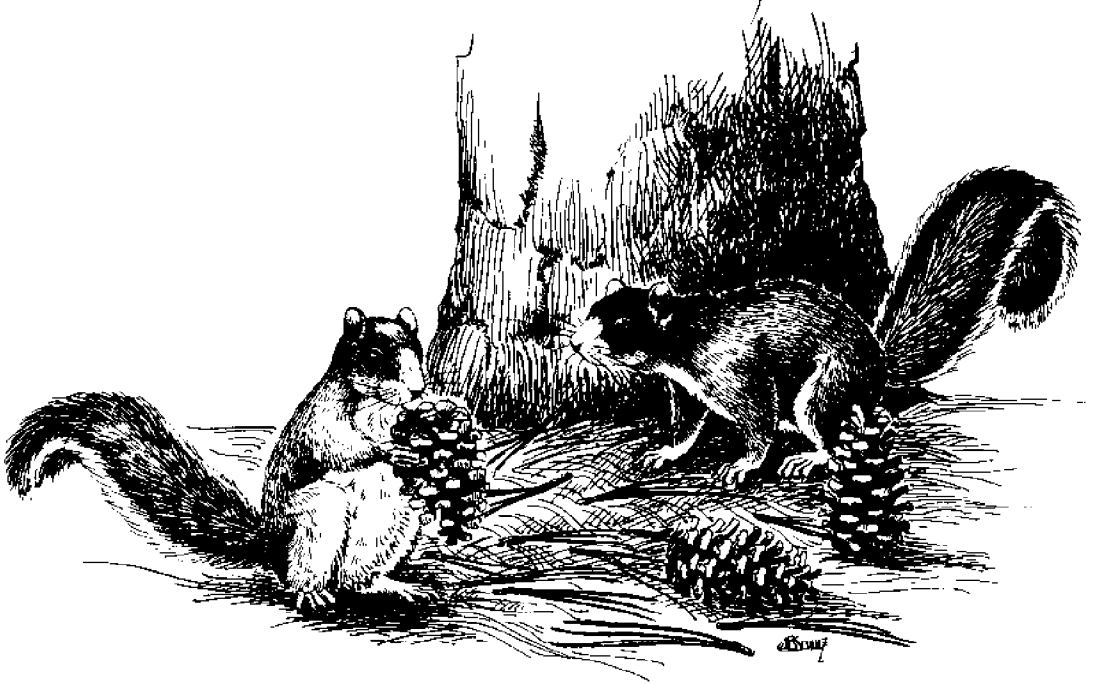


Figure 8. Fox Squirrel (*Sciurus niger*)

Distribution in Virginia: Formerly statewide. Now *Extirpated* from the Coastal Plain and most of the Piedmont. Still present in small numbers in Fairfax, Loudoun and upper Fauquier counties, and in most of the mountain counties.

Habitat and Mode of Life: It has been stated often that the preferred habitat of *Sciurus niger cinereus* is "old-growth loblolly pine (*Pinus taeda*) forests" or "deep deciduous swamps or backwood ... nearly always close to or adjacent to pine woods" (Dozier and Hall, 1944). On Chincoteague National Wildlife Refuge, Britton (pers. comm., 1978) found that this squirrel prefers open stands of loblolly pine with minimal undergrowth. However, Taylor and Flyger (1974) have expressed a slightly different view: "Contrary to popular local opinion, the fox squirrel does not require, or prefer, loblolly pine; this squirrel does prefer mature timber with a minimum of underbrush." *Sciurus niger niger* is found most often in open underbrush-free, park-like forests of mature long-leaf and loblolly pine, oak, or mixed stands of pine, oak, and sweetgum. Forests which contain a variety of nut and suitable seed-bearing trees, and over-age trees with hollows and holes which can be used as den sites, and which have corn and bean fields nearby, are especially attractive to fox squirrels (Harper, 1927; Golley, 1962). *Sciurus niger vulpinus* is mostly associated with hardwoods, particularly in farmland, with scattered trees along fence lines, small woodlots, orchards, and streamside stands of mature trees.

Apparently fox squirrels prefer dens in tree hollows. These provide maximum safety for young and the best protection from cold or wet weather. However, fox squirrels also construct leaf nests, usually in pines (*Sciurus niger cinereus* and *Sciurus niger niger*) or oaks (*Sciurus niger vulpinus*). Leaf nests most often are situated in crotches in the trunk or towards the ends of the larger branches, 30 to 50 feet above the ground, and are composed of leaves and twigs from the tree in which they are located. Evidently fox squirrels can survive with only leaf nest shelters when tree hollows are scarce or absent. They seem to readily accept nest boxes as substitutes for tree holes (D. L. Allen, 1943; Dozier and Hall, 1944).

In comparison to the gray squirrel, *Sciurus niger* is more terrestrial and less agile. It is slower and more deliberate in its movements. When it moves from one tree to another it usually descends to the ground rather than leaping from tree to tree. That this squirrel spends much of its time on the ground is a fact reflected in hunters' reports of shooting it there rather than in trees. The fox squirrel is shy and often wary and rather quiet. Its call is deeper than that of the gray squirrel. When it is disturbed or excited it may fan out its tail, making the whole animal appear larger than it actually is (Rhoads, 1903; Harper, 1927; Dozier and Hall, 1944; Mansueti, 1952).

The home range of a fox squirrel averages about 10 acres, but in the course of a year an individual may travel over three or four times that much area. Most activity is in the morning and early afternoon. Activity is discouraged by cold or inclement weather. In unusually cold weather a squirrel may "hole-up" and not leave its nest for a week or more. Numbers of fox squirrels vary from year to year depending on weather, availability of food, and disease-predator-hunter pressure. Healthy, stable populations probably benefit from hunter harvest (D. L. Allen, 1943).

The eastern lowland fox squirrels feed largely on green and mature pine cones when they are available. The green burs are cut in summer, and many are buried for future use. The presence of this squirrel in a particular forest area may be indicated by tell-tale piles of discarded pine cone scales and cores. Other favorite foods are acorns, hickory nuts, berries, buds, maple and elm seeds, corn, soybeans, and insects. In the absence of pines, fox squirrels of the interior uplands subsist on nuts, seeds, berries, green shoots, apples, and corn. Apparently, buried stores of nuts and seeds are located by odor, and a large percentage of those buried ultimately are retrieved (Harper, 1927; D. L. Allen, 1943; Dozier and Hall, 1944; Golley, 1962).

Reproduction: Most mating occurs in late winter and early summer. Older females breed twice a year and yearlings only once. The gestation period probably is about 45 days. Most young are born in March and April; there is a smaller crop in July and August. Probably a few young are born at any time between February and September. Litter size varies from 1 to 6, but the average is 3 or 4. Young are dependent on their mothers for about 3 months (D. L. Allen, 1943; Dozier and Hall, 1944).

Number in Captivity: No data.

Status: *Sciurus niger cinereus* - Endangered
Sciurus niger niger - Endangered

Morphological characteristics of at least four subspecies have appeared in Virginia populations of *Sciurus niger*. Most widespread (statewide except for the Eastern Shore and possibly the Dismal Swamp) was *Sciurus niger vulpinus*. In the National Museum there are specimens typical of this subspecies from Giles, Roanoke, Highland, Augusta, Fququier, Loudoun, Fairfax, King

George, and Southampton counties. Presumably, typical *Sciurus niger cinereus* once inhabited Accomack and Northampton counties on the Eastern Shore. The white snout, crown, ears, and fore and hind extremities and sometimes the gray dorsum of *Sciurus niger cinereus* appear west of Chesapeake Bay in squirrels with the orange tail and dorsum of *Sciurus niger vulpinus* in Loudoun, Fairfax, Fauquier, and Prince George counties. Typical *Sciurus niger niger* supposedly occurred in the Dismal Swamp, but there are no specimens to substantiate that possibility. Among populations with the orange dorsum and extremities and white underparts of *Sciurus niger vulpinus*, the black hood and white snout of *Sciurus niger niger* appears in 3 of 6 specimens from Fairfax County, in 1 from Russell County, and in 1 of 26 from Greenbrier County, West Virginia; the white snout, ears, fingers, and toes of *Sciurus niger niger* show up in one specimen from Montgomery County; and the white snout alone appears in 5 of 26 specimens from nearby Lewisburg, West Virginia. The orange underparts of *Sciurus niger rufiventer* E. Geoffroy are found frequently in specimens from western Virginia and eastern West Virginia.

At the time of European settlement the fox squirrel probably occurred throughout Virginia, in the Coastal Plain as well as in the highlands. Apparently it varied in numbers and was sometimes abundant (Handley, in press). Today this squirrel is still found in the northern Piedmont and in the mountains west of the Blue Ridge. It may also occur in small numbers in some of the upper Piedmont counties, but it possibly is gone from the rest of the state. Handley found one dead on the road in Fauquier County in 1965. In a statewide survey in 1973 by the Game Commission (Anonymous, 1974) the only evidence of the fox squirrel east of the Blue Ridge and south of Loudoun and Fairfax counties was an unconfirmed report from Louisa County. There were fox squirrels in the Chickahominy Swamp, Hanover County, until the late 1940's, but there have been no reports of them in that area since a big logging operation altered the habitat. Handley and Patton (1947) reported this squirrel to have been common throughout southeastern Virginia at the turn of the century, but in 1945 they knew of its occurrence only in Chesterfield and Prince George counties, where it was rare. It had occurred in Amelia County before the 1930's. According to the Game Commission survey (Anonymous, 1974), the fox squirrel was harvested in Prince George County until about 1968, and it was reported in Chesapeake (=Norfolk County) during the 1940's.

The former occurrence of *Sciurus niger cinereus* in Accomack and Northampton counties on the Eastern Shore is substantiated by unpublished field notes of Harry Oberholser and Leonard Llewellyn (Handley and Patton, 1947). There were no fox squirrels on Assateague Island in 1956, but old residents of Chincoteague said that they once had been there. A 1976 survey conducted by the Game Commission did not find evidence of surviving populations of this squirrel anywhere in Accomack or Northampton counties. However, attempts to reestablish it on Assateague Island apparently have succeeded (Britton, pers. comm., 1978):

In an effort to protect the Delmarva Peninsula fox squirrel from extirpation, the Chincoteague National Wildlife Refuge acquired in 1968 a permit to trap and remove squirrels from the Blackwater and Eastern Neck National Wildlife refuges. Between November 13 and December 19, 1968, seventeen of these squirrels were transplanted to Chincoteague Refuge (Assateague Island). Nine of the squirrels were received from Blackwater Refuge and eight from Eastern Neck. The Blackwater squirrels were in good condition and survived the move and release. However, three of the Eastern Neck squirrels died. The fourteen remaining squirrels included seven males and seven females. They remained near the release point until early spring, 1969. With an abundance of natural food

available they then spread out to points unknown. One female was killed in early April on a power line and a male was struck and killed by a vehicle on November 14, 1969.

There were no new transplants in 1969, but a formal management study was prepared and approved. Objectives were: (1) To establish a protected breeding reserve colony of the Delmarva Peninsula fox squirrel as insurance against the possibility of a natural disaster destroying the Maryland population, (2) To establish a breeding colony that could be used as a source of animals for restocking areas formerly in the range of this squirrel; and (3) To use this study as a means of educating the visiting public to the Service's efforts to protect and manage endangered wildlife.

On December 10, 1970, three more fox squirrel from Blackwater Refuge were released on Assateague Island, and on December 23, thirteen (10 female, 3 male) squirrels were transported to Assateague from Eastern Neck Refuge. Several of the Eastern Neck squirrels appeared to be weak upon arrival, so all squirrels were kept overnight in a heated service building. On December 24, three squirrels (2 male, 1 female) were dead. The remaining ten were released on the Lighthouse Ridge. One female appeared sick, and died within a few hours. The squirrels' food supply was supplemented with shelled corn placed in feeders at the release site. At least five squirrels from the 1968 release were still surviving at this time. On January 6, 1971, seven more squirrels were picked up from Eastern Neck Refuge and released on Chincoteague Refuge the following day. Two of these squirrels appeared weak, and on January 16, one was dead near the Lighthouse Trail.

Altogether, between 1968 and 1971, forty squirrels were transported from Maryland, and 34 were released on Assateague Island. Ten are known to have died within a year after release. Because of Maryland's Endangered Species Act, no further transfers could be made to augment the Assateague population.

The first young fox squirrel on Chincoteague was sighted in the summer of 1971 in the residence area. Three more were seen in 1972. During the spring and summer of 1974, nine young squirrels were seen using the feeders. This was the most young seen or known to have been raised on the refuge in a single year. Apparently the island population was doing much better than had been anticipated. Surveys showed that the squirrels had expanded from the original release area of approximately 100 acres to an area of 784 acres. At the same time there was a report that a Delmarva fox squirrel had been seen in the Town of Chincoteague. This sighting was verified by refuge staff.

By 1975, a census of the squirrels seemed appropriate. We first considered a capture and marking type. But, since we were working with a limited and endangered resource, it was decided that we could not take the chance of any mortality by handling the squirrels. We had noticed that with careful observation many squirrels could be identified by pelage characteristics. We began to census with this method in June, 1975. The Pony Trail area, which consists of approximately 240 acres, was checked by the use of feeders. Twenty-four individual squirrels were recognized. By extending the observed density of one squirrel in ten acres to the entire occupied range of 784 acres, the total population was estimated at 78 squirrels.

In 1976, observations from February 3 to April 24, conducted on 330 acres of the refuge, revealed 34 individuals. During August, 150 nest boxes were put up by the Delmarva Fox Squirrel Recovery Team. Inspection and cleaning of the nest boxes is conducted in spring and winter. In February, 1978, the Recovery Team found 50 squirrels (19 male, 16 female, and 15 unconfirmed) during the winter check of nest boxes. Two of these were pregnant females. One dead squirrel was found. A squirrel picked up on 24 May 1977 had died of tularemia.

The Chincoteague Refuge population of Delmarva fox squirrels is presently estimated to be between 80 and 100 individuals. In the very near future we plan to attach radio telemetry collars to a few individuals so that we can obtain a better understanding of the squirrel's habits and range. We consider the introduction of the Delmarva Peninsula fox squirrel on Assateague to be a grand success. The population is presently self-sustaining and is continuing to grow.

Protective Measures Proposed: The Fish and Wildlife Service has shown with its program on the Chincoteague National Wildlife Refuge that *Sciurus niger cinereus* can be successfully established in suitable protected habitat. The Game Commission should continue its efforts to find additional sites for stocking this handsome squirrel elsewhere in Accomack and Northampton counties. Similarly, if there are large enough stands of longleaf or loblolly pine, free of underbrush, in the Dismal Swamp area or elsewhere in southeastern Virginia, it might be feasible to restock *Sciurus niger niger*. Suitable habitat might be created and maintained for both *Sciurus niger niger* and *Sciurus niger cinereus* by controlled burning to clear underbrush.

Sciurus niger vulpinus is hunted today in Fairfax and Loudon counties and in all counties west of the Blue Ridge. The long hunting season (from about 60 days in some counties to about 100 days in others) and high bag limit (6 squirrels per day and 75 per season), the same as those for the abundant and ubiquitous gray squirrel, may be excessive for the uncommon and irregularly distributed fox squirrel.

It can be inferred from the Game Commission's survey of the distribution and abundance of this squirrel in Virginia (Anonymous, 1974) that the season limit of 75 fox squirrels per hunter is in force in five counties (Dickenson, Buchanan, Grayson, Floyd, and Rockbridge) which reported no fox squirrels at all within their boundaries; as well as in nine counties (Lee, Wise, Carroll, Craig, Roanoke, Botetourt, Page, Loudoun, and Fairfax) which estimated populations of less than 100 fox squirrels each (Figure 9).

In the past two hundred years, *Sciurus niger vulpinus* has lost 50 percent or more of its range (eastern Virginia, northern Pennsylvania, New Jersey, New York, and Connecticut). Perhaps the most important factors in this decline have been destruction of mature forest and over-harvest of squirrels. This squirrel's preference for morning and early afternoon activity, its habit of foraging mostly on the ground, its slow and deliberate movements, its choice of habitat (open woods, farm woodlots, orchards, scattered large trees, and its occurrence in small discontinuous populations predispose it to over-harvest.

Virginia may harbor the largest surviving population of this once widespread subspecies. Because of the value and frailty of this population, the Game Commission ought to make a special effort to manage it back to healthy numbers. Initial steps might be (1) a precise survey of distribution and abundance; (2) shorten or close the hunting season and reduce the bag limit in areas where the animal occurs only in small numbers or has been extirpated; (3) upgrade habitat; (4) protect overage trees as potential den sites; (5) put up nest boxes where squirrels are present but natural den

sites are few; (6) plant food trees in areas of food scarcity; (7) attempt to reestablish this squirrel at suitable places in the Piedmont and Coastal Plain; and (8) monitor populations regularly and adjust harvest to remove only surplus animals.

Remarks: Other vernacular names are gray, big-gray, and stump-eared squirrel (Handley and Patton, 1947), Bryant fox squirrel, Delmarva fox squirrel, and peninsula fox squirrel.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

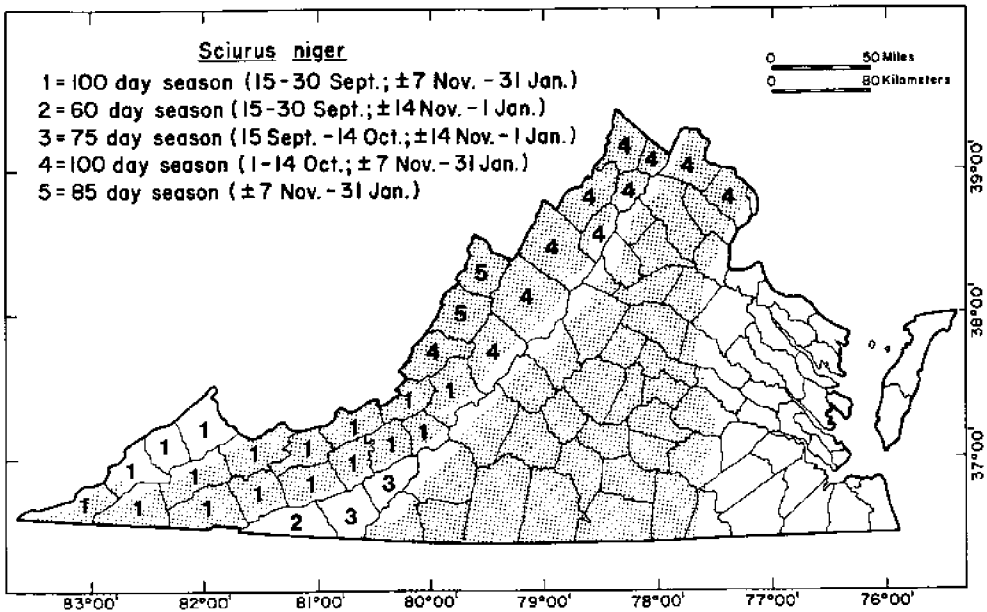


Figure 9. Distribution of Fox Squirrel (*Sciurus niger*) in Virginia

7. NORTHERN FLYING SQUIRREL

Glaucomys sabrinus fuscus Miller

Phylum: Chordata
 Class: Mammalia

Order: Rodentia
 Family: Sciuridae

Description: *Glaucomys sabrinus* is a small squirrel-like mammal specialized for gliding and for nocturnal activity. It has dense, soft, rather short, smooth fur and a relatively small, flattened, furry tail. A loose fold of furry skin, which can be extended for gliding, extends along the side of the body between fore and hind limbs. Its eyes are prominent, large, and

blackish. Dorsal coloration is pale brown; underparts are whitish (but the hairs are gray-based), more or less washed with cinnamon or rust-color (Fig.10). Average and extreme measurements (in millimeters) of five adults from West Virginia: total length 266 (256-274), tail vertebrae 115 (108-127), hind foot 37 (35-39).

This species resembles the southern flying squirrel, *Glaucomys volans* Linnaeus, but is larger (average total length in local specimens 266 vs. 228 millimeters), more brightly colored, and has the hairs of the underparts gray-based rather than pure white. The subspecies *Glaucomys sabrinus fuscus* can be distinguished from *Glaucomys sabrinus coloratus* Handley of the Great Smoky Mountains by its smaller size (total length 266 vs. 286 millimeters), shorter tail (115 vs. 134 millimeters), and duller coloration.



Figure 10. Northern Flying Squirrel (*Glaucomys sabrinus fuscus*)

Present Range: The species inhabits boreal forests throughout Canada, the interior of Alaska; New England, Michigan, Wisconsin and Minnesota; and extends southward in the mountain ranges of the western United States to California and Utah, and in the Appalachians to North Carolina and Tennessee. South of Pennsylvania this species occurs in small, isolated, relict populations. The subspecies *Glaucomys sabrinus fuscus* is known at a few sites in West Virginia and Virginia (Figure 11). The type locality of *Glaucomys sabrinus fuscus* is Cranberry Glades, Pocahontas County, West Virginia.

Distribution in Virginia: The northern flying squirrel has been found in Virginia only on the upper slopes of Whitetop Mountain (Smyth County), where it seems to be rare. Another report of it from a lower elevation in western Virginia has not yet been published.

Habitat and Mode of Life: On Whitetop Mountain this species was trapped on a large mature red spruce in mixed spruce-maple-birch forest a few hundred feet from the dense, almost pure stand of red spruce that capped the mountain. Elsewhere in the southern Appalachians it has been found in conifers (spruce, fir, hemlock), yellow birch forest, and mixed conifer-northern hardwood forest (Kellogg, 1937; McKeever, 1952; Weigl, 1977). Weigl (1977) believed it to be more omnivorous than *Glaucomys volans*, feeding mostly on lichens and mushrooms, supplemented with seeds, buds, fruit, staminate conifer cones, meat, and arthropods. Possibly it makes little use of spruce and fir seeds. Grimm and Whitebread (1952) observed: acorns, beechnuts, cherry pits and seeds of various coniferous trees are evidently the staple foods of this flying squirrel. *Glaucomys sabrinus* is nocturnal, secretive, and not often observed, but it can sometimes be located by its high pitched insect-like chirps. It has a large home range, and commonly moves from tree to tree and from tree to ground by gliding.

Reproduction: The northern flying squirrel usually lives in small family groups in nests constructed in tree holes or on old bird nests. It produces 1 or 2 litters of 2 to 6 young yearly. Mating occurs in late winter and in mid-summer. The gestation period is 30 to 37 days (Asdell, 1964; Godin, 1977).

Number in Captivity: No data. Although they did not breed well, Weigl (1977) succeeded in maintaining southern Appalachian *Glaucomys sabrinus* in captivity.

Status: *Endangered*. Very likely, the numbers and range of the northern flying squirrel in the southern Appalachians have been shrinking as climate and habitat have changed ever since the Pleistocene. Even before the arrival of European settlers these processes probably had fragmented its range in the mountains of Virginia into relict segments. Logging and clearing for other land use and the consequent invasion of its habitat by the southern flying squirrel undoubtedly have accelerated the decline of the northern flying squirrel in the past two hundred years. It must now be on the verge of extirpation in Virginia.

The research of Weigl (1977) on interactions of *Glaucomys sabrinus* and *Glaucomys volans* in North Carolina suggests that the smaller *Glaucomys volans* is more aggressive and may displace *Glaucomys sabrinus* when the two overlap in distribution. Weigl also had evidence that a nematode parasite (*Strongyloides* sp.) of *Glaucomys volans* is lethal or debilitating when transferred to *Glaucomys sabrinus*. Thus, it may be that even if it survives alteration of its habitat, the northern flying squirrel may not survive the subsequent spread of the southern flying squirrel into its range.

In Virginia, *Glaucomys volans* now occurs to the tops of the highest mountains and occupies the best remnants of habitat suitable for *Glaucomys sabrinus*. *Glaucomys volans* is abundant at all elevations in the Mountain Lake area (Giles County); it has been found up to 3650 feet on Allegheny Mountain (Highland County), in the most boreal portion of Virginia; and several specimens have been taken in the spruce-fir forest on the summit of Mount Rogers (5719 feet, Grayson County). The future looks bleak, indeed, for *Glaucomys sabrinus* in Virginia.

Protective Measures Proposed: Suitable habitats should be more thoroughly explored for *Glaucomys sabrinus*. If populations of this squirrel are found, an effort should be made to prevent further alteration of its habitat.

Remarks: It would seem most logical for the northern flying squirrel on Whitetop Mountain to be the subspecies (*Glaucomys sabrinus coloratus*) that is found on nearby mountain ranges in North Carolina and Tennessee (Handley, 1953). However, the single specimen from Whitetop that I have examined is

an intergrade, more like *Glaucomys sabrinus fuscus* of West Virginia. It has the underparts heavily washed with ochraceous buff, the underside of the tail dark, rich cinnamon, and the tail long, as in *Glaucomys sabrinus coloratus*, but the dorsum is pale and the skull is small and like that of *Glaucomys sabrinus fuscus* in all details.

Author: Charles O. Handley, Jr.

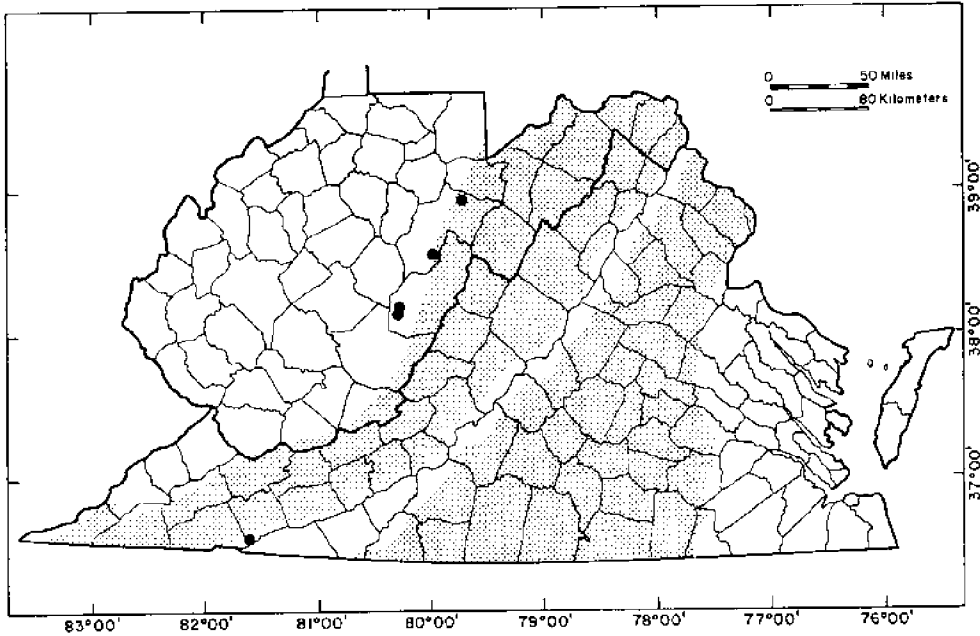


Figure 11. Distribution of Northern Flying Squirrel (*Glaucomys sabrinus*) in Virginia and West Virginia

8. BLACK RAT

Rattus rattus rattus Linnaeus

Phylum: Chordata
Class: Mammalia

Order: Rodentia
Family: Muridae

Description: This is the prototype rat, a rodent of moderate size; with long, scaly, sparsely haired, concolor tail, as long or longer than the head and body; coarse, shaggy fur; prominent ears; and rather small eyes. Its color varies from slaty black throughout, to brown back and sooty underparts, to brown back and white or cream-colored underparts. Individuals with these various color combinations originally were thought to represent distinct species or subspecies, but now are regarded simply as color variants of a single taxon. Measurements (in millimeters) of five adults from Virginia and the District of Columbia (means and extremes): total length 402 (375-

423), tail vertebrae 212 (200-238), hind foot 36 (30-39). Color illustration: Burt and Grossenheider (1976, plate 18).

The Norway rat, *Rattus norvegicus* Berkenhout, is similar in color to the brown and white phase of *Rattus rattus*, but it has a shorter tail (less than the head and body length) and smaller ears. Three native rats could be confused with the black rat, but all have two, rather than three, rows of cusps on the upper cheek teeth. In addition, the pack rat (*Neotoma floridana* Ord), about the same size as the black rat, has longer, softer fur, larger eyes and ears, longer vibrissae, and a shorter, hairy, bicolored tail; the cotton rat (*Sigmodon hispidus* Say and Ord) and rice rat (*Oryzomya palustris* Harlan) are smaller and have shorter tails.

Present Range: Originally the black rat was an inhabitant of southern Asia, but it has been widely dispersed by ships. Although it is potentially worldwide in distribution, it is most abundant and widespread in tropical and warm temperate latitudes and near seaports. It reached Europe in the Middle Ages, and North America in the 16th or early 17th Century.

Distribution in Virginia: *Rattus rattus* came to Virginia with the first English colonizers and spread with settlement to all parts of the state. After the introduction of *Rattus norvegicus*, about 1775, black rat populations declined. The species is still found at widely scattered localities throughout the state, and it may even be locally common, but the remnant populations are isolated and irregularly distributed (Figure 12). Apparently the black rat today is absent from most of Virginia.

Habitat and Mode of Life: Usually, the black rat is found in human dwellings and outbuildings where it commonly inhabits walls, ceilings, and attics. Away from such habitations it lives in swamps and viney thickets. It is a good climber, and seldom burrows. It is primarily nocturnal and crepuscular. It is omnivorous, and does much damage to stored grain and foodstuffs (Bailey, 1923; Hinton, 1931).

Reproduction: This rat is very prolific. It is sexually mature at the age of three months, long before it is full grown. It breeds throughout the year (although most commonly between January and June). Females usually are impregnated within a few hours after parturition, and commonly are found to be both lactating and pregnant. A vaginal plug helps insure fertilization, and gestation is 21 to 31 days. Litters range in size from 4 to 11 young, with an average of 5 to 6. Nests are made of grass, rags, paper, or almost any handy soft material. They usually are placed above the ground, near a food source. They often contain a food cache (Hinton, 1931; Asdell, 1964).

Number in Captivity: No data. This rat is easily maintained in captivity.

Status: *Endangered*. This introduced pest, once widespread, perhaps throughout Virginia, does not compete successfully with another introduced pest, the Norway rat. It has declined as the latter has spread, and it now survives in Virginia only in scattered relict pockets where the Norway rat does not occur. It is doomed to extirpation in Virginia by increasing urbanization and consequent immigration and colonization by the Norway rat. Seaports are constantly subject to new introductions of black rats, but the chances of their survival there in the presence of the Norway rat are minimal.

Protective Measures Proposed: None. The black rat is included in these accounts, not because of any wish to protect it, but for the sake of completeness. Although it has been an alien member of the Virginia fauna for almost 400 years (and probably now has very little impact on the native fauna), very few persons would mourn its loss, should it be extirpated.

Remarks: Other common names: Roof rat, ship rat, wharf rat, Alexandrine rat.
Authors: Charles O. Handley, Jr. and Linda K. Gordon.

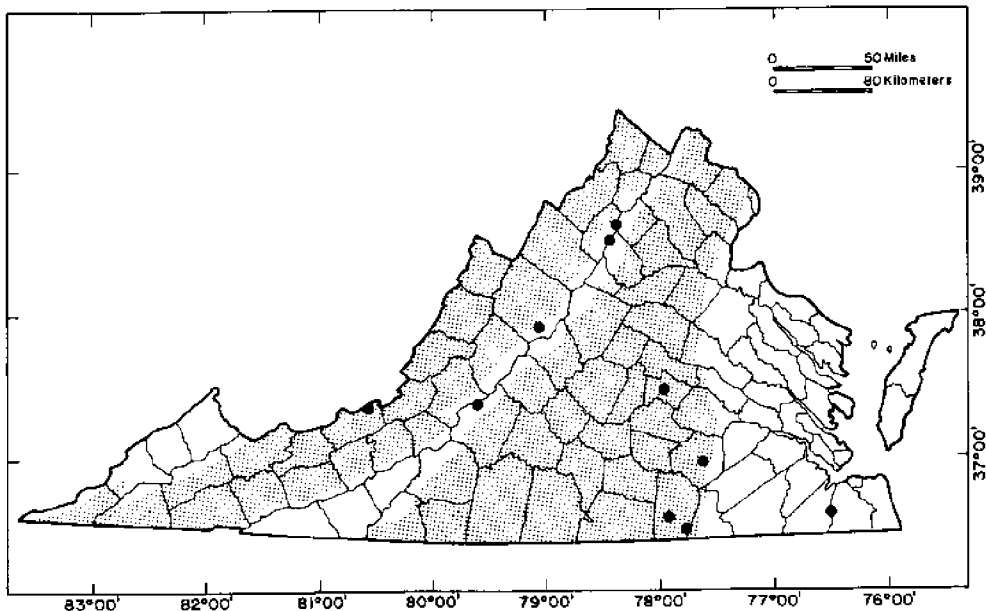


Figure 12. Distribution of Black Rat (*Rattus rattus*) in Virginia

9. Fisher

Martes pennanti pennanti Erxleben

Phylum: Chordata
 Class: Mammalia

Order: Carnivora
 Family: Mustelidae

Description: The fisher is a fox-size, blackish mammal with a long, slender body and bushy tail. Its thick and soft but rather shaggy fur is dark brown to blackish. More or less white-banded hairs over much of the dorsum, especially on the head and shoulders, give the animal a grizzled appearance (Figure 13). Average measurements (in millimeters) of 27 males and 42 females (in parentheses) from the Adirondacks are as follows: total length 940 (808), tail vertebrae 350 (306), hind foot 118 (100); average weight in grams 3707 (2057) (Hamilton and Cook, 1955). Color illustrations: Burt and Grossenheider (1976, plate 5); Grinnell *et al.* (1937); and Herter (1975).

In Virginia, the fisher might be confused with the mink, which has similar proportions and somewhat similar coloration, but is much smaller, only one-half to two-thirds the size of the fisher. Foxes are near the size of

the fisher but have longer legs and bushier tails. Some dogs have a vaguely fisher-like appearance.



Figure 13. Fisher (*Martes pennanti pennanti*)

Present Range: The fisher inhabits the boreal forest belt from Quebec, the Maritime Provinces and northern New England to southeastern Alaska, and extends south in the western mountains to Wyoming and California. Formerly it occurred southward to Illinois, Indiana, Tennessee, and North Carolina. In recent years the fisher has been expanding its range in the East, and also has been reintroduced into some of its former habitations.

Distribution in Virginia: Probably the fisher was formerly widespread in the mountains of Virginia. Audubon and Bachman (1849) saw one on Peters Mountain above Gray Sulphur Springs, Giles County, Virginia (0.6 miles southeast of Peterstown, West Virginia) (Figure 14). In 1943, old residents on Middle Mountain in northwest Highland County described to me "black foxes" (most likely *Martes pennanti*) that occurred in that area until the red spruce was cut out, after 1890 (Handley and Patton, 1947). Thereafter, there were no other observations of fishers in Virginia until 1972, when local hunters on Allegheny Mountain in Highland County told Morris Brooks (pers. comm., 1973) about "the trapping of a mammal which none of them knew ... they described

it as 'like a very dark mink, but twice as big as any mink they had ever seen.'" Another fisher was seen near Harrisonburg, Rockingham County, in 1978 (Pennington, pers. comm., 1978). These latter observations undoubtedly stem from introductions in West Virginia in 1969.

Habitat and Mode of Life: The fisher's geographic range coincides closely with the transcontinental spruce-fir belt, but within that region it is by no means confined to the conifers. In Virginia it originally occurred in both red spruce and mixed hardwood forests. It survives best in extensive forest and wilderness areas, for its home range is large -- 8 to 10 miles, or more, in diameter -- and it sometimes wanders farther. Dens of the fisher can be found in hollow trees, in cavities under rocks and among boulders, and in log piles. It is solitary except at mating. It is abroad both day and night, moves swiftly, both through trees and on the ground, and searches large areas in short periods of time. It swims well but does not catch fish. Small mammals up to the size of groundhogs and hares usually dominate its diet, but it is more omnivorous than most other mustelids and there is considerable seasonal variation in its diet. Hamilton and Cook (1955) reported that fall and winter foods of the fisher in the Adirondacks included deer (carriion), red squirrel, red-backed vole, shrews, snowshoe hare, porcupine, ruffed grouse, fruit of swamp holly, tips of fern fronds, and mosses. Young of various mammals and birds and a variety of fruits are included in the summer diet; and beechnuts are consumed in large quantities when they are available.

Reproduction: Mating occurs in the spring a few days after parturition. Although the gestation period is on the average an astonishing 352 days, development of the blastocysts ceases entirely soon after fertilization, and implantation is delayed for about ten months. Growth of the embryos then proceeds rapidly to parturition (Hamilton and Cook, 1955). Litter size varies from 1 to 5, with an average of 3 (Asdell, 1964).

Number in Captivity: No data.

Status: *Endangered.* The only known Virginia observations of native fishers date from the middle and late 19th Century. This animal was extirpated from the entire Appalachian portion of its range, except in the extreme North, by the turn of the century. Probable causes of extirpation were habitat destruction and indiscriminate trapping and shooting. The fisher's reproductive rate is too low to survive such pressure.

The Department of Natural Resources is trying to reestablish the fisher in West Virginia with introductions of northern stock. Twenty-three fishers were released in 1969; fifteen on Canaan Mountain, Tucker County, and eight at Cranberry Glades, Pocahontas County (Figure 22). In view of the normally large home range of this mammal there seems not to have been an unusual amount of wandering away from the release points. The present range in West Virginia covers about 2000 square miles. One fisher per trapper per year can legally be taken in West Virginia. Most that have been trapped have come as a surprise to the trapper, who usually was attempting to trap fox or beaver. To date there has been only one verified incident of poaching. Fishers have been trapped or observed every year since 1969, and trap returns indicate that it is reproducing in West Virginia. However, the population appears to be static. Thus, although the program of reintroduction has been at least modestly successful, it is still by no means certain that the fisher is firmly established in West Virginia (Rawson, pers. comm., 1978). Through 1978, at least 18 fishers have been trapped in West Virginia, one near Mountain Lake Park, Garrett County, Maryland (Cottrell, 1978), and one in Highland County, Virginia (Brooks, pers. comm., 1973).

Wanderers from the West Virginia nucleus are now appearing in bordering areas of Virginia, but there is no evidence of a reproducing population in the state. Should the West Virginia restocking program ultimately succeed, it is possible that the fisher might eventually become reestablished in Virginia as well. In the meantime it must be regarded as *Endangered* in this state.

Protective Measures Proposed: The Virginia Game Commission should be aware of the possibility of wandering fishers and should attempt to return troublesome individuals to the West Virginia Department of Natural Resources unharmed. Although its esthetic value is high, it is doubtful that there are ecosystems in Virginia that would successfully support the fisher at the present time. Dietary staples would probably include the snowshoe hare and the New England cottontail. The two subspecies of snowshoe hare are *Endangered* and of *Special Concern* in Virginia, while the New England cottontail is classified as *Status Undetermined*.

Remarks: Other vernacular names: black fox, black cat, and pekan.

Author: Charles O. Handley, Jr.

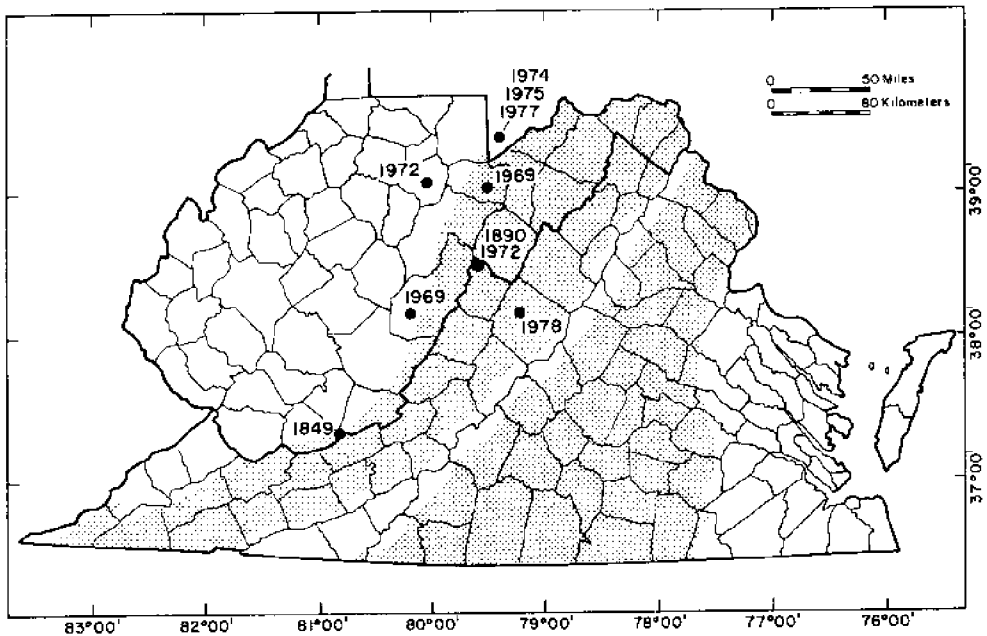


Figure 14. Distribution of Fisher (*Martes pennanti pennanti*) in Virginia, West Virginia, and Maryland

10. RIVER OTTER

Lutra canadensis lataxina F. Cuvier

Phylum: Chordata
 Class: Mammalia

Order: Carnivora
 Family: Mustelidae

Description: The river otter is a large (about four feet long) weasel-like mammal with long streamlined body, short legs, webbed toes, very small eyes and ears, tapering tail (very thick at the base to thin at the tip), and very dense, short, dark brown fur (paler on lips, throat, and breast). Approximate measurements (in millimeters, compiled from several sources): total length 1000-1200, tail vertebrae 325-425, hind foot 110-135. Males are larger than females. Color illustration: Burt and Grossenheider (1976, plate 5).

Lutra canadensis is slightly larger and distinctly paler in color than the geographically nearby *Lutra canadensis canadensis* Schreber, the smallest and darkest subspecies (Van Zyll de Jong, 1972).

Present Range: *Lutra canadensis* is found on the Eastern Seaboard from Delaware to Texas and from New England, New York, northern Michigan, Minnesota, western Montana, Idaho and northern California north to the limit of trees. It formerly occurred throughout the United States except in the deserts of the Southwest. The subspecies *Lutra canadensis lataxina* is isolated in the Coastal Plain and Piedmont from Delaware to Texas. Formerly it occurred throughout the eastern United States, south of the Great Lakes, from Connecticut to the foot of the Rocky Mountains (Van Zyll de Jong, 1972; Nilsson and Vaughan, 1978).

Distribution in Virginia: The river otter once was common throughout Virginia. It still is fairly numerous in parts of the Coastal Plain and lower Piedmont, but is rare or extirpated in the remainder of the state (Figure 15).

Habitat and Mode of Life: The river otter is semiaquatic and is always associated with a watery environment, either marsh, swamp, stream, or pond. Because they have abundant food, salt marshes, estuaries, and swamps are ideal habitat, but otters can also thrive in ponds, and even small streams. The best stream habitats have forested undisturbed banks, clean unpolluted water, deep pools with mud bottoms and slow-moving water, and stretches where the water flows swiftly enough to stay open in winter (Grimm and Whitebread, 1952; Smith *et al.*, 1960; Bottorff *et al.*, 1976).

Streamlined body; thick, muscular tail; short legs; webbed feet; small eyes and ears; and short, dense fur adapt the otter to life in the water. It is a fast and very maneuverable swimmer. It is awkward but fairly swift afoot and often travels long distances overland, particularly in snow, where it alternately bounds and slides.

Mud and snow slides are characteristic of this species, and have been traditionally associated with play behavior. Slides are well known on ditch banks in the Dismal Swamp and have been observed elsewhere in Virginia, both in the lowlands and in the mountains.

In winter, otters usually move about overland on snow alone, but sometimes they travel in groups of two to five individuals. They use existing snow trails (including those made by deer, snowshoe hares, or other otters) when these are available. Otters may swim long distances under ice or walk on ice in winter (Bailey, 1923; Field, 1970).

Otters have large home ranges and travel widely, especially during the breeding season and at times of food scarcity in winter. In North Carolina, a typical family of otters occupies 4 to 9 square miles. Depending upon abundance of prey, individuals have been known to hunt over as much as 50 or 60 miles of stream and to cover 10 to 100 square miles in a year (Liers, 1951; Bottorff *et al.*, 1976).

On the banks of otter-populated streams one may find hauling-out places where otters come out on the bank to rub themselves dry and to wallow in the grass, sand, leaves, or snow. Urine and excrement are left at such places. Strong musky scent from the anal glands is used for marking territories. Otters have a sociable and playful disposition. They are primarily nocturnal but often are abroad in the daytime. Otters are fairly noisy. Their sounds include shrill chirps and soft chuckles. Angry and frightened otters scream, and females "caterwaul" when copulating (Liers, 1951).

The diet of the otter varies seasonally, depending upon the availability and accessibility of prey. The otter is an opportunist. It will take the most abundant and easily caught fish. In most cases, these are mostly small, sluggish, often bottomfeeding forage or rough fish, the removal of which may actually benefit game fish. It also catches panfish and trout, usually in smaller numbers and often in exceptional circumstances such as in fish hatcheries and stocked ponds. Crayfish are important in the otter's diet, and it may also eat crabs, shrimp, clams, fishing worms, and aquatic insects. It frequently takes frogs and salamanders, and catches marsh birds such as rails, and small mammals including voles, mice and young lagomorphs. In coastal areas it sometimes subsists on dead coots, ducks, and other carrion when it is available. The otter seems not to be a significant predator of the muskrat as has been claimed. The only serious predator of the otter is man (Lagler and Ostenson, 1942; Liers, 1951; Wilson, 1954; Ryder, 1955; Knudson and Hale, 1968; Field, 1970).

Reproduction: Otters den in cavities under overhanging banks, among tree roots, and in abandoned streambank burrows of beavers, muskrats, or groundhogs. An otter might renovate and enlarge an existing burrow but probably would not dig its own (Liers, 1951).

Female *Lutra canadensis* breed for the first time at the age of two years in New York State and subsequently mate shortly after each parturition. Males are capable of producing mature sperm cells at two years of age, but they do not breed successfully until they are five or six years old. Captive otters in Minnesota were in heat for 42 to 46 days but were not equally receptive to male advances on all days of this period. Otters occasionally mate on land, but usually mate in the water. After fertilization, development and implantation of the blastocyst may be delayed for eight months or more. The total gestation period is about twelve months (Liers, 1951; Asdell, 1964; Hamilton and Eadie, 1964; Ewer, 1973).

Breeding begins in March or April in New York, and young are born the following year during the same months. Births are earlier in more southerly areas. In northeastern North Carolina, breeding starts during January and continues into February and possibly into March, with young being born in February and March of the following year. There are 2 or 3 young per litter (usually 2) in New York, and 2 to 4, with a mean of 2.88 (based on embryo counts), in North Carolina. The male tends to stay away from the area where a female has given birth to her cubs, but when the young are old enough to leave the den he rejoins the family while young learn to swim and forage (Liers, 1951; Wilson, 1961, Asdell, 1964; Hamilton and Eadie, 1964; Bortorff *et al.*, 1976).

Number in Captivity: No data.

Status: *Endangered*. Formerly it occurred throughout the state, and judging by the early reports it must have been abundant, at least in the coastal region. Excessive trapping, persecution by fishermen, clearing of streambanks, and later, pollution, drove down its numbers. By the early 1900's it had disappeared or was becoming rare in most parts of Virginia: one or two were caught in Nottoway County in 1875, one was taken at Great Falls in Fairfax County in 1896, one in Nelson County in 1899, and the last one in Orange

County about 1900. The capture of one on the James River about 1901 was newsworthy, and by 1909 it was seen only occasionally in Westmoreland County. It declined abruptly in Amelia County after 1910, and in 1936 only the older residents of Dinwiddie and Sussex counties remembered that it once had been common there. It was occasionally seen in Charlotte County in the 1929-1938 interval, was uncommon enough in the Chickahominy Swamp (Hanover County) to rate a newspaper picture in 1937, was considered to be very rare in Amelia County in 1940, and was rare in Brunswick County in 1943. The estimated average yearly kill, statewide, for the eight-year interval 1937-1935 was 138 (96-163). Lewis (1940) observed that at the date of his writing, the otter was protected by state law.

In the mid-1940's the otter was uncommon but widespread in Virginia. Handley and Patton (1947) observed that it was most abundant in the Coastal Plain swamps, but was "too rare in Virginia to rank as an important furbearer." However, there were reports of otters as late as 1925 in Bath and Highland counties. Handley and Patton (1947) had recent records from Montgomery (1945), Rockingham (1930), and Shenandoah (about 1945) counties, and they believed that it was "becoming increasingly common in the mountain rivers and creeks."

Subsequently, the otter reoccupied some haunts from which it had been extirpated east of the Blue Ridge and even became relatively abundant (Figure 15). West of the Blue Ridge the story was different. There the otter continued to decline and today it has been nearly or completely extirpated. Except for Downing's (pers. comm., 1978) observation of tracks of a family group of three otters in the snow in Wise County in 1977 and one trapped in Frederick County in 1977, there are no recent records for western Virginia. It has not been seen in West Virginia since about 1955.

The otter seems to be doomed to extirpation in Virginia by excessive fur harvest and the menace of stream pollution. It is almost gone from the mountain counties, and it is rare or absent in much of the Piedmont and in parts of the Coastal Plain. It still is fairly numerous in other parts of the Coastal Plain and lower Piedmont, but judging by trapping statistics, that abundance should be short-lived. Because of the demand in foreign markets, fur prices are on the rise (Table 4) and otter trapping has become quite profitable. Top grade hides bring as much as \$80. Until recently, probably most otters were caught accidentally in beaver traps. Now it is worthwhile to trap specifically for otters.

Table 4. Average prices paid by large buyers for pelts of Virginia caught beaver and otter 1975-1977 (Game Commission compilation).

	<u>1974-75</u>	<u>1975-76</u>	<u>1976-77</u>
Beaver	\$ 9.42	\$ 7.95	\$17.55
Otter	20.84	27.35	38.25

In 1976-77, there were 828 beaver and otter trappers in Virginia (Game Commission estimate), and their take of otters exceeded the five-year average (1972-76) by 32 percent (Table 5). In contrast the beaver catch in 1976-77 was only 11 percent above the five year average.

Table 5. Fur trappers take of otters in Virginia, 1973-1977.

Regions	1972-73	1973-74	1974-75	1975-76	1976-77	Five year average
North Mountain	0	0	0	0	1	0.2
South Mountain	0	0	0	0	0	0.0
North Piedmont	75	44	104	70	88	76.2
South Piedmont	88	134	121	98	155	119.2
North Tidewater	276	365	353	266	405	333.0
South Tidewater	43	32	34	67	127	60.6
Statewide Total	482	575	612	501	776	589.2

In 1978, the Game Commission closed the trapping season on the otter west of the Blue Ridge. Everywhere east of the Blue Ridge the no bag limit trapping season extends from December 15 to February 28. The otter is easy to trap and is easily trapped out in an area by persistent trapping. Judging by the decline in pelts taken in marginal areas and the sharp rise in harvest where the otter is still numerous it is probable that it is being over-harvested west of the Blue Ridge. The result of over-harvest is depressingly apparent in western Virginia, Pennsylvania, Ohio, West Virginia, Kentucky, Tennessee, and westward to the Pacific. In that vast area the otter has been extirpated.

Protective Measures Proposed:

- (1) First priority should be given to review of the status of the otter east of the Blue Ridge. Probably the southeastern counties, all of the northern Piedmont counties, and the upper southern Piedmont counties ought to be closed to otter trapping immediately. Counties where the harvest of otters is now high should be carefully and continuously monitored to insure against over-harvest.
- (2) Means of coping with over-harvest must be developed. Unfortunately, captures of beaver and otter are linked by trapping methods currently used. How can the abundant beaver be harvested (5546 were taken in Virginia in the winter of 1976-77) without killing the otters sharing the same habitat? Presumably traps or trapping techniques would have to be modified, perhaps at considerable expense to the trapper. Colorado, which is restocking otters, and West Virginia, which anticipates restocking, are confronting the problem. Until there is a solution, closed seasons or bag limits are rather meaningless.
- (3) The reproductive strategy of the otter poses another management problem. Extending the trapping season to February 28 presumably overlaps the birth season (February and March) and mating season (January to March) of the otter. Capture of a female who has a litter of young in her den and who already has mated again would simultaneously wipe out three generations. With a birth rate of only two or three young per year it is easy to see why heavy trapping pressure is disastrous to the otter. The trapping season needs to be earlier to avoid conflict with the reproductive season, or live traps must be used so that harvest can be selective for males.

- (4) There is urgent need for careful study of the distribution, abundance, demography, and natural history of the otter in Virginia. Conservation measures will be more effective and easier to sell if based on knowledge of reproduction, population dynamics, food habits, and behavior of Virginia otters. Now it is necessary to cite studies in North Carolina, New York, or Michigan.
- (5) Fishermen and pond owners must be educated with facts about the food habits and value of the otter so that their detrimental negative attitude toward the animal can be altered.
- (6) A program of removing and relocating otters from fish hatcheries, ponds, and streams where they are unwanted should be developed. Relocation of otters from heavily polluted streams to more productive sites should be contemplated.
- (7) In the mountain counties an otter introduction and management program should be developed in cooperation with the West Virginia Department of Natural Resources.

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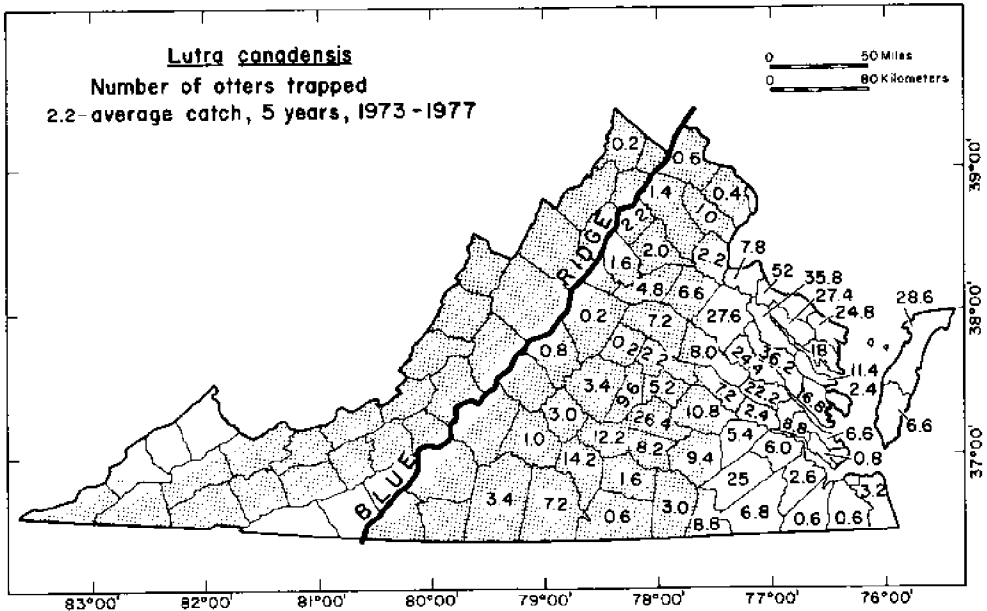


Figure 15. Distribution of River Otter (*Lutra canadensis laticarina*) in Virginia, 1973-1977

11. MOUNTAIN LION

Felis concolor cougar Kerr

Phylum: Chordata
 Class: Mammalia

Order: Carnivora
 Family: Felidae

Description: The mountain lion is a large, long-tailed, plain-colored cat. Its fur is short and soft; dorsal color tawny or some other shade of brown in summer, more grayish in winter; underparts whitish; tail dusky toward tip, ears whitish inside, black outside, with a whitish central area; upper lip white; vibrissal area black (Figure 16). Young mountain lions are paler and have a spotted coat and ringed tail until they are about six months old. Adult males from the eastern United States measure 7 to 9 feet, total length; tail 2 feet 3 inches to 3 feet; weight 150 to 200 pounds. Females are 30 to 40 percent smaller. Color illustration: Burt and Grossenheider (1976, plate 8).

Although such an animal should be unmistakable, views of it are often fleeting and in poor light. Under such conditions it is possible to confuse dogs, bobcats, and even foxes with it. More often tracks (up to 3-1/2 inches across and lacking claw marks) may be seen. The tail leaves marks in snow. The mountain lion usually is comparatively silent and weak-voiced, and most vocalizations attributed to it probably had some other origin.

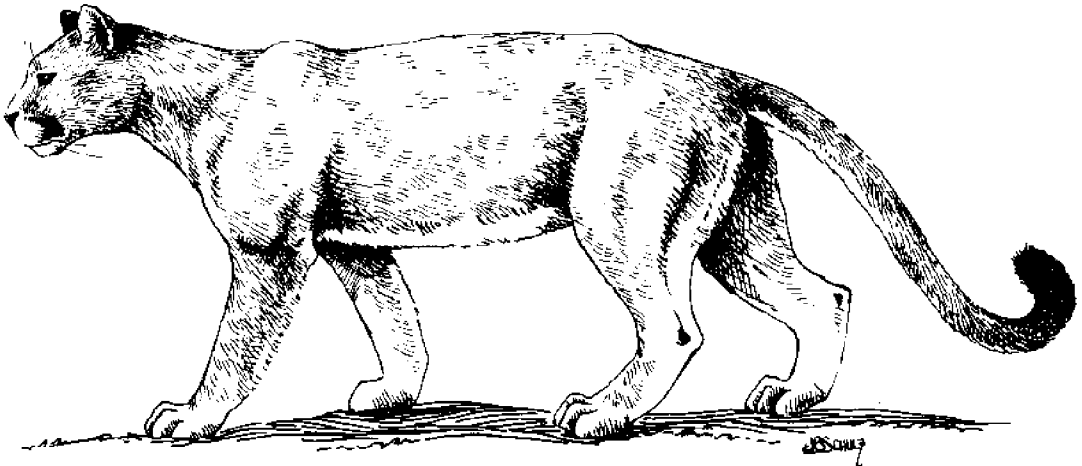


Figure 16. Mountain Lion (*Felis concolor cougar*)

Present Range: Once the most widespread mammal of the Western Hemisphere, with a range extending from ocean to ocean and from British Columbia to Patagonia, the mountain lion has been much persecuted and has been extirpated from most populated and agricultural areas. It is still present in much of its Latin American range and in North America west of the Great Plains and around the Gulf of Mexico. Mountain lions of uncertain origin are found now in the Maritime Provinces and in upper New England, in the

Appalachians, and possibly on the Coastal Plain from North Carolina southward. The subspecies *Felis concolor couguar* formerly occurred in the eastern United States and southern Canada from Nova Scotia, New Brunswick, southern Ontario, and lower Michigan to Tennessee and South Carolina.

Distribution in Virginia: Formerly probably statewide, the mountain lion was mentioned in 17th- and 18th-century accounts of eastern Virginia and persisted in the mountain counties until the late 19th Century. After a lapse of about 75 years, reliable reports of mountain lions in the mountain counties began to appear again in the 1960's. It now seems to be rather widespread and increasing in Virginia (Figure 17).

Habitat and Mode of Life: The mountain lion lives today in Virginia in extensive mountain hardwood forest, or mixed forest, with rock outcrops and ledges and thickets of mountain laurel, rhododendron, and greenbrier. It probably does not resort to permanent dens except during the breeding season, but it does utilize a variety of shelters on a temporary basis. These include spaces beneath overhanging rocks, caves and fissures in cliffs and ledges, spaces under fallen trees, and dark, secluded spots in dense vegetation. It is nimble on rocks and often climbs trees when pursued by dogs. The mountain lion is primarily nocturnal, but it sometimes hunts and travels in the daytime, particularly in late afternoon. The home range of a mountain lion averages 15 to 30 square miles, but the animal may range over a substantially larger area, and during its lifetime it may wander as much as 75 to 100 miles from its birthplace. Males are solitary most of the year, but a female may be accompanied by her young for up to two years.

Throughout its range the mountain lion feeds most often on larger prey, mostly hoofed mammals such as deer, pronghorn, peccary, and sometimes livestock and elk. It also resorts to a wide variety of smaller prey, including rabbits, squirrels, voles, beaver, smaller carnivores, birds, fish, and arthropods. Despite numerous stories to the contrary, attacks on human beings seem to be very rare. The mountain lion stalks its prey and leaps upon it from the ground rather than from ambush in trees and rocks. It will hide uneaten portions of its kills for future meals, but it will not eat spoiled meat (Palmer, 1954; Wright, 1972; Guggisberg, 1975; Burt and Grossenheider, 1976).

Reproduction: Female mountain lions become sexually mature in their second or third year. Gestation is 90 to 96 days. Pregnancies are usually at intervals of 24-36 months, but sometimes occur as often as every 12-15 months. Parturition occurs in any month of the year, but most commonly in summer (June-September), and it peaks in July. Litters contain 1 to 7 (usually 2 to 4) young. Young remain with their mother one to two years, depending on her reproductive interval. Longevity in captivity is 10 to 12 years (Robinette *et al.*, 1961; Asdell, 1964; Wright, 1972; Guggisberg, 1975).

Number in Captivity: No data.

Status: *Endangered*. Also *Endangered* throughout its range. The English colonists found the mountain lion in the coastal lowlands and wherever they penetrated into the Virginia wilderness. Always, however, it quickly disappeared from the vicinity of their settlements. Even the very early accounts of colonial Virginia chronicle its retreat. Beyond the farms, wherever it survived, it remained the dominant predator. Reports of it usually were unequivocal; of a big cat at close quarters, on an outhouse roof, in a cowshed, or shot to death. Such records ended abruptly in the latter half of the 19th Century. Supposedly, the last mountain lions were killed in Pennsylvania in 1871 (Doutt, 1969), in Virginia in 1882 (Handley and Patton, 1947), in West Virginia in 1887 (McKeever, 1952), and in New

York in 1890 (Stoner, 1950). At that time the mountain lion was regarded as vermin and substantial bounties were offered for its extermination. After the 1880's no bounties were claimed in Virginia, although they were still offered.

Subsequently, for a period of 50 to 75 years, observations were few and were mostly problematical of animals seen at a distance, in poor light, or in brief fleeting glimpses. Often the reports were secondhand or were rumors. This was a period when mountain lions should not have been so difficult to see if they were in fact present in Virginia. Uncontrolled forest burning was prevalent and the deer herd had reached a low ebb, extirpated in most of western Virginia.

In the absence of their dietary mainstay (the white-tailed deer), mountain lions should have had to forage more widely than normal to survive on prey no larger than rabbits, rodents, frogs, arthropods, and birds. Their wanderings in search of food should have taken them into adjacent agricultural areas where there was easy and attractive prey such as sheep, pigs, and calves, as well as greater concentrations of rabbits and voles, than could be found in the forest. Surviving mountain lions should have been obvious, as they apparently were up to the 1880's when the last were thought to have been killed. However, they were not obvious. If there were survivors, they were secretive, did not come out of the forest, and they were very seldom, if ever, seen. Nor was any sign of them seen.

To Handley and Patton (1947) all of this added up to no mountain lions: "Probably once statewide but now extinct; apparently the last Virginia 'mountain lion' was killed in Washington County in 1882. More recent sight records, such as A. H. Howell's field report (Biol. Surv. files) in 1911 from Rappahannock County and an even later report from Giles County, must be looked upon with considerable skepticism."

The "more recent sight records" included a number of other reports which Handley and Patton considered to be even less substantial and of which they kept no record. If *Felis concolor cougar* had in fact been extirpated, the occasional sightings in Virginia in the 75 years following 1882 might be attributable to vivid imagination, misidentification, deliberate hoax, or sometimes to escape of a caged mountain lion.

Following the disappearance of *Felis concolor cougar*, the habitat in its former haunts gradually recovered, thanks in large measure to the establishment of the National Forest system and strong state game management programs. By the mid-20th Century, mountain forests had been restored to a fairly mature and productive state; most small, isolated mountain farms away from good roads had been abandoned; once again there were large blocks of uninhabited forest with limited access; and white-tailed deer had reached a level of abundance probably higher than in presettlement days. Conditions were ideal for reestablishment of the mountain lion in the former range of *Felis concolor cougar*.

By the 1940's in New Brunswick, and the late 1960's in the southern Appalachians, mountain lion sightings became more frequent and more convincing. Several mountain lions were killed in West Virginia and Pennsylvania, hair was found in North Carolina, and casts were made of tracks in Virginia. Between 1970 and 1977 there were 27 sightings, which the Game Commission regarded as possibly reliable, in eleven western Virginia counties. A twelfth county was added to the list with sightings in 1978.

There is no doubt that the mountain lion is back -- once again a part of the Virginia scene. But, where has it been since 1882? Has it been here all the time, hiding out, or has it come recently from somewhere else? Does the subspecies *Felis concolor cougar* still exist or is it extinct? Do the now frequent Virginia sightings represent a fairly substantial and spreading

population, or do they stem from a few individuals who wander widely? Almost every sighting raises new questions. No wonder the mountain lion has been termed "mysterious American cat" (Young and Goldman, 1946). Certainly, mystery cloaks its presence in Virginia. Very little about its status can be stated as fact.

Perhaps *Felis concolor couguar* was not exterminated. Relying almost entirely on sight records, Wright (1972) convincingly documented the presence of the mountain lion in New Brunswick. He believed that the native *Felis concolor couguar* survived in very small numbers in an almost uninhabited block of forest, 20,000 square miles in area, in central New Brunswick, and from there spread into Maine, Quebec, and Nova Scotia. Mountain lions of another subspecies, *Felis concolor coryi* Bangs, survived in Florida and in parts of southern Georgia and Alabama.

Did *Felis concolor couguar* survive in smaller pockets, from which it is now spreading, elsewhere in the eastern United States? Perhaps so, if there were, without interruption, enough wilderness and enough food to support it. It seems unlikely that the cat could survive very long on a diet of minor prey, in the absence of deer; and the whitetail was extirpated in much of the eastern United States at about the same time that the lion disappeared. In Virginia there was a hiatus of at least 25 years between the demise of the deer and the beginning of successful restocking in 1926. However, the native deer persisted in the Tidewater section, where it had the protection of extensive river swamps. It disappeared from all of the mountain counties except Craig, Alleghany, Bath, and Highland, where it continued to thrive in considerable numbers in the best remaining mountain wilderness area in the State (Handley and Patton, 1947). It also survived in the contiguous counties of Pocahontas, Randolph, and Pendleton in West Virginia (Kellogg, 1937).

It is possible that *Felis concolor couguar* and the white-tailed deer persisted together in this haven, 1500 to 2000 square miles, extending from Randolph County, West Virginia to Craig County, Virginia. There have been many mountain lion sightings in this region. Since most other Virginia and West Virginia sightings have been clustered within 25 to 50 miles of it, conceivably it could have been the source of all or most of the mountain lions that have been found in recent years in the Virginias, Maryland, and southern Pennsylvania (Figure 17).

Recently there have been persistent rumors of mountain lions in Hampshire County, West Virginia, and a mountain lion was shot and another was captured when they killed sheep on a farm in Pocahontas County, West Virginia, in April 1976. In a popular article, Taylor (1974) summarized the mounting evidence of the presence of mountain lions in Virginia:

In 1950, a panther was closely observed on Shenandoah Mountain near Harrisonburg, and there have been more recent sightings in Highland County along the West Virginia line ... Malcolm Edwards, a Jefferson National Forest biologist; Harold Trumbo, a biologist with the Game Commission; and Ronald Warfield, a ranger on the Blue Ridge Parkway, have logged reports of panthers. In August, 1971, they listed twenty records for the previous twelve months. Most of them came from the Potts Mountain area in Craig County and from the territory around the Peaks of Otter.

The Virginia Game Commission has tabulated sightings of mountain lions in Virginia counties between 1970 and 1977 as follows: Bath (1), Craig (3), Alleghany (1), Botetourt (5), Bedford (6), Amherst (3), Rockbridge (1), Augusta (2), Rockingham (2), Fauquier (1), and Tazewell (2) (Coggin, 1978).

According to a newspaper report, one was well seen near Afton, Nelson County, in July, 1978.

Thus, although it is regarded as *Endangered* in Virginia, and indeed, wherever it occurs in the East, the mountain lion appears to be increasing in numbers and in distribution. Because of the scarcity of complete, useful specimens, the identity of the eastern lions, except those in Florida, is uncertain. If descendants of the original native stock have somehow managed to survive to the present day, then the animal we see is *Felis concolor cougar*. If *Felis concolor cougar* became extinct in the late 1800's, as has long been accepted as fact, then the cats in the East must have been introduced accidentally or deliberately from the West. They could represent any one of several subspecies. Or, perhaps some eastern populations are native, while others are introduced. These uncertainties cannot be resolved at the present time.

Protective Measures Proposed: Acceptance of the idea that there are mountain lions in the East was a giant step toward their protection. Subsequently, conservation agencies have reacted with unusual speed. In 1971, Virginia gave the mountain lion complete protection, with a continuous closed season against hunting, trapping, and any other form of destruction. It is also totally protected in West Virginia. The U.S. Department of the Interior and the I.U.C.N. have listed *Felis concolor cougar* as *Endangered*. A project of the Virginia Game Commission is designed to gather data on distribution and abundance of the mountain lion in Virginia. The U.S. Fish and Wildlife Service and the U.S. Forest Service are jointly sponsoring a five-year study of the status of the mountain lion in the Southern Appalachians.

In spite of these actions, efforts to determine status, develop management plans, and insure protection, ought to be increased. Several additional steps can be taken:

- (1) More publicity is needed to create public interest and to curb needless killings. Farmers need to be informed that mountain lions are not likely to be a serious menace to their livestock. They need to be reassured that they will be compensated for losses should depredations occur.
- (2) The public should be encouraged to report observations of mountain lions as soon as they occur, to:

<p>Dr. Donald W. Linzey Department of Biology Virginia Polytechnic Institute and State University Blacksburg, Virginia 24061 (703) 961-5025</p>	<p>Robert L. Downing U.S. Fish and Wildlife Service Department of Forestry Clemson University Clemson, South Carolina 29631 (803) 656-3284</p>
---	--
- (3) When established mountain lion home ranges are located, access to such areas should be limited as much as possible, particularly to vehicular travel, and habitat alteration should be discouraged.
- (4) Old county records should be searched for information on bounty payments. These data would give clues to former distribution and abundance, would reveal "last strongholds," and could tell much about the demise of the mountain lion.
- (5) Newspaper archives should be searched for information on sightings. These records would provide clues to the resurgence of the mountain lion.

- (6) The limited range of the mountain lion straddles the boundary between the Virginias. The animal would surely benefit if the Virginia Game Commission and the West Virginia Department of Natural Resources could develop cooperative or coordinated programs of management and protection for it.

Remarks: Other vernacular names: puma, panther, cougar, painter, catamount, American lion.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

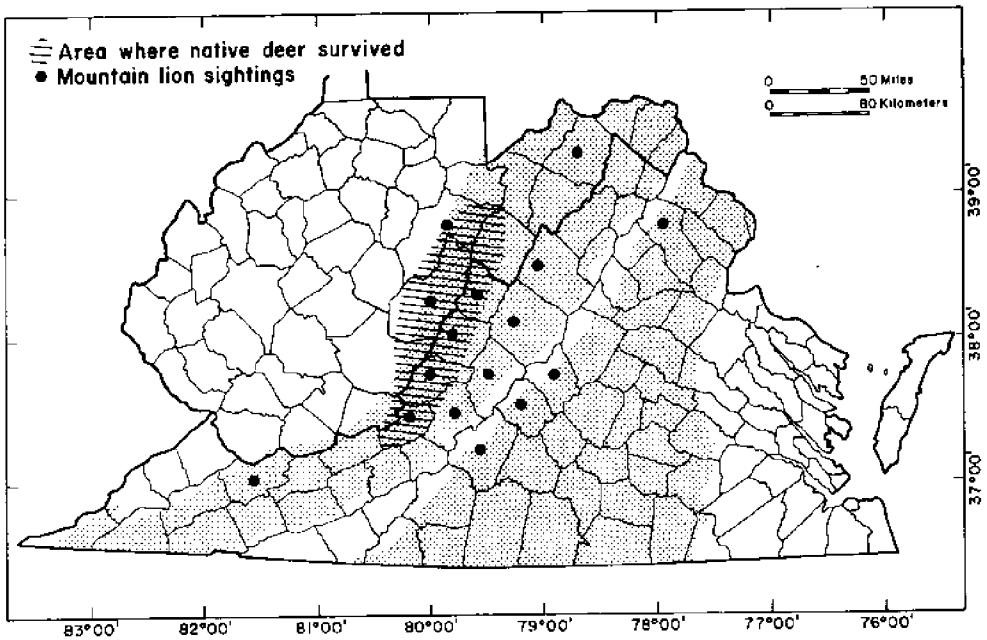


Figure 17. Distribution of Mountain Lion (*Felis concolor cougar*) in Virginia and West Virginia

THREATENED (3)

1. MASKED SHREW

Sorex cinereus fontinalis Hollister

Phylum: Chordata
 Class: Mammalia

Order: Insectivora
 Family: Soricidae

Description: *Sorex cinereus fontinalis* is a small shrew with delicate feet, tail between one-half and one-third of the total length, long snout, dark brown dorsum and paler, buffy underparts. Measurements of the type (in millimeters): total length 90, tail vertebrae 31, hind foot 10 (Hollister, 1911; Jackson, 1928). A specimen from Landover, Maryland, weighed 2 grams, but was possibly dehydrated. Color illustration: Burt and Grossenheider (1976, plate 1).

This shrew is similar to *Sorex cinereus cinereus* in color but is slightly smaller and has a shorter tail; smaller skull; shorter, less attenuate but relatively broader rostrum; more crowded unicuspid, decreasing in size from first to fourth (third occasionally equal to fourth); and a narrower, more compressed braincase. It is very similar to *Sorex longirostris longirostris* Bachman in size and in summer coloration, but its winter pelage is slightly grayer; rostrum slightly longer and narrower; unicuspid less crowded, the third usually larger than the fourth (vs. usually smaller than fourth); molars slightly narrower, and lower incisors longer.

Present Range: *Sorex cinereus fontinalis* is found in typical form and is common to abundant in Montgomery (337 specimens in U.S. National Museum) and upper Prince Georges (23 specimens in U.S. National Museum) counties, Maryland. It is atypical (larger) in St. Mary's, Anne Arundel, and Baltimore counties on the Western Shore, and in Worcester, Dorchester, and Cecil counties on the Eastern Shore of Maryland. It is found also in Delaware and in southeast and south-central Pennsylvania, where it reportedly intergrades with *Sorex cinereus cinereus* (Poole, 1937; Gifford and Whitebread, 1951; and Roberts and Early, 1952; but see Kirkland, 1977c, for a contrary view).

Distribution in Virginia: *Sorex cinereus fontinalis* is known in Virginia only by seven specimens taken in February, 1938, near Little Pimmit Run, 2 miles southwest of Chain Bridge, Arlington County (Bray, 1939). It can be expected anywhere on the Potomac bluffs in Arlington, upper Fairfax, and Loudoun counties. Its southward distribution may be limited by the presence of *Sorex longirostris*, a species with similar habitat requirements, with which *Sorex cinereus* in more or less allopatric. It may be limited westward by the presence of *Sorex cinereus cinereus*. It may also occur in Accomack County on the Eastern Shore. A skull of *Sorex cinereus fontinalis* was recovered from a barn owl pellet on Mills Island, Maryland, in Chincoteague Bay, about two miles from the nearest point on the Virginia mainland by Paradiso (1969) (Figure 18).

Habitat and Mode of Life: The Virginia specimens were taken in low, moist, soft bottomland, with a thick leaf mat, many rotting logs, and a dense cover of honeysuckle, in second growth oak-gum-sycamore forest (Bray, 1939). Maryland specimens have come from a variety of habitats: a marshy meadow near Glen Artney (Hampe, 1936), lowland tracts of mixed forest with patches of sphagnum near Cambridge (Jackson, 1929), under logs and in marsh vegetation and sphagnum in a cold swamp near Hyattsville (Bailey, 1923), and in a dry upland field in Bethesda (Kilham, 1951). In southeast Pennsylvania, Roberts and Early (1952) found it most commonly in moist sedge-grass meadows, and

also in moist woodland, dry fallow fields, and marshes. According to Bailey (1923), this shrew makes tiny runways and burrows (about three-fourths of an inch in diameter) and uses the runs of *Microtus* and *Synaptomye* as well. As shown by the experience of Roberts and Early (1952) in Chester County, south-east Pennsylvania, *Sorex cinereus fontinalis* is subject to large population fluctuations. They captured only three individuals in two months of trapping in the fall of 1949, but they caught 78 in the same length of time in the same place in the fall of 1950. Food includes insects, insect larvae, earth-worms, and possibly small mammals (Roberts and Early, 1952; Bailey, 1923). It is active both day and night. Sometimes *Sorex cinereus* utters very high-pitched squeaks, inaudible to some persons (Tuttle, 1964).

Reproduction: Nests of dried leaves or grass of this subspecies have been found under a discarded box (Hampe, 1936) and under roots, logs and stumps; or old nests of *Peromyscus leucopus* may be reconditioned (Roberts and Early, 1952; Kilham, 1951). According to Roberts and Early (1952) males in southeast Pennsylvania have enlarged testes by late February, and females may be pregnant March 28 to September 16, with 4 to 6 embryos (average 5). In Maryland, Kilham (1951) found a nest with 6 naked young 19 April 1951; Hampe (1936) trapped a lactating female 14 April 1935, and observed 6 young in a nest from 18 October to 8 November 1936. Short (1961a) estimated a gestation period of 22 days, lactation for 21 days, and sexual maturity in 20 to 26 weeks for *Sorex cinereus*.

Number in Captivity: No data. Pruitt (1954) described care and feeding of *Sorex cinereus* in captivity.

Status: *Threatened*. *Sorex cinereus fontinalis* is at the southwestern edge of its range in Virginia. It has been found only once in this state, in 1938, but it inhabits an infrequently collected area, and may be more numerous than the single record would seem to indicate. It is unlikely that it occurs in Virginia beyond the Potomac bluffs in Arlington, Fairfax, and Loudoun counties, an area that is becoming increasingly urbanized. Fortunately, however, urban development commonly avoids the damp, low ground most favored by this shrew. Thus, it probably is not immediately *Endangered* within its limited range in Virginia, but it could become so. It is common to abundant across the Potomac in Maryland.

The subspecies *Sorex cinereus cinereus* Kerr is abundant in Virginia.

Protective Measures Proposed: Field studies should be conducted to map distribution and abundance of *Sorex cinereus fontinalis* in Virginia. Its behavioral relationship with *Sorex longirostris* should be examined.

Remarks: Other common names are Maryland shrew, common long-tailed shrew, and masked long-tailed shrew.

Author: Charles O. Handley, Jr.

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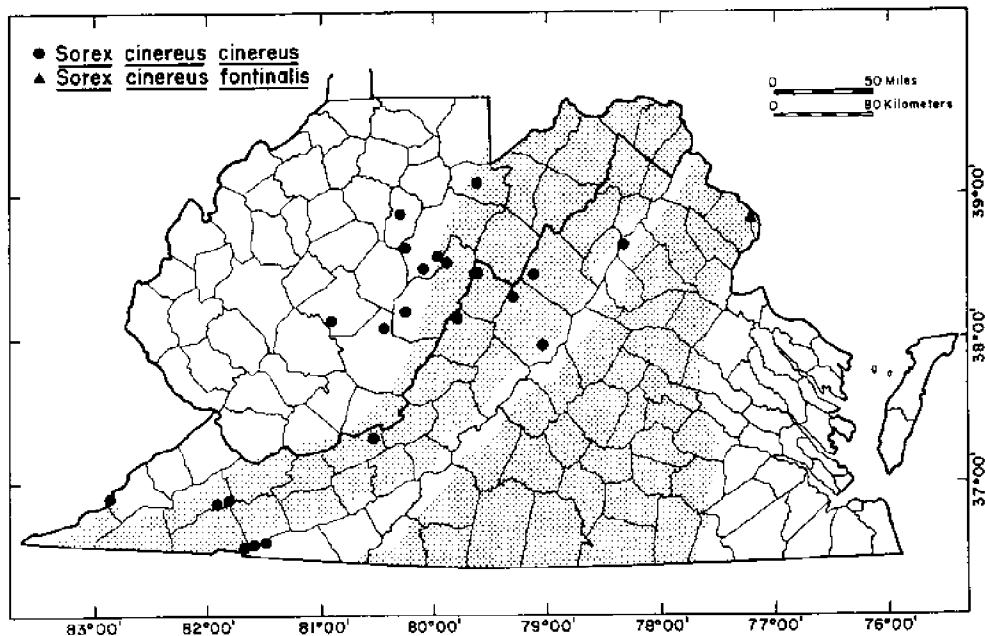


Figure 18. Distribution of Masked Shrew (*Sorex cinereus fontinalis*) in Virginia and West Virginia

2. DISMAL SWAMP SHREW

Sorex longirostris fisheri Merriam

Phylum: Chordata
Class: Mammalia

Order: Insectivora
Family: Soricidae

Description: *Sorex longirostris fisheri* is a small long-tailed shrew, with brown dorsum, slightly paler underparts, indistinctly bicolored tail, and buffy hands and feet. In spite of its scientific name, *Sorex longirostris*, it has a relatively short, broad rostrum. Its toothrows are crowded, and the third upper unicuspid is usually smaller than the fourth. Measurements (in millimeters) of the holotype and a topotype (in parentheses), both males: total length 108 (102), tail vertebrae 39 (40), hind foot 12 (12) (Jackson, 1928).

The Dismal Swamp shrew is larger than *Sorex longirostris longirostris* and averages duller in color. It is superficially similar to *Sorex cinereus* Kerr in size and coloration, but its underparts usually are darker and less distinct from the upperparts, its rostrum is broader and the anterior portion is shorter and deeper, and its teeth average wider and more crowded. Usually the third upper unicuspid is smaller than the fourth in *Sorex longirostris* and larger in *Sorex cinereus*, but this tooth is variable in size in southern *Sorex cinereus* and not diagnostic. This may account for the supposed records of *Sorex longirostris* at montane localities such as Blacksburg (Handley and Patton, 1947) and Mountain Lake (Odum, 1944).

Present Range: The species *Sorex longirostris* ranges at lower elevations on the Atlantic Seaboard from Maryland to Florida, west along the Gulf Coast to Louisiana and Arkansas, and north in the Mississippi Valley to Missouri, Illinois, Indiana, and Kentucky. The subspecies *Sorex longirostris fisheri* is found only in the Dismal Swamp in Virginia and North Carolina. Its type locality is Lake Drummond, Dismal Swamp, Virginia (Merriam, 1895).

Distribution in Virginia: This shrew is confined to the Dismal Swamp in Virginia (cities of Suffolk and Chesapeake, formerly Nansemond and Norfolk counties) and adjacent portions of North Carolina (Perquimans County) (Fig. 19).

Habitat and Mode of Life: In the Dismal Swamp this shrew has been found at the edge of cane brakes and around rotting logs on drier ground in thickets of myrtle, blackberry, poison ivy, and holly. In his account of *Sorex longirostris fisheri*, Bailey (1946) gave a detailed description of its natural history, but his information probably was gleaned from the literature and applied to long-tailed shrews in general and not specifically *Sorex longirostris fisheri* as implied. Actually, almost nothing is known about the behavior of this subspecies, and little more is known about the more widespread *Sorex longirostris longirostris*.

Reproduction: W. L. Ralph found a litter of 5 young of *Sorex longirostris fisheri* in the Dismal Swamp in May, 1905 (probably May 14 or 15) (Hollister, 1911).

Number in Captivity: No data.

Status: *Threatened*. This shrew is thought to have a very limited range -- the Dismal Swamp, which has shrunk in area considerably in recent years through clearing and draining. It is known only from about twenty specimens, mostly from the vicinity of Lake Drummond in the heart of the Swamp. It has been taken at least as recently as 1953, and in spite of limited range and small number of specimens, I suspect that it is reasonably numerous in the Dismal Swamp. Thus, it cannot be regarded as *Threatened* because of small numbers. The danger lies in losing its genotype through the interbreeding of upland and swamp shrews.

Sorex longirostris and *Sorex fisheri* may have been sibling species, geographically isolated in the Late Pleistocene. Existing museum specimens of *Sorex longirostris fisheri* show an unusually wide range of morphological variation, from large to almost as small as *Sorex longirostris longirostris*. This suggests that *Sorex longirostris fisheri* is no longer geographically or genetically isolated from its upland relative. Continued clearing and draining could convert the swamp environment into a habitat more suitable for *Sorex longirostris longirostris*. This could hasten its ingress into the Swamp, leading to genetic "swamping" of *Sorex longirostris fisheri*. It is possible that this has already happened or is happening, for the specimen of *Sorex longirostris fisheri* collected in 1953 is smaller and more like *Sorex longirostris longirostris* than any collected in 1895-1905.

Protective Measures Proposed: To protect *Sorex longirostris fisheri*, further draining in the Dismal Swamp should be prevented. A series of shrews should be collected in the Swamp for comparison with the 1895-1905 material. This would show whether the genetic integrity of *Sorex longirostris fisheri* has been preserved.

Remarks: Other common names: Fisher's shrew, Dismal Swamp long-tailed shrew, Dismal Swamp southeastern shrew.

Author: Charles O. Handley, Jr.

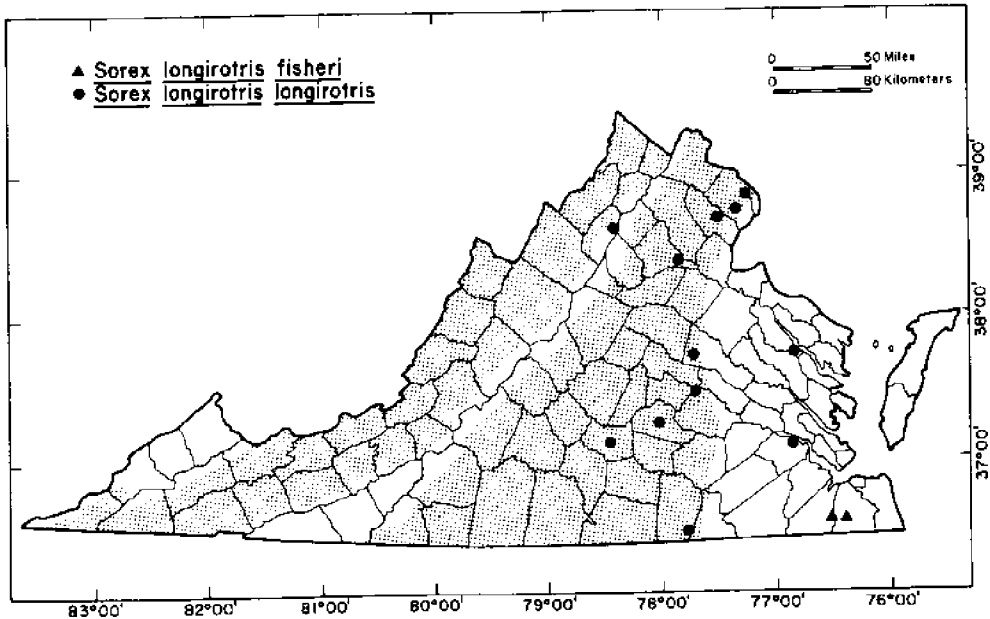


Figure 19. Distribution of Dismal Swamp Shrew (*Sorex longirostris fisheri*) in Virginia

3. STAR-NOSED MOLE

Condylura cristata parva Paradiso

Phylum: Chordata
Class: Mammalia

Order: Insectivora
Family: Talpidae

Description: Body form is mole-like in *Condylura cristata*. It has tiny but visible eyes; vestigial external ears; short neck; enlarged, long-clawed, spade-like forefeet; and thick, silky, blackish to blackish-brown fur. Unlike most other moles, it has a long (one-third of total length), thick, scaly, scantily haired tail, and it is unique in possession of rosettes of eleven fleshy, pink, tentacle-like projections surrounding each nostril. The two subspecies occurring in Virginia differ from one another mostly in size. The following measurements in millimeters are from Paradiso (1959). *Condylura cristata cristata* (ten specimens from Massachusetts) is larger: total length 199.8 (195-208), tail vertebrae 78.1 (76-83), and hind foot 28.4 (27-30). *Condylura cristata parva* (six adults and subadults from Virginia, North Carolina, and South Carolina) is smaller: total length 163.8 (158-170), tail vertebrae 60.3 (57-63), and hind foot 25.2 (25-26). Color illustration: Burt and Grossenheider (1976, plate 1).

The star-nosed mole can be distinguished from all other mammals in Virginia by its mole-like form, enlarged forefeet, relatively long, thick tail, and rosettes of fleshy tentacles surrounding its nostrils.

Present Range: The species occurs in southeastern Canada and northeastern United States from Labrador and the Maritime Provinces west to Manitoba and south to Minnesota, Wisconsin, Indiana, Ohio, and northern Virginia; in the Appalachians to eastern Tennessee, western North Carolina, and northwestern South Carolina; and in the Atlantic Coastal Plain to Georgia. The subspecies *Condylura cristata parva* is thought to occur, mostly at medium to high elevations, in the Appalachians from Greenbrier County, West Virginia (4.2 miles northeast of Richwood), and Patrick County, Virginia (5 miles northwest of Stuart), to extreme northeastern Tennessee (Shady Valley, Johnson County), Great Smoky Mountains National Park, and extreme southwestern North Carolina (Hayesville, Clay County). A supposedly disjunct population of *Condylura cristata parva* is known from a few widely scattered localities in the Coastal Plain between Accomack County, Virginia (2.3 miles east of Wattsville), and the Okefenokee Swamp in southeastern Georgia. The type locality of *Condylura cristata parva* is 5 miles northwest of Stuart, Patrick County, Virginia.

Distribution in Virginia: Although the northern subspecies *Condylura cristata cristata* is rather widespread in northern Virginia, with numerous records from the Piedmont as well as from the coastal plain and mountain counties, there are very few records for *Condylura cristata parva*. It has been reported but not collected in the New River Valley (Wythe County) and there is one specimen, the holotype, from Patrick County. Across the state, along the coast, one specimen has been taken in Accomack County, another in Surry County (near Scotland, 4 miles northeast of Surry), and there are a number of specimens and observations for the Dismal Swamp. There is a report but no specimen from Henrico County (Figure 20).

Habitat and Mode of Life: *Condylura cristata* usually is associated with water and is found regularly in such places as the "soft marshy ground along stream borders" (Simpson, 1923) and wet meadows, but it is taken occasionally in the "leaf mold of dense forests, or in relatively dry fields" (Paradiso, 1969).

The star-nosed mole is an excellent swimmer and diver and many museum specimens have been taken incidentally in traps set for minnows or muskrats. Since several individuals often have been found together in traps, it is possible that this is a gregarious species. It is both diurnal and nocturnal and is active during all months of the year (Hamilton, 1931; Eadie and Hamilton 1956).

The forefeet are used, usually in unison, to excavate tunnels (about 1-1/2 to 3 inches across and 1-1/2 to 2 inches high) in soft earth. The tunnels may be alternately shallow or deep and often they open directly into a stream or lake or onto the surface of the ground, to continue for a short distance as surface runs. When it digs deep burrows, the mole pushes closely packed dirt which conforms to the shape of the tunnel to the surface to form molehills. In winter months this mole burrows less than at other times of the year. At that season it sometimes runs on the surface of the snow, and it takes even greater advantage of water pathways for travelling and foraging (Hamilton, 1931).

Insects and annelid worms, mostly aquatic forms, together make up 82 percent of this mole's diet. Commonly ingested items from these two groups are caddis fly, midge, and dytiscid larvae, aquatic oligochaetes, and leeches. Vertebrates (a minnow), molluscs, and crustaceans (chiefly shrimp of the genera *Gammarus* and *Hyalella*) have also been found in *Condylura* stomachs (Hamilton, 1931).

This mole's known predators include red-tailed hawks, owls (great horned, screech, and barn) and skunks. It probably also is the prey of such fish as large bass and pike, although this has not been documented (Hamilton, 1931). A case of predation by a bullfrog has been recorded (Pine, 1975). In Great

Smoky Mountains National Park it has been preyed upon by corn snake and house cat (Linzey and Linzey, 1971). One was pecked to death by chickens in Fairfax County, Virginia.

Reproduction: The nest of the star-nosed mole usually is situated on or just below the surface. It usually is placed under a stump or log, or in humus among rotten tree roots, often near a stream, but always above high-water line (Simpson, 1923). Nests have also been found in a compost heap (Kennard, 1929) and in a manure pile (Simpson, 1923). The nest is constructed with whatever materials are readily available -- perhaps straw, dry grass, or dead leaves, and it usually takes the shape of a "depressed sphere" (Hamilton, 1931), 5 to 6 inches across and 4 to 5 inches high (Paradiso, 1969).

Condylura cristata cristata produces one litter per year (Eadie and Hamilton, 1956). Field observations indicate that males and females pair off in the fall and remain together through the breeding season (Paradiso, 1969). A peculiar swelling of the tail (incrassation) occurs in both sexes during the winter and spring months (Hamilton, 1931). Eadie and Hamilton (1956) thought that in males, at least, this may serve as a temporary reservoir for energy needed in the breeding season.

In upstate New York, male gonads and accessory glands are in breeding condition from mid-February until early or mid-June, but most matings take place in late March and April. A "copulatory plug" is formed, composed in part of a secretion from the prostate gland. The gestation period is about 45 days. In central New York State, young may be born anytime from late March to early August. The average number of young found in nine nests was 5 (range 3-7); figures substantiated by examination of a larger number of pregnant female specimens. Both males and females breed the first spring after they are born (Eadie and Hamilton, 1956).

Number in Captivity: No data.

Status: *Threatened*. The known range of *Condylura cristata parva* is fragmented and it seems to be absent from most suitable habitats. Its total population may be very small. The greatest threat to its survival is alteration of its habitat by draining and by trampling of livestock. It would be considered endangered, except that probably little alteration of its remnant occupied habitats is going on at the present time.

Protective Measures Proposed: Surviving populations must be located and land-owners must be encouraged to protect occupied habitat by excluding livestock and maintaining poor drainage. If suitably large and vigorous populations can be located, the possibility of restoring *condylura cristata parva* to suitable protected habitats might be considered. It would be desirable to have this mole more widespread for a number of reasons. Not only is it probably totally beneficial, it is so bizarre in appearance that its chance discovery almost always arouses public interest and curiosity. It is one of the few mammals whose type locality is in Virginia.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

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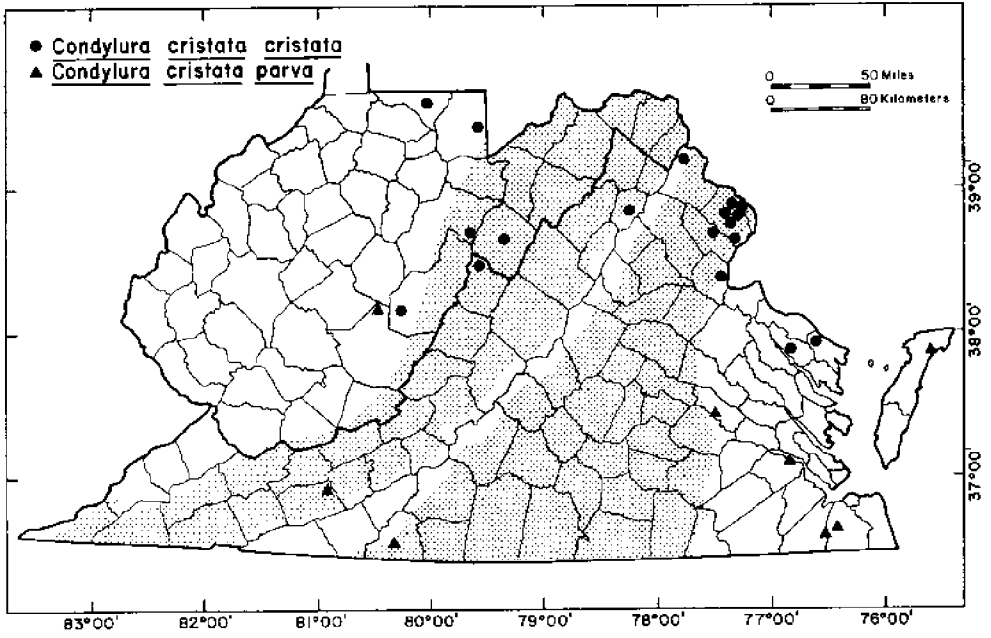


Figure 20. Distribution of Star-Nosed Mole (*Condylura cristata parva*) in Virginia and West Virginia

SPECIAL CONCERN (7)

1. BIG-TAILED SHREW

Sorex dispar dispar Batchelder

Phylum: Chordata

Order: Insectivora

Class: Mammalia

Family: Soricidae

Description: *Sorex dispar* has typically shrew-like form, but compared with other eastern shrews, it is rather flat-headed. It is relatively large, has an unusually long, thick tail, black above and only a little paler below, and has whitish hands and feet. At all seasons its pelage is almost uniformly dark gray, very slightly paler gray on the underparts (Figure 21). Measurements (in millimeters) of 30 *Sorex dispar* from Virginia are: total length 124 (114-132), tail vertebrae 56 (49-59), hind foot 15 (14-15); weight 5.4 grams (4.6 to 6.9). Diagrams of *Sorex dispar*: Mearns (1898) and Harper (1929).

Sorex palustris somewhat resembles *sorex dispar* but can be easily distinguished from it by brighter, more blackish upper parts, silvery underparts, sharply bicolored tail, fimbriated (hair fringed) toes and feet, and larger size (hind foot 19-20 vs. 14-15 millimeters). *Sorex fumeus* Miller, although distinctively brown in summer, is grayish, something like *Sorex dispar* in winter. Its gray, however, is notably darker and browner than the clear gray of *Sorex dispar*, and its tail is thinner and shorter (average 44 millimeters, range 39-50) in 25 Virginia specimens.

Sorex dispar blitchi Schwartz of the mountains of North Carolina and Tennessee differs from *Sorex dispar dispar* in longer tail (average 64 millimeters), larger body and skull, and slightly darker coloration. Schwartz (1956), in describing *Sorex dispar blitchi*, thought that it intergraded with *Sorex dispar dispar* in the Virginias. However, the many additional specimens now available from the southern Appalachians show that all Virginia and West Virginia specimens, down to Clinch Mountain and Whitetop, can be assigned to *Sorex dispar dispar*. Specimens from even farther south, at Roan Mountain, are intergrades, perhaps averaging closer to *Sorex dispar dispar*, but some of them are indistinguishable from typical *Sorex dispar blitchi*.

Present Range: The big-tailed shrew is an Appalachian endemic, found from North Carolina and Tennessee to Maine (Hall and Kelson, 1959). In North Carolina, *Sorex dispar blitchi* is thought to be rare and local, known only from four localities, all above 4400 feet, in Haywood and Swain counties (Lee and Fundenburg, 1977). Linzey and Linzey (1971) regarded it as "not rare" in suitable habitat in Tennessee, but it has been taken there only at elevations above 2200 feet at four localities in Carter and Sevier counties.

The subspecies *Sorex dispar dispar* is found from the Virginias northward. It seems to be more widespread and abundant than the southern *Sorex dispar blitchi*. There are numerous records for Virginia and West Virginia and points northward. Although there are no records, it may also occur in Kentucky, for there is seemingly suitable habitat in Bell and Harlan counties (Davis, pers. comm., 1978).

Distribution in Virginia: This shrew is known in Virginia from Whitetop Mountain at the northern terminus of the Great Smoky Mountains and from scattered localities in the Alleghenies, where it likely occurs throughout in suitable habitat. It is unknown in the Appalachian Plateau in Virginia, Kentucky, and Tennessee partly because of unfavorable habitat, but it has been found on the plateau in West Virginia, Maryland, and Pennsylvania. It has not been taken in the Blue Ridge in Virginia or Pennsylvania, but it has been found

near the southern end of that mountain range in North Carolina. Capture localities in Virginia vary in elevation from 2300 to 5300 feet and in West Virginia from 2200 to 4600 feet (Figure 22).

Sorex dispar has been found at the following localities in Virginia: Bath County, Little Back Creek, 3500 feet (Pagels and Tate, 1976); Bath County, Warm Springs Mountain, 5.4 miles southwest of Burnsville, 2300 feet; Giles County, Mountain Lake area (numerous localities), 4000-4200 feet (Handley, 1956; Holloway, 1957); Russell County, Clinch Mountain, Mutters Gap, 6.5 miles northwest of Saltville, 4200 feet; Smyth County, Whitetop Mountain, north slope, 5300 feet. It is known as a Late Pleistocene fossil at Clark's Cave, 1500 feet, Bath County, Virginia (Guilday *et al.*, 1977).



Figure 21. Big-Tailed Shrew (*Sorex dispar dispar*)

Habitat and Mode of Life: In Virginia the big-tailed shrew has been found *always* in cool, moist cliffs or rock slides in northern hardwood or conifer forests. For example, frequent sampling of all habitats in the Mountain Lake area in the past twenty years has taken altogether about 900 shrews of five species. Only about 150 of these were caught in 13,678 trapnights in rock habitats; none of the *Cryptotis parva*, only 9 percent of all *Blarina brevicauda*, and 12 percent of the *Sorex cinereus*. In contrast, 42 percent of the *Sorex fumeus* and all (45) of the *Sorex dispar* were taken in rock

habitats. The *Sorex dispar* came from habitats such as cliff bases, crevices in cliffs, breakdown beneath cliffs, and deep, mossy talus; all on ridges, far from running water; in red oak, black birch, red maple forest, with an understory of witch hazel, striped maple and mountain ash, and a ground cover of blackberry, mountain wood fern (*Dryopteris compelloptera*), *Aster*, numerous herbs and moss. Pagels and Tate (1976) found it in similar habitat on Little Back Creek, but there a stream was nearby, and beach, yellow birch, sugar maple and black oak were among the dominant trees. On Warm Springs Mountain *Sorex dispar* was in moist, mossy, humus-laden, gently sloping talus near a stream in a hardwood cove; and on Whitetop Mountain it was in moist talus near a small seep, in mixed red spruce-black birch forest. The Clinch Mountain specimens came from deep, anchored talus in mixed northern hardwood-conifer forest on a ridgetop.

The habitat of *Sorex dispar* often, if not always, has considerable depth as well as horizontal area, and thus cannot always be effectively sampled with traps during unusually hot, dry periods. This might account in part for its apparent rarity in some places. All Virginia specimens have been taken in summer (May-September), but see Richmond and Grimm (1950).

Aside from a few stomach analyses, from which food habits have been inferred, almost nothing is known of the natural history of *Sorex dispar*. Richmond and Grimm (1950) found mostly centipede remains and fragments of insects and spiders in three Pennsylvania shrews. Conaway and Pfitzer (1952) reported mostly insect remains in six stomachs from Great Smoky Mountains National Park; there were fragments of beetles in five, spiders in two. Nine shrews from New York examined by Connor (1960) contained mostly insects, along with some centipedes and spiders, and a little plant material.

Southern Appalachian specimens are in long winter pelage from late September or early October to April or May, and in short summer pelage from late April or May to September or early October. Most May, June (occasionally late July) and September specimens are molting.

Reproduction: In specimens from Virginia and Tennessee females with 3 to 5 embryos were found May 22 to August 9, and lactating females were collected June 22 to August 1. Males with enlarged testes have been taken March 30 to July 23.

Number in Captivity: No date.

Status: *Special Concern.* *Sorex dispar* is of concern, not because it is rare but because of its very specialized habitat requirements. An estimate of its abundance can be had at Mountain Lake, Virginia, where it is best known, and where its favored habitat has been sampled over a period of twenty years by 13,678 trapnights. In the rock habitats frequented by *Sorex dispar* at Mountain Lake, some sort of shrew is taken once in every 98 trapnights on the average. Some kind of *Sorex* (*Sorex cinereus*, *Sorex dispar*, *Sorex fumeus*) comes up once in every 155 trapnights. One *Sorex dispar* has been caught in each 472 trapnights. Thus, although it makes up only 3 percent of all the shrews caught in all habitats at Mountain Lake, *Sorex dispar* makes up 21 percent of the shrews caught in its chosen habitat. So, *sorex dispar* cannot be described as rare. However, its status might be changed by events that would dry up, warm up, eliminate its habitat. While this may be happening in some states within its range, it does not seem to be imminent in Virginia, where suitable cliffs and talus are extensive.

Protective Measures Proposed: Study of the life history of *Sorex dispar* should be encouraged, and the possibility of management of its habitat and creation of suitable habitat for it should be explored. Forest might be managed so that cliffs and talus would be spared in logging. Some kinds of habitat destruction may not even be entirely detrimental. Kirkland (1977b) found

Sorex dispar in dry, recent clearcut in red spruce forest in West Virginia. However, more typical habitat was contiguous and subsequent trapping did not produce more specimens. There is also the possibility of creating habitat for *Sorex dispar*. Conaway and Pfitzer (1952) found this shrew in a stone highway retaining wall and in sparsely vegetated artificial talus created by roadcuts and fills in Great Smoky Mountains National Park.

Remarks: Other common names: rock shrew, long-tailed shrew, and gray long-tailed shrew.

Author: Charles O. Handley, Jr.

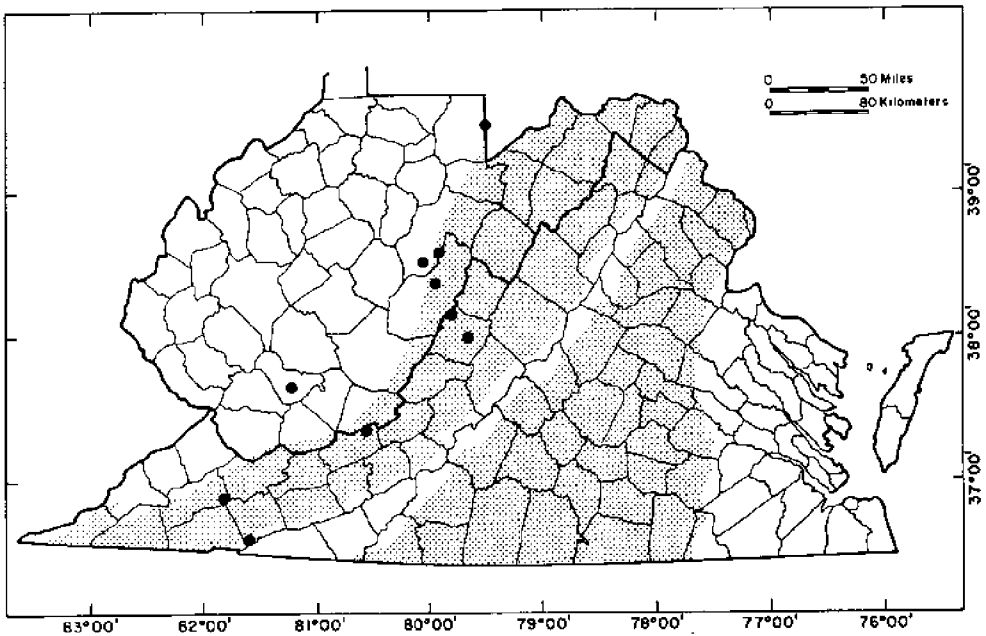


Figure 22. Distribution of Big-Tailed Shrew (*Sorex dispar dispar*) in Virginia and West Virginia

2. PYGMY SHREW

Microsorex hoyi winnemana Preble

Phylum: Chordata
 Class: Mammalia

Order: Insectivora
 Family: Soricidae

Description: Of all of the mammals of the Western Hemisphere, *Microsorex hoyi winnemana* is the smallest, weighing only a fraction of an ounce (less than three grams). It is tiny! Only a few Old World shrews are smaller. It has typical shrew proportions: slender snout; tiny eyes; small, partly concealed ears; delicate feet; and tail about one-third of the total length. Its body is colored dark gray-brown above, whitish buff below; its feet are whitish; and its tail is bicolored, dark above and pale below. Based on a dozen specimens, this subspecies seems to be largest in Maryland and in the highlands of North Carolina (measurements in millimeters): total length 81 (75-86), tail vertebrae 30 (28-33), hind foot 10(9-10); intermediate in the lowlands of Virginia (6 specimens): total length 77 (70-80), tail vertebrae 27 (25-28), hind foot 9 (7-9); and smallest in the mountains of Georgia (2 specimens): total length 66 (62-70), tail vertebrae 28 (27-28), hind foot 8 (8-8).

Throughout its range *Microsorex hoyi winnemana* occurs together with *Sorex* almost as small as it is: with *Sorex cinereus fontinalis* in Maryland; *Sorex cinereus cinereus* in North Carolina and Georgia; and with *Sorex longirostris* in Virginia. It is a little smaller, has a shorter snout and more delicate feet, and is a little grayer than any of these, but for positive identification, its upper unicuspid teeth must be checked. In side view, *Microsorex* appears to have only three unicuspid teeth while *Sorex* has five.

Present Range: The species ranges in the forest belt from Nova Scotia and Labrador across Canada almost to the Bering Sea Coast of Alaska, and from the edge of the tundra south to British Columbia, Washington, Montana, the northern edge of the Great Plains, Iowa, northern Illinois, northeastern Ohio, northern Pennsylvania, New York, and New England. Apparently isolated populations are in the southern Rocky Mountains in Wyoming and Colorado (*Microsorex hoyi montanus* Brown), and in the southeast from Maryland and Virginia south to western North Carolina and northern Georgia and west to Kentucky and southern Illinois (*Microsorex hoyi winnemana*). The type locality of *Microsorex hoyi winnemana* is the bank of the Potomac River, near Stubblefield Falls, 2 miles north-northwest of McLean, Fairfax County, Virginia.

Distribution in Virginia: Specimens of *Microsorex hoyi winnemana* have been taken in Virginia (Figure 23) as follows (several other reports have been neither verified nor published):

1. Fairfax County, bank of Potomac River near Stubblefield Falls, 2 miles north-northwest of McLean, April 25, 1903. E. A. Preble, collector. USNM 126320, female, skin and skull. The holotype of *Microsorex hoyi winnemana*.
2. Campbell County, near Altavista. G. W. J. Blume, collector, received through Col. Wirt Robinson, July 8, 1920. USNM 236647, (sex ?), in alcohol, skull removed.
3. Rockbridge County, Vesuvius, July 3, 1956. Max Carpenter, collector. USNM 521113, female, skin and skull.
4. Surry County, near Scotland, 4 miles northeast of Surry, August 8, 1971. Roger H. de Ragoet, collector. USNM 536084, (sex ?), in alcohol.

5. Prince William County, 4 miles southeast of Manassas, June 18, 1973. R. C. Laybourne, collector. USNM 521112 (sex ?), skin and skull.
6. Prince Edward County, bank of Appomattox River at Route 15; July 26, 1976. J. F. Pagels and Cathy Tate, collectors. Virginia Commonwealth University 1330, male, skull only.
7. Essex County, 3.5 miles southwest of Center Cross, April 23, 1978. M. P. Gardner, collector. USNM 526837, female, skin and skull.
8. Essex County, 3.5 miles southwest of Center Cross, May 21, 1978. A. L. Gardner, collector. USNM 526836, male, skin and skull.

Altogether, 17 specimens of *Microsorex hoyi wirmemana* are known. Eight of them were taken in Virginia, two in Maryland (Preble, 1910; Lee, 1974), one in Illinois (USNM 154175), one in Kentucky (Barbour, 1956b), three in North Carolina (Jackson, 1928; Hoffmeister, 1968), and there are two specimens from Georgia (Wharton, 1968). It has not been found as yet in New Jersey, Delaware, Pennsylvania, Ohio, Indiana, West Virginia, Tennessee, or South Carolina. However, there are records of *Microsorex hoyi thompsoni* f. Pennsylvania, Ohio and Illinois.

Most of the Virginia records of the pygmy shrew are from the Piedmont, but three are from the Coastal Plain and one is montane. This shrew may well have a statewide distribution in Virginia. It is one of the most poorly known mammals of the state, partly because of rarity, but also because it is notoriously difficult to capture. Only three of the Virginia specimens were trapped, all in pitfall traps (cans sunk level with the surface of the ground). The other five specimens were all accidental (fortuitous) captures. Two were found in or under rotting logs by persons hunting for salamanders, one was caught by hand when it was observed rustling through leaf litter, one was brought in by a house cat, and one was found floating dead in a swimming pool.

Habitat and Mode of Life: Most of the specimens of *Microsorex hoyi wirmemana* for which habitat data are available came from well drained sites -- slopes or tops of ridges or banks above streams, in or under decaying logs, or in deep leaf litter in hardwood forest with little or no underbrush.

1. Maryland, Baltimore County. On slope of wooded ravine in red maple, chestnut oak, white ash, tulip poplar forest whose floor was layered with leaf litter but lacked undergrowth except for scattered clumps of poison ivy, *Smilax*, and Christmas fern (Lee, 1974).
2. Maryland, Prince Georges County. In decayed heart of dead chestnut, on dry hillside, some distance from water (Preble, 1910).
3. Virginia, Fairfax County. In decayed interior of log on slope above river in mixed forest of red maple, beech, and tulip poplar (Jackson, 1928).
4. Virginia, Prince William County. In farmland near stream and planted hemlocks (Laybourne, pers. comm., 1973).
5. Virginia, Campbell County. On dry, wooded hillside with little underbrush but with scattered rocks and rotting logs and thick layer of dead leaves, not over 100 yards from a stream (Jackson, 1928).
6. Virginia, Prince Edward County. Beside an aging stump on a relatively steep north-facing bank about 30 meters above river, in deciduous forest with numerous rotting logs and stumps and deep litter of decomposing plant material.

7. Virginia, Surry County. Under a small decaying log in hardwood forest on a low ridge, several hundred yards from river.

Very little is known of the natural history of *Microsorex hoyi winnemana* (summarized by Long, 1974). Judging by reported capture times it must be active both day and night. Rageot compared the activity of captive *Microsorex hoyi winnemana* and *Sorex longirostris* and found that the pygmy shrew was more active and considerably quicker ("incredibly quick") in its movements.

Reproduction: The Prince Edward County, Virginia, specimen had much enlarged testes on July 26. The literature provides enough additional data on breeding elsewhere in the range of *Microsorex hoyi* to suggest a very brief breeding season (pregnancy records July 17 to August 9, with 3 to 8 embryos, and lactation July 1 to August 26). Judging by the frequency of capture of pygmy shrews in and under rotting logs, this is a likely place to look for nests of this mammal.

Number in Captivity: No data. Rageot maintained a pygmy shrew for two weeks on a diet of various arthropods.

Status: *Special Concern.* Although it seems to be widespread in Virginia, the pygmy shrew evidently is rare and possibly local in distribution. The species appears to increase in abundance in more northern latitudes, and judging by the abundance of fossils, it must have been more numerous and much more widespread at the latitude of Virginia at the end of the Pleistocene than it is now. Fossil remains of this species have been found outside of its present known range in Pennsylvania, Virginia (a total of 14 individuals from two deposits), Kentucky, Tennessee (17 individuals in one cave deposit), Illinois, Missouri, Arkansas and Colorado (Guilday *et al.*, 1971; Guilday *et al.*, 1977; Long, 1972a). These facts suggest a general decline in abundance in Virginia extending over thousands of years. Our concern should be that we do not inadvertently accelerate the decline. Because the center of abundance of *Microsorex hoyi winnemana* seems to be in Virginia, and because of its status as the most diminutive New World mammal, and one of the most elusive, we should take a special interest in the welfare of this tiny shrew.

Protective Measures Proposed: Until we know more about the natural history of the pygmy shrew and about its ecological requirements there is nothing that can be done to protect it and to enhance its future. High priority should be given to studies designed to learn more about *Microsorex hoyi winnemana* and its needs.

Authors: Charles O. Handley, Jr., John F. Pagels and Roger H. de Rageot.

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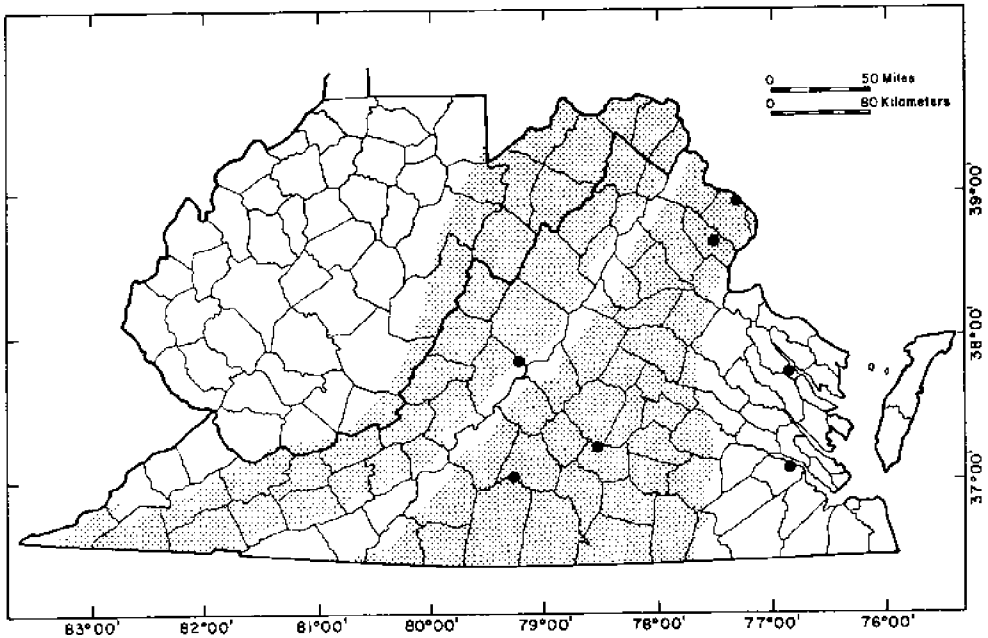


Figure 23. Distribution of Pygmy Shrew (*Microsorex hoyi winnemana*) in Virginia

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3. EASTERN BIG-EARED BAT

Plecotus rafinesquii rafinesquii Lesson
Plecotus rafinesquii macrotis LeConte

Phylum: Chordata
 Class: Mammalia

Order: Chiroptera
 Family: Vespertilionidae

Description: The eastern big-eared bat has enormous ears, more than twice the length of the head, connected by a low band across the forehead; odd, mitten-shaped glandular masses on either side of the muzzle between nostril and eye; and elonged nostril opening. Its fur is long and rather shaggy, yellowish-brown to reddish-brown on the dorsum, white or whitish below, with sharply defined blackish hair bases throughout. For color picture see Burt and Grossenheider (1976, plate 2). Range of measurements (in millimeters): total length 91-106, tail vertebrae 41-54, hind foot 10-12, ear from notch 32-36, forearm 40.4 to 45.8.

Plecotus rafinesquii differs from *Plecotus townsendii* in having whitish rather than buffy underparts and blackish rather than grayish or brownish hair bases. These bats can be distinguished from all others in the eastern United States by their huge ears (the "long"-eared *Myotis* have much smaller ears). *Plecotus rafinesquii rafinesquii* has the underparts almost pure white and the upperparts slightly paler, more yellowish-brown (Handley, 1959).

Present Range: The species ranges throughout the southeastern United States, west to Louisiana and Oklahoma, north in the interior to Illinois, Indiana, Ohio, and West Virginia, and north on the Atlantic Seaboard to Virginia. The subspecies *Plecotus rafinesquii rafinesquii* occurs mainly in the Ohio and Tennessee River valleys and in the Southern Appalachians. *Plecotus rafinesquii macrotis* is found in the Atlantic and Gulf lowlands and to a limited extent in the adjacent Piedmont.

Distribution in Virginia: *Plecotus rafinesquii macrotis* is known in Virginia only by one specimen collected at Lake Drummond in the Dismal Swamp in June, 1897, and by a recent report of it from Virginia Beach. *Plecotus rafinesquii rafinesquii* has not been found in Virginia, but has occurred nearby in West Virginia (Frum, 1948), Kentucky (Barbour and Davis, 1974), and Tennessee (Handley, 1959). Tuttle (pers. comm., 1978) recently found a large nursery colony 5 miles east-northeast of Kyle's Ford, Hancock County, Tennessee, very close to the Virginia-Tennessee boundary (Figure 24).

Habitat and Mode of Life: In the Midwest, *Plecotus rafinesquii rafinesquii* usually roosts in small caves or near the entrance in larger caves and mines where it is dimly lighted but not dark. *Plecotus rafinesquii macrotis* most often is found in houses, or sometimes in hollow trees, behind loose bark, in culverts, or in caves and mines. This species roosts singly, in small clusters, or in larger groups containing as many as one hundred or more individuals. It hibernates in the northern part of its range, and torpid individuals can be found in most roosts, even in the South. At rest, particularly in winter, the ears (but not the tragi) are coiled back against the side of the head. When the bat is aroused its ears are quite mobile. This species is nocturnal and not crepuscular. Food habits have not been studied (Handley, 1959).

Reproduction: Mating must occur in fall and winter. Single young are born in May and June. They can fly at three weeks of age and they reach adult size in about four weeks. Longevity is at least eight to ten years (Handley, 1959; Jones, 1977).

Number in Captivity: No data.

Status: *Plecotus rafinesquii macrotis* - *Special Concern*
Plecotus rafinesquii rafinesquii - *Status Undetermined*

Both subspecies are at the edges of their ranges in Virginia, so their occurrence here is tenuous at best. They are uncommon to rare throughout their ranges, and *plecotus rafinesquii rafinesquii*, at least, seems to be declining. In view of the paucity of records of *Plecotus rafinesquii macrotis* in Virginia, it must be viewed with *Special Concern*. In 1897, it was found roosting in small hollow cypress snags in the eastern portion of Lake Drummond, but apparently there are fewer such roost sites now (Handley, in press). The status of *Plecotus rafinesquii rafinesquii* is *Undetermined*. It ought to occur in caves in southwest Virginia, but hasn't been found there. Since it habitually roosts near cave entrances, it is subject to more disturbance than most cave bats and may be the first to disappear (Tuttle, pers. comm., 1978).

Protective Measures Proposed: Refer to "Bats--General."

Remarks: Other common names are eastern lump-nosed bat, eastern long-eared bat, Rafinesqui's big-eared bat, and LeConte's big-eared bat.

Authors: Charles O. Handley, Jr., Ginny Tipton, and Alan Tipton.

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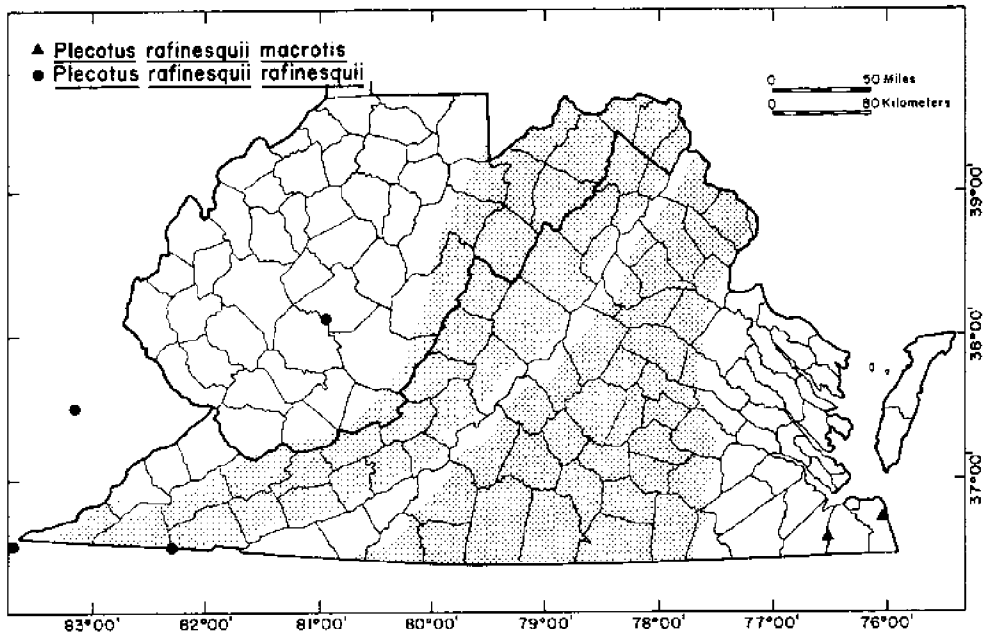


Figure 24. Distribution of Eastern Big-Eared Bat (*Plecotus rafinesquii*) in Virginia and West Virginia

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4. MARSH RABBIT

Sylvilagus palustris palustris Bachman

Phylum: Chordata
Class: Mammalia

Order: Lagomorpha
Family: Leporidae

Description: This rabbit is about the size of the eastern cottontail, with relatively short legs and small, slender, orange-buff or reddish-buff feet; rather dark buffy-brown to reddish-brown dorsum; poorly defined rufous nape patch; and small tail which is dingy gray or brownish (rarely whitish) on the undersides. The toenails of the hind feet are unusually long and conspicuous, and the feet appear small and slender because they are not so furry as in the cottontails. Measurements (in millimeters) of two adults from the Dismal Swamp average: total length 448, tail vertebrae 40, hind foot 99. Color illustrations: Burt and Grossenheider (1976, plate 21). Dark coloration, lack of a white powderpuff-like cottontail, and small, dark, long-clawed feet distinguish the marsh rabbit from all other Virginia lagomorphs. Virginia specimens have heavier skulls than other *Sylvilagus palustris* (Nelson, 1909).

Present Range: The marsh rabbit is found in the Coastal Plain, from Alabama to Virginia. The subspecies *Sylvilagus palustris palustris* occupies this entire area except for the peninsular portion of Florida. Its type locality is eastern South Carolina.

Distribution in Virginia: Probably the marsh rabbit occurs in suitable habitat throughout the southeastern corner of Virginia and along the south shore of the James River at least to Surry County. There are specimens in the National Museum from the Dismal Swamp. In addition, a few were caught on Hog Island, Surry County, in the early 1960's (Coggin, pers. comm., 1978), and it has been reported in Virginia Beach from North Landing and from the islands in Back Bay (Figure 25).

Habitat and Mode of Life: *Sylvilagus palustris* is the most aquatic of North American rabbits. Its usual habitat is low, wet marshland. It occasionally frequents places inundated by salt or brackish water, but in Virginia it is found most often in freshwater marshes. In tidal marshes it seems to prefer the inner edges, adjacent to higher ground, which may offer protection during high tides (Seton, 1929; Tomkins, 1935).

This rabbit makes runways in the marshes. Sometimes it hops, but more commonly it walks. When walking in soft mud, it steps alternately with each foot, leaving a trail which looks like that of a porcupine or skunk in soft snow. No other rabbit makes a trail like this. The long claws of forefeet and hind feet contribute to distinctive foot prints. Compared to other rabbits, the marsh rabbit keeps low to the ground and is rather clumsy and slow in its movements. It lacks the strong and agile leaps and ease of movement typical of other rabbits. When pursued, *Sylvilagus palustris* might seek refuge in thickets in the marsh, or it might plunge directly into the water to hide submerged with ears laid back on the neck and only the eyes and nose visible above the water surface. This rabbit is at home in the water and enters it not only to escape its enemies but possibly also for sport. It is a good swimmer and individuals have been observed swimming far out in a body of water, as much as 700 feet from shore. When it swims, its ears and the top of its head or all that show above the water (Seton, 1929; Tomkins, 1935).

Sylvilagus palustris eats a variety of herbaceous and woody foods, including grass, cane, forbs, leaves of deciduous trees, and stems and buds of shrubs (Golley, 1962). Seton (1929) reported that it eats the tender twigs of young sassafras and pond-spice (*Laurus geniculata*). It has been known to dig for roots, bulbs of the wild potato (*Apios tuberosa*), and a small species of amaryllis (*Amaryllis atamasco*). Ordinarily it does not bother gardens or cultivated fields. It is more nocturnal than diurnal, but feeding in tidal marshes prevents it from being completely nocturnal (Tomkins, 1935).

Enemies of the marsh rabbit include several birds of prey, most notably the marsh hawk, but the red-tailed hawk and great horned owl as well. Other enemies are the mink and man (Tomkins, 1935).

Reproduction: Tomkins (1935) described a nest of *Sylvilagus palustris* found in sedges about thirty feet from the high-water mark. The nest measured 14 inches in diameter and was 8 inches deep. Its walls and floor were composed of a mixture of soft grass blades and rabbit fur about an inch thick. Seton (1929) described nests in wetter situations.

According to Golley (1962), the marsh rabbit probably breeds throughout the year in Georgia, with a peak in late winter and a depression in the fall. Along the lower Savannah River, Tomkins (1935) observed reproductive activity as early as February and as late as November. Litters commonly contained 3 to 5 young.

Number in Captivity: No data.

Status: *Special Concern.* The marsh rabbit is uncommon to occasionally common in a small area in southeastern Virginia. It is at the northern edge of its range here. There is *Special Concern* for it because of its limited range and because of its ecological preference for relatively undisturbed marshes, an ever-shrinking environment. In Virginia it is considered to be a game

mammal (lumped with cottontails and hares in the game regulations as a "rabbit"), but it probably is subject to very little hunting pressure.

Protective Measures Proposed: A study of the distribution, ecology, populations and natural history of the marsh rabbit is much needed in Virginia.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

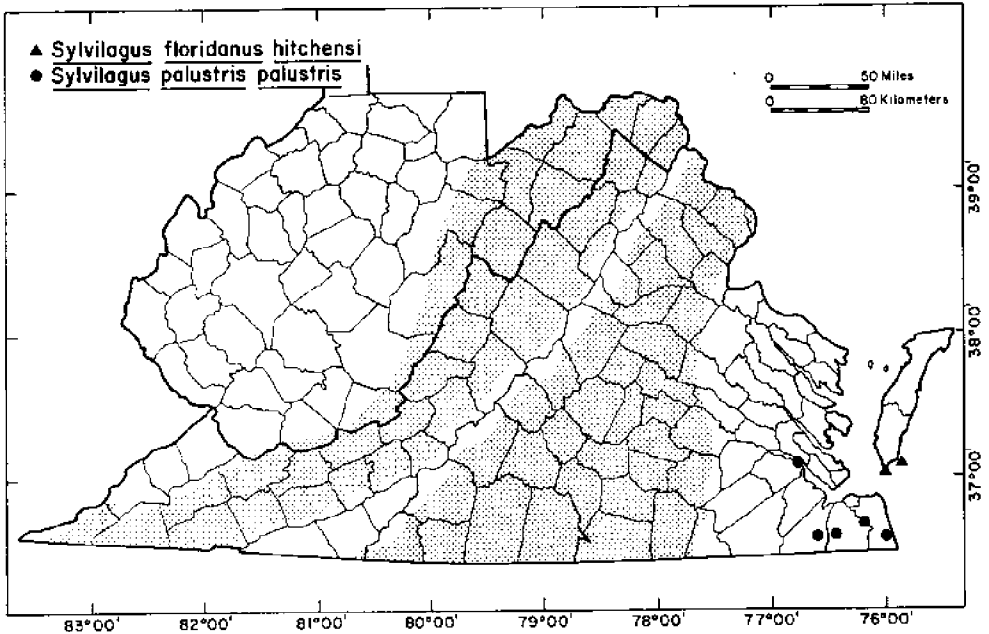


Figure 25. Distribution of Marsh Rabbit (*Sylvilagus palustris palustris*) in Virginia

5. BLACK BEAR

Ursus americanus americanus Pallas

Phylum: Chordata
Class: Mammalia

Order: Carnivora
Family: Ursidae

Description: The black bear is a large, bulky animal with relatively small, rounded ears and a short tail, almost concealed by the long coarse fur. In the eastern United States its pelage is glossy black, its muzzle is always brown, and its breast often has a small patch of white. Its facial profile is nearly straight. Adult males range in total length from 4.5 to 5.8 feet; adult females are smaller, 4.2 to 4.8 feet (Jackson, 1961). Height at

shoulders is about 2 to 3 feet. Weight of an adult bear ranges from 225 to 500 pounds, with most falling in the 300- to 400-pound category. Several 400-pound bears are killed each year in Virginia, and weights of over 600 pounds have been reported. The skull of an adult male is longer (300 millimeters \pm) and has a greater zygomatic breadth (170 millimeters \pm) than that of the female. The sagittal crest and temporal ridges are more pronounced and the posterior end of the skull is V-shaped in the male (usually U-shaped in the female) (Carpenter, 1973). The black bear cannot be confused with any other Virginia mammal. Color illustration: Burt and Grossenheider (1976, plate 4).

Present Range: Formerly continent-wide, and from Alaska, Hudson Bay, and Labrador south to central Mexico, the range of *Ursus americanus* has diminished considerably since colonial days. This bear now is absent from areas that have been extensively cleared and where human populations are high. Most notably it has been extirpated from much of the Atlantic Seaboard, the Midwest, the Great Plains, and the interior of Oregon and Washington. Most of this vast area, south to the upper edge of the Gulf Coastal Plain and west to the Rockies, is (or was) occupied by the nominate race, *Ursus americanus americanus*, whose type locality is "eastern United States."

Distribution in Virginia: The black bear is uncommon but widely distributed in the mountainous portions of Virginia, except in the northernmost counties, the southern Blue Ridge, and in the far southwest, where it is rare. It is uncommon to rare in the Dismal Swamp (Figure 26). The black bear is a notorious wanderer. One recently returned in a matter of days from Mountain Lake, Giles County, to its home territory in Shenandoah National Park, a distance of almost 150 miles. It had to cross several interstate highways and other major highways and much open farmland en route. Thanks to wanderers, bears may occasionally be encountered almost any place in Virginia, even in urban centers such as Arlington, Springfield, and Richmond. There are recent observations of individuals in Arlington, Fairfax, Stafford, Spotsylvania and Henrico counties, as well as in the upper Piedmont.

Habitat and Mode of Life: In Virginia the black bear is found in mountain forests and lowland swamps. Ideal upland habitat includes rugged areas with boulders, rock outcrops, ledges, and rock slides; thickets of mountain laurel and rhododendron; scrubby forest with numerous small openings; and no human habitations. Forest in upland bear range typically contains several species of oaks, pines, hickories, red maple, black gum, black birch, and wild cherries, and small openings with blueberries and blackberries. Ideal swamp habitat has myrtle thickets, cane brakes, tupelo, red maple and tulip poplar, and adjacent uplands with dense thickets of *Smilax*, brambles, poison ivy and sweet gum.

The black bear is primarily nocturnal, but it occasionally rambles about during the day. With the exception of females with cubs, it is usually solitary. A male may range as far as 15 miles or more from its den, but females do not wander as far. Dens may be found beneath fallen trees, in hollow trees and logs, beneath large roots, or wherever there is shelter and concealment. This bear does not hibernate in the true sense, but it does "den up" during the winter months (November or December through March or April) for long periods of sleep. This lethargy may be triggered by cold weather, scarcity of food, or other factors. On warm days during this period the bear may leave its den and move about sluggishly, but it is disinterested in food.

The diet of the black bear includes acorns, berries and other fruit (especially apples), nuts, tubers, insects and insect larvae, small mammals and birds, honey, carrion, garbage, and herbaceous material, including grass.

Analysis of stomachs of black bears in the George Washington National Forest during November and December 1935-1938 revealed that acorns made up about 60 percent of the total volume, deerberries ("blueberries" in Carpenter) 17 percent, and in order of decreasing percentage, tupelo, grape, chokeberry, cottontail rabbit, greenbrier, lobelia, mountain winterberry, holly, and buttercup (Cottam *et al.*, 1939; Carpenter, 1973).

Reproduction: The peak breeding season for black bears is mid-June to mid-July. Implantation probably occurs in November. Since the time of ovulation is not known, it is debatable whether the lag between insemination and implantation is due to delayed ovulation or delayed implantation (Asdell, 1964). Cubs are born in late January or early February. They are very immature at birth, with a length of only six to eight inches and a weight of only six to twelve ounces. Their eyes do not open until about 40 days after birth. Female black bears usually begin to breed at 3-1/2 years of age, and they produce an average of 2.4 cubs per litter, every other year (Carpenter, 1973).

Number in Captivity: The number of *Ursus americanus americanus* in captivity is unknown, but it probably is many. This bear is easily maintained and breeds readily in captivity. It is common in zoos.

Status: *Special Concern.* When the colonists arrived in Virginia they found the black bear along the coast and wherever they went inland. It was state-wide in distribution and apparently was numerous. Now, almost 400 years later, the bear is still hunted in almost a third of Virginia's counties (in the mountains and in the Dismal Swamp), and judging by harvest statistics it is actually increasing in 13 counties (Figure 26).

Why then should the black bear be considered in an endangered species symposium? Because, while it is thriving in part of its range in Virginia, with hunter harvest not keeping pace with bear population increase, it is not doing very well elsewhere. Its status in the Dismal Swamp, for example, gives cause for concern. Here the lowland population, which inhabits the great river swamps of the southeastern United States, is at the northern limit of its range. For centuries the great swamp has been a bear hunter's mecca. Some of the largest black bears in the eastern United States have been taken in the Dismal. In the 19th and early 20th centuries, estimates of annual bear kill in the swamp were in the hundreds. In the 1890's, a lone hunter was credited with killing 21 bears in a single year, another with 13 (Handley, *in press*). Formerly, the black bear was often observed and was easily the most notable mammal in the Swamp. Now it is rarely seen and its numbers are dwindling. In the past decade there has been a 30 percent drop in hunter harvest from the harvest level of 1947-1966 in the Virginia portion of the Swamp (Table 6). The shrinking dimensions of the Swamp (due to clearing and draining), increased hunting pressure, and the thwarting of Game Commission conservation management by the hunter lobby in the state legislature, are factors in the decline of the bear population. Even more alarming is the situation in the most productive bear range in Virginia. In a four-county area (Augusta, Rockbridge, Bath and Highland) where hunters harvested 1021 bears three decades ago, the harvest was only 610 in the past decade -- a 40 percent decline (Table 7).

There must also be concern for the black bear in all of southwest Virginia. Populations there seem to be stable or even slowly increasing, but they are low throughout the area (Figure 26). They are so low, in fact, in the extreme southwest and in the southern Blue Ridge that hunting is not permitted. In the nine counties southwest of Roanoke where hunting is legal, the average annual bear kills per county in the past 10 years have been 7 (Giles), 3-5 (Bland, Tazewell, Wythe and Smyth), 1 (Pulaski), and less than 1 per year (Montgomery, Washington and Russell). The vigorous hunter lobby

in the state legislature keeps the bear season open, contrary to sound conservation principles. Where there ought to be protection, the Game Commission is powerless to protect and powerless to manage the bear back to harvestable numbers.

Table 6. Black Bear Kill, Virginia Portion of Dismal Swamp, 1947-1977

	1947-56	1957-66	1967-76	1976	1977
Chesapeake (=Norfolk County)	64	68	53	3	4
Suffolk (=Nansemond County)	78	77	49	2	7
Decade Total	142	145	102		
Yearly Average	14	15	10	5	11

Table 7. Black Bear Kill in Four Virginia Counties, 1947-1977

	1947-56	1957-66	1967-76	1976	1977
Highland	65	71	58	1	0
Bath	197	145	112	10	7
Augusta	554	528	321	20	16
Rockbridge	205	170	119	17	15
Decade Total	1021	914	610		
Yearly Average	102	91	61	48	38

Protective Measures Proposed:

- 1) Where there is a short hunting season for deer (*e.g.*, west of the Blue Ridge and in certain other counties), the deer and bear seasons ought to be separate so that bears will not be taken incidentally by deer hunters. This would reserve bears for bear hunters and would result in a lowered harvest. Such a plan was tried briefly (1956 through 1959) in the western counties but was abandoned because of hunter pressure (Carpenter, 1973). In spite of its unpopularity, this test seems to have proved the point that separate deer and bear seasons reduce the bear kill (Table 8). In the western counties, the four years with separate seasons (1956-1959) recorded 23 percent fewer bears killed than in the preceding four years, and 18 percent fewer than in the succeeding four years, when deer and bear seasons were concurrent. In contrast, during the four years when deer and bear seasons were separated in the west, the eastern counties registered 39 percent greater bear kill than in the preceding four years, and 2 percent greater kill than in the succeeding four years.

The Game Commission has already taken a step toward separate seasons by cutting two weeks off the front of the bear season, so that now there is no bear hunting during the first week of the deer season.

Table 8. Comparison of Bear Kill in Years (1956-1959) when Deer and Bear Seasons were not Concurrent West of the Blue Ridge with Years in which the Seasons were Concurrent (1952-1955, 1960-1963). East of the Blue Ridge the Seasons were Concurrent in All Years.

Year	'52	'53	'54	'55	'56	'57	'58	'59	'60	'61	'62	'63
Bear Kill East of Blue Ridge												
Annual totals	37	47	43	63	50	49	81	84	66	55	59	79
4-yr. totals		190				264				259		
Bear Kill West of Blue Ridge												
Annual totals	290	312	232	91	85	164	191	275	142	151	280	302
4-yr. totals		925				715				875		

- 2) Steps should be taken to further reduce the nonlegal kill of wandering, nuisance, and marauding bears. In 1976, the nonlegal kill amounted to 10 percent of the total bear harvest in Virginia. The Game Commission already has done an excellent job of reducing this waste. Comparatively, neighboring West Virginia has a much larger problem. There, the nonlegal kill was 30 percent of the total bear harvest in 1977 (Rawson, pers. comm., 1978). The Game Commission's bear research program should be enlarged and its program of removing troublesome bears and releasing them in new areas should be expanded if evaluation shows that this is an effective procedure. The wandering propensity of some individuals unfortunately seems to make relocating an impractical procedure. All nonlegal removal should be at the discretion of the Game Commission and not at the discretion of individual citizens.
- 3) Bear sanctuaries should be established in prime bear range. An unexpected dividend of setting aside the northern Blue Ridge as the Shenandoah National Park, closed to all hunting, was dramatic improvement of bear hunting in surrounding areas. When the park was established in 1935 it was thought that the black bear had long since been extirpated there. The last bear had been seen in 1910 (in Albemarle County). The value of the sanctuary was soon obvious. Two bears were seen in the park in 1937, and by 1944 there was an estimated population of ten, which increased to thirty by 1951. A bear with cubs was seen in the park in 1953, and another in 1954 (Manville, 1956). Thereafter the increase of bears in the park was rapid, and the bear kill began to rise in the counties contiguous to the park. In the decade ending in 1976, the bear harvest in those counties had risen a whopping 1350 percent above the kill of 1947-1956 (Table 9). (Augusta and Rockingham counties have not been included because the impact of the National Park on their bear kill cannot be assessed in the data available to us. These counties already had substantial bear populations in the Big Levels area and across the valley in the Alleghenies when the park was established.)

Table 9. Bear Kill by Decade in Counties Contiguous to the Shenandoah National Park

	1947-56	1957-66	1967-76
Page	44	18	110
Warren	0	3	29
Rappahannock	0	16	44
Madison	1	57	177
Greene	0	42	132
Albemarle	5	86	185
GRAND TOTAL	50	222	677

The experience in the Shenandoah is proof enough that establishment of bear sanctuaries is an idea whose time has come. The loss of hunting territory is more than compensated for by the increase of harvestable bears in surrounding areas. West Virginia recently took the step of closing two large areas of excellent bear range to hunting (Figure 26). The Cranberry Closed Area in Greenbrier, Pocahontas and Webster counties is huge, about as large as Rappahannock County. The Spruce Knob Closed Area in Pendleton and Randolph counties is about one-third as large. More bear sanctuaries ought to be set aside in Virginia -- one perhaps in the Augusta-Rockbridge-Bath-Highland quadrangle, and another in southwest Virginia -- to reverse the trend of decline and restore the black bear to a significant status in the environment.

- 4) The hunting season for bears should be reduced or closed in southwest Virginia and in the Dismal Swamp until populations can be built up again. The Game Commission acted in 1974 to reduce the statewide bear harvest by closing 67 counties to all bear hunting. Bear populations had already been extirpated in most of those counties, but in a few the closures may have been beneficial in curtailing harvest pending the outcome of population studies in progress. However, those studies are not likely to benefit the bears in the Dismal Swamp and in southwest Virginia where the bear harvest is controlled by the hunter lobby in the state legislature. In those areas, which now have the smallest huntable bear populations in the state, hunters demand, and get, long open seasons (Table 10) because it takes them longer to find a bear where bears are so scarce. They believe that longer seasons give them better hunting. This quaint philosophy guarantees fewer and fewer bears and poor hunting. For most of the state, legislature approves bag limits and hunting seasons recommended by the Game Commission, but for the Dismal Swamp and the Southwest, bear seasons are set by special legislative acts. Such an antiquated procedure is an embarrassment to Virginia, at a time when hunters in most other states profit from progressive research-based management plans. For the benefit of the bear hunters themselves, and the citizenry in general (to whom the bears belong as much as they do to the hunters), it is imperative that the state legislature retire from game management and rely on the advice of the trained professionals of the Game Commission.

Table 10. Correlation of Length of Hunting Season (1978) and Bear Kill in Virginia

	Length of Open Season	Average Yearly Bear Kill Per County (1969-76)	Average Bear Kill Per Week Per County
General Open Season (set by Game Commission)	5 weeks 27 Nov-1 Jan	13.1	2.6
Southwest Virginia (set by state legislature)	8 weeks 6 Nov-5 Jan	3.2	0.4
Russell County (set by state legislature)	2 weeks 5-17 Dec	0.6*	0.3
Chesapeake and Suffolk (set by state legislature)	9 weeks 2 Oct-30 Nov	5.1	0.6
Isle of Wight and Suffolk West of Dismal Swamp (set by state legislature)	8 weeks** 10 Nov-5 Jan	No open season 1969-1976	

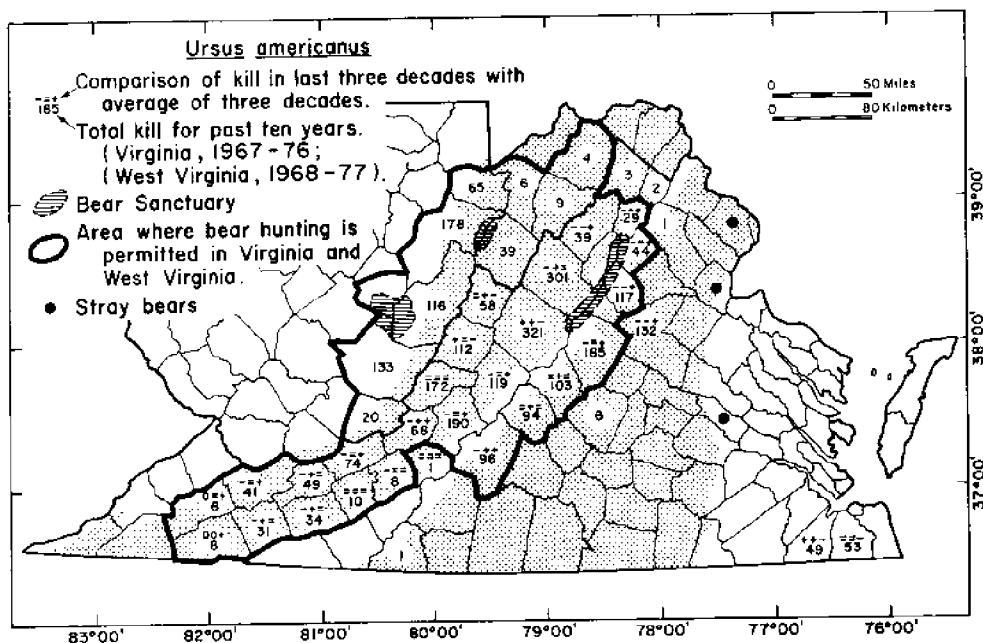
*Bears are so uncommon in Russell County that only seven have been killed by hunters in the past thirty years.

**Total open season for the three-county area in southeastern Virginia is 14 weeks.

- 5) The recent establishment of the Dismal Swamp National Wildlife Refuge in the northwest quarter of the Swamp ought to help the bears in that region. However, more protected high ground and swampwide management are needed to stimulate bear population recovery in the Dismal.
- 6) An environment dominated by the mast producers (oaks and hickories) with a variety of other fruit- and nut-bearing species among the sub-dominants must be maintained in the bear ranges. The present trend toward clearcutting and replanting with pines may be the most productive forest management procedure in terms of dollars and cents, but it certainly is not consonant with the philosophy of multiple land use, for it produces forests largely sterile for harvestable wildlife. Care must be taken to insure that pine plantings are not so extensive that they reduce the bear-carrying capacity of the environment.

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6. BOBCAT

Felis rufus floridanus Rafinesque

Phylum: Chordata
Class: Mammalia

Order: Carnivora
Family: Felidae

Description: *Felis rufus* is a medium-sized cat with a very short tail; relatively long legs; pointed (but scarcely tufted) ears; rather long, loose body fur; and longer cheek fur (forming rather conspicuous "sideburns"). The upperparts are grizzled reddish to grayish-brown; face and legs are spotted and banded with black; cheek patches ("sideburns") are whitish, streaked with black; ears are whitish inside, black outside, with a conspicuous central white spot; the tail is banded and tipped with black (on upper surface only); the underparts are mostly whitish, irregularly streaked and spotted with black. The subspecies *Felis rufus floridanus* can be distinguished from *Felis rufus rufus* of western Virginia by its narrower skull (width averages 74.9 percent of length vs. 78.4 percent). Average measurements (in inches) of 9 males from Georgia and Louisiana: total length 34.2; tail vertebrae 6.2; hind foot 6.5; and weight 18.3 pounds. Females average smaller (Peterson and Downing, 1952; Young, 1958). Color illustration: Burt and Grossenheider (1976, plate 8).

The bobcat is quite distinctive, but under poor viewing conditions it might be confused with a housecat, gray fox, or dog. Its short tail, large ears, long legs, "sideburns," and patterned face should distinguish it.

Present Range: The species inhabits the wilder, less urbanized parts of the United States from coast to coast, immediately adjacent parts of Canada, and the uplands of Mexico to the Isthmus of Tehuantepec. *Felis rufus floridanus* occurs in the lowlands of the southeastern United States from the Dismal Swamp in southeastern Virginia south to Florida, west to Louisiana, and north in the Mississippi Valley to Missouri. The type locality of *Felis rufus floridanus* is "Florida."

Distribution in Virginia: *Felis rufus floridanus* reaches the northeastern limit of its range in the Dismal Swamp. It is not known from other places in Virginia. The bobcat of western Virginia is *Felis rufus rufus*.

Habitat and Mode of Life: The bobcat usually sticks to the cover of thickets and swamps and seldom ventures into the open except at night. It is so wary and secretive that it can live close to farms and human habitations when suitable habitat is contiguous and yet seldom be seen except when surprised on ditch banks and in roads. It is swift of foot and runs with a distinctive bounding gait. Although it easily climbs trees, and can be treed by dogs, it prefers to stay on the ground. It swims well but, except when pursued by dogs, usually crosses streams and ditches on natural bridges or by bounding leaps of as much as 12 feet. The home range of the bobcat varies from 5 to 50 miles in diameter, depending upon habitat and availability of prey. Visual acuity is great and the bobcat hunts with equal facility day or night. It hunts silently, and commonly covers two to seven miles in a hunt.

The bobcat is to the rabbit what the mountain lion is to deer. It is the primary predator of small game and the young of big game. Rabbits and rodents such as squirrels, meadow voles, cotton rats, white-footed mice and muskrats make up the bulk of its diet. It preys to a lesser extent on opossum, raccoon, poultry, turkey, other birds, swine and deer. It rarely takes snakes, lizards, insects and vegetable matter. Bobcats often scrape or rake a small mound of leaves and earth over urine and feces. Adult bobcats have few natural enemies in the Dismal Swamp, although their young may be preyed upon by great horned owls and foxes. Dogs sometimes annoy bobcats, but no domestic dog is a match for a full-grown bobcat. It uses its razor-sharp claws and strong legs with deadly effect for ripping and tearing (Young, 1958; Ewer, 1973; Guggisberg, 1975).

Reproduction: The voice of the bobcat in quiet moods is very much like that of the domestic cat, but very large bobcats make loud mating calls that may carry as much as a mile. Dens of bobcats most often are located under logs concealed by vines, in tree falls, and in hollow trees. In the mountains, holes under boulders, and crevices in cliffs and ledges may also be used. Sometimes the bed is lined with moss or dry leaves and grass.

Young may be born at any season but most reproductive activity occurs between February and May. The gestation period was listed as 50 to 60 days by Young (1958), but Ewer (1973) questioned such brevity. Litter size varies from 1 to 6 young (average 2 to 3) and there is 1, or occasionally 2, litters per year. The young open their eyes after 3-9 days, nurse for about 60 days, and then are brought meat by both parents until they learn to hunt for themselves. Longevity in the wild is thought to be 10 to 14 years (Young, 1958; Asdell, 1964).

Number in Captivity: No data.

Status: *Special Concern.* *Felis rufus floridanus* is thought to be relatively common in the Dismal Swamp and elsewhere in its range in the southeastern United States. However, because it is at the edge of its range in Virginia, and because it has such a limited distribution here, major alterations of its

habitat or in numbers harvested for the fur trade could have a disastrous effect on local populations. For these reasons it is classified as of *Special Concern* in Virginia. Fortunately, a large block of habitat suitable for the bobcat is protected in the Dismal Swamp National Wildlife Refuge.

There also must be concern (though perhaps not "special" concern) for the population of *Felis rufus rufus* in western Virginia. It is or recently has been common and widespread but the rapidly increasing pressure from trappers is alarming (Table 11).

Table 11. Statewide Harvest of Bobcats in Virginia, 1974-1977
(Game Commission Compilation)

	1974-75	1975-76	1976-77
Number of Hides	370	451	965
Average Value Per Hide	\$ 13.32	\$ 27.56	\$ 39.03

Protective Measures Proposed: The Dismal Swamp National Wildlife Refuge ought to sponsor a definitive study of the distribution, ecology, abundance, and natural history of *Felis rufus floridanus* in the Swamp, so that habitat can be managed to maintain the bobcat population at an optimum level.

Prompted by the soaring value of the pelts of furbearers and the astonishing rise in numbers of animals harvested, the Virginia Game Commission is conducting studies of furbearers, with emphasis on the otter and bobcat. It is crucial for the Commission to match the level of effort to the urgency of the situation. Unquestionably, the populations of both otter and bobcat throughout Virginia need to be carefully and continuously monitored for signs of stress. If it should prove to be needed, remedial action should be taken quickly, before populations decline to low levels.

Remarks: Other vernacular names are wildcat, bay lynx, and Florida bobcat. *Lynx* is usually used as the generic name for the bobcat. However, the supra-specific nomenclature of the Felidae is in such a state of flux that the most conservative course is to include most of the cats in the genus *Felis*.

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7. SIKA DEER

Cervus nippon Temminck

Phylum: Chordata
Class: Mammalia

Order: Artiodactyla
Family: Cervidae

Description: The sika is a small deer, 2.5 to 3 feet high at the shoulders; with short, rounded ears; small antlers (8-14 inches long and less than 1 inch in diameter at base) with two or three tines on the forward edge (three or four points) and none on the hind edge; a well-developed neck ruff in males; narrow, inconspicuous, mostly white tail; pure white, erectile rump patch with blackish border; conspicuous white-haired metatarsal gland just below heel; and dark grayish-brown body, faintly spotted with white in summer, unspotted

or indistinctly spotted in winter (Figure 27). The body averages a little less than four feet long; average live weight of adult male is 120 pounds, of adult female, 100 pounds.



Figure 27. Sika Deer (*Cervus nippon*)

The white-tailed deer (*Odocoileus virginianus* Boddaert) and sika occur together on Assateague Island. The whitetail is larger; has a large, conspicuous, flag-like tail; has a plain-colored rump, like the rest of the dorsum, and without a patch of erectile hair; has longer more pointed ears; lacks white spots on its body except as a fawn; and has the tines branching from the hind edge of the antler beam. Also, the whitetail is much less vocal, and its movements are smoother and more graceful.

Present Range: The sika deer (several subspecies) occurs on the Japanese islands, Taiwan, and the Asiatic mainland from southeastern Siberia, Korea and Manchuria to southern China and northern Vietnam. It is now extirpated from much of the mainland. Feral populations have been established in the United States, Ireland, Great Britain, France, Denmark, Germany, Austria, Russia and New Zealand.

Distribution in Virginia: *Cervus nippon* is found in Virginia only on Assateague and Chincoteague islands, Accomack County. Sika of unknown origin originally were kept in an enclosure near Cambridge, Maryland. Four or five of these

were released on James Island, in Chesapeake Bay, southwest of Cambridge, in 1916. From there the deer spread on their own to nearby Taylors Island and then to the mainland. By 1964 they were widespread in the western third of Dorchester County. Other deer from the Cambridge enclosure were moved to the vicinity of Berlin, Maryland, in 1920, and in 1923 seven of them were released on the northern end of Assateague Island. Now sika are found throughout the southern (Virginia) portion of the island, in the Chincoteague National Wildlife Refuge, and two or three miles beyond the state line into Maryland (Flyger, 1960; Flyger and Davis, 1964; Paradiso and Handley, 1965; Britton, 1978).

Habitat and Mode of Life: On Assateague Island the sika is found in the loblolly pine forests and in the open marshes, but it is most often encountered at the forest edge, in thickets of myrtle, greenbrier, and poison ivy. It feeds in marsh edges and in marshy glades, often standing in 6-8 inches of water while grazing (Paradiso and Handley, 1965; Britton, pers. comm., 1978).

The diet of the sika deer is less restricted than that of the white-tailed deer. On James Island, Maryland, the deer eat "wax myrtle, grasses, red maple, red gum, loblolly pine twigs, needles, bark and tree roots. Many plants have been grazed or browsed so heavily that they no longer exist or are rare on the island, and for this reason statements concerning food preferences cannot be made. Japanese honeysuckle and greenbrier, which are common on the adjacent mainland, are not seen on the island. Poison ivy leaves are found only on trees above the reach of the deer. Many of the loblolly pines on the island bear extensive scars where deer have stripped the bark from the trees" (Christian *et al.*, 1960). Other plants identified as food of the sika in Maryland include pokeweed, large-toothed aspen, and *Spartina patens* (Flyger and Warren, 1959).

Cervus nippon is a gregarious species. On James Island it has been seen in groups of 6 to 60 individuals (Flyger, 1960). On Assateague Island where it is not so crowded it is more often seen alone or in groups of 2 to 10. Although it is primarily nocturnal it is not unusual to see it grazing in marshes at any hour of the day. When surprised it bounds off, splashing through the marsh, avoiding the thickets of myrtle and pine. It has an unusual gait, quite unlike that of the white-tailed deer -- a stiff-legged, bounding trot, more or less pogostick-like. The sika does not hesitate to swim, although it is reluctant to cross water where ice has formed at the land-water interface. It wades across the water between the north and south portions of James Island, and regularly it swims from the island to the mainland, a distance of about 1 mile. The population on Chincoteague Island may have reached there by swimming from Assateague (Christian *et al.*, 1960; Britton, pers. comm., 1978).

The sika is a vocal deer. When disturbed, females produce a bird-like chirp, and males utter a sharp whistle, much like a full-blown human whistle. They respond to imitations of these notes with chirps and whistles of their own, and often approach the source of the imitation. During the breeding season the males utter loud, often three-noted, penetrating whistles (Flyger and Warren, 1959; Flyger, 1959; Flyger and Davis, 1964; Britton, pers. comm., 1978). Antlers are shed in the spring, as late as April and May on James Island (Flyger and Warren, 1959).

Reproduction: In its native Japan, the rutting season of the sika deer begins in mid-September and lasts until the end of October. The gestation period is 8 months. Fawns are born from late May to late June. Births of twins occasionally have been observed in zoos but singles are the rule in nature (Asdell, 1964; Whitehead, 1972).

On the Eastern Shore of Maryland and Virginia, sikas mate later, in November and December. All mature females collected on James Island in March and April were either pregnant or lactating. Surprisingly, lactating females were checked in by hunters on Assateague Island on December 22 and 27, 1977. Females on Assateague have their first fawn when they are two years old, and they never produce more than a single young per pregnancy (Christian *et al.*, 1960; Flyger and Davis, 1964).

Number in Captivity: The sika is common in zoos and game parks. It is easily maintained in captivity.

Status: *Special Concern.* There is special concern for the sika in Virginia only because it inhabits such a small area in the state (a little over 2000 acres) that a natural catastrophe or a management failure could eliminate it from our fauna. For example, unusually high seas could over-run the barrier dune and wipe out much of the habitat of the sika with salt water. Mass starvation would result.

There is the possibility of competition between the sika and the white-tailed deer on Assateague. If there were competition the sika might not fare well against the larger whitetail. However, as long as the whitetail's population remains small, contact and competition for resources should be limited by the whitetail's preference for forest and the sika's liking for edge habitats, leading to ecological segregation (Britton, pers. comm., 1978).

Lack of natural enemies makes over-population a constant threat. The mass die-off on James Island in January and February 1958 revealed the dire consequences of high population density (Christian *et al.*, 1960). This danger is being addressed by current management practices, as outlined by Britton (pers. comm., 1978):

The sika deer population has increased steadily since its introduction onto Assateague Island in 1923. Because of its tremendous reproductive success, the sika populations had risen to an estimated 1056 individuals in 1963, on about 2,154 acres of habitat. This unusually high population density led to controlled herd management by annual public harvests, which began in 1964. The whitetail was rarely seen prior to 1967, but the population began increasing in 1968, and it was added to the legal bag limit.

Controlled herd management of sika and white-tailed deer on Chincoteague Refuge is accomplished by an annual public harvest. The harvest keeps the deer herd within limits which the land can support. If the herd were allowed to exceed that size, the deer would overbrowse and destroy their habitat as well as the habitat of other species which depend on the same environmental resources. In the absence of natural controls (other than disease and starvation), management of herd size is effectively achieved by annual hunts.

The number of deer harvested is regulated, to an extent, by the number of permits issued. Qualified hunters (8 per week for 5 consecutive weeks in 1977) are chosen from among qualified applicants by a lottery (the bow hunt is open to all qualified applicants, without limit; there were 60 bow hunters in 1977). The emphasis is on qualified hunters. Very rigid qualification standards are required. In 1977, the number of qualified applicants exceeded the 40 permit limit by 22. Only 23 percent of the bow hunters were

successful in taking deer, whereas 77 percent of the gunners were successful. Although it is smaller than the whitetail, there is a hunter preference for the sika, probably because it is exotic (also the sika population is much larger and more diurnal).

The current estimate of the Assateague Island population of sika deer is approximately 700. This estimate is based on night deer censuses, harvest data, and track count area surveys.

The physical condition of the sika herd appears very healthy. Each deer that is harvested on the refuge must be checked in by refuge personnel. During this check-in a physical examination is routinely conducted. In the 1977 hunt, the sika's coat appeared sleek, body condition was generally excellent, and there were no signs of major infestation by ectoparasites. There have been no reported sightings of deer whose death was attributed to sickness.

The attitude of the Chincoteague National Wildlife Refuge toward the sika deer is that it is a special asset, found only in a very limited range, which included Dorchester County, Maryland, and Assateague Island, Virginia. The sika roam freely in the daylight hours and can be observed at very close range even upon approach in a vehicle. Since the sika was a resident of Assateague prior to establishment of the refuge in 1943, and its presence does not conflict with the primary purposes of the refuge, it is managed as if it were a native species.

Protective Measures Proposed: The successful management practices in current use should be continued.

Remarks: The subspecies is undetermined, but is probably *Cervus nippon nippon* Temminck. Other vernacular names include sika, Japanese sika, Japanese deer.

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STATUS UNDETERMINED (6)

1. EASTERN COTTONTAIL

Sylvilagus floridanus hitchensi
MearnsPhylum: Chordata
Class: MammaliaOrder: Lagomorpha
Family: Leporidae

Description: The eastern cottontail is an average size rabbit with moderately long ears and hind legs and a conspicuous, mostly white, powderpuff-like "cottontail." The insular subspecies *Sylvilagus floridanus hitchensi* is characterized by pale yellowish-brown (sandy) dorsal coloration, lack of rufous and black dorsal streaking, rather dark chestnut color on the backs of the hind legs, and relatively large skull and teeth. Color illustration: Burt and Grossenheider (1976, plate 21). Measurements (in millimeters) of three adult *Sylvilagus floridanus hitchensi*: total length 425 (375-477), tail vertebrae 58 (50-70), hind foot 94 (90-97) (Llewellyn and Handley, 1945). *Sylvilagus floridanus hitchensi* can be distinguished from the true marsh rabbit (*Sylvilagus palustris*) by its "cottontail"; larger, whitish feet; longer legs; paler dorsal color; and more contrasting nape patch.

Present Range: The species occurs throughout the eastern United States (except in northern New England), and is widespread in southern Canada, Mexico, Central America to Costa Rica, and northern South America. The subspecies *Sylvilagus floridanus hitchensi* is found on the barrier islands off the Eastern Shore of Virginia. The type locality of *Sylvilagus floridanus hitchensi* is Smith Island, Northampton County, Virginia.

Distribution in Virginia: *Sylvilagus floridanus hitchensi* has been reported only from Smith's Island and nearby Fishermans Island (Figure 25).

Habitat and Mode of Life: On the barrier islands this cottontail is found in grassy areas behind dunes, in marsh edges, thickets of myrtle and poison ivy, and to a lesser extent in scrubby pine forest or in mixed deciduous and pine forest. Summer food probably consists of a wide variety of green herbaceous vegetation, such as legumes, dandelions, plantains, grass, annuals, young blackberry canes, and fallen fruit. Winter diet adds buds, shoots, and tender parts of shrubs and trees, and sometimes includes bark.

Enemies of the barrier island cottontail include red fox, mink, feral house cats, great horned owl, and red-tailed hawk. Raccoons and some of the larger snakes undoubtedly consume nestling cottontails. This rabbit is primarily crepuscular and nocturnal, and is solitary. It rests in a "form" -- a shallow, oval depression, sometimes lined with grass, leaves or fur, and usually concealed by grass or other low vegetation.

Reproduction: Nothing is known of reproduction of the barrier islands cottontail but judging by the mainland subspecies of *Sylvilagus floridanus*, breeding may be expected at any time except during the winter months. Gestation should be about thirty days, and litters probably contain 4 or 5 (2-8) young. Mating likely occurs immediately after parturition and a female may produce as many as 3 to 5 (usually 2-3) litters in a year. The young probably are concealed by leaves and fur pulled from their mother's body, in a more or less cylindrical nest in the ground, 4 or 5 inches in diameter and about as deep (Llewellyn and Handley, 1945; Asdell, 1964; Douth et al., 1966; Chapman et al., 1977).

Number in Captivity: No data.

Status: *Undetermined*. Mearns (1911) reported that cottontails were supposed to have inhabited Smith Island continuously for at least fifty years prior to 1910. Specimens in the U.S. National Museum were taken there in 1894, 1897, 1898, and 1910. Another specimen, regarded as *Sylvilagus floridanus hitchensi* by Mearns, was taken on nearby Fishermans Island in 1898.

Llewellyn and Handley (1945) speculated: "A severe hurricane which swept the Eastern Shore in August, 1933, inundated the islands in question and probably exterminated the race, because residents have reported no rabbits seen there since." However, Dueser *et al.* (1976) found cottontails abundant on Smith Island in 1975, and present in lesser numbers on Hog Island and Parramore Island. Ake (pers. comm., 1975) observed "marsh rabbits" at about the same time on Fishermans Island. Paradiso and Handley (1965) found cottontails to be abundant on Assateague Island, farther north.

Probably cottontails occur on most, if not all, of the Virginia barrier islands and are periodically abundant on some of them. The subspecific status of these rabbits and of those on the adjacent Eastern Shore mainland has not been determined. Nor is it known whether the subspecies *Sylvilagus floridanus hitchensi* is restricted to Smith and Fishermans islands. It seems unlikely that it is so limited in distribution.

Two additional subspecies of eastern cottontail inhabit Virginia. Both *Sylvilagus floridanus mallurus* Thomas and *Sylvilagus floridanus mearnsi* J. A. Allen are abundant in the state.

Protective Measures Proposed: The first step in protecting *Sylvilagus floridanus hitchensi* has to be collection of a representative series of specimens and study of variation in the cottontail on all of the barrier islands, as well as on the Eastern Shore mainland. In this way the distribution of *Sylvilagus floridanus hitchensi* can be determined. Then, if necessary, special protective measures can be instituted. Since most of Virginia's barrier islands are part of The Nature Conservancy's Virginia Coast Reserve, a National Wildlife Refuge, and a National Seashore, and thus protected from hunting and most habitat degradation, the future of the cottontail on the islands seems rather secure.

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2. NEW ENGLAND COTTONTAIL

Sylvilagus transitionalis Bangs

Phylum: Chordata

Order: Lagomorpha

Class: Mammalia

Family: Leporidae

Description: Form is rabbit-like, with slender body, elongated hind legs and ears, and very short powderpuff-like tail. Pelage is soft and dense, whitish on the underparts, grayish to brown to reddish-brown mixed with black on the dorsum; cheeks grizzled buffy, gray, and black; forehead usually marked with a small black spot. Mean and extreme measurements (in millimeters) of three adults from Highland County, Virginia (Handley and Patton, 1947): total length 403 (390-410), tail vertebrae 50.7 (50-51), hind foot 91.7 (90-94).

Sylvilagus transitionalis is quite similar to *Sylvilagus floridanus*, the eastern cottontail, and is not easily distinguished from it. Cranial characters are most distinctive. The hind margins of the nasals are saw-toothed rather than smooth in *Sylvilagus transitionalis*; the antorbital notch of the frontal is shallow, poorly defined, or absent (*vs.* deep and conspicuous);

the postorbital process of the frontal is slender and tapered and its tip is usually free; and the auditory bulla is smaller. *Sylvilagus transitionalis* averages smaller in most dimensions than *Sylvilagus floridanus*; its dorsal color, especially on the rump, tends to be darker and more reddish; and its forehead has a small black spot or is unmarked, whereas most *Sylvilagus floridanus* have a small white spot.

Present Range: The New England cottontail is an Appalachian endemic, found from northern New York and northern Vermont to Alabama in the mountains, and from southern Maine to New Jersey along the coast. The western limits of its range are in Pennsylvania, West Virginia, and the eastern edge of Kentucky.

Distribution in Virginia: This species is known in Virginia mostly from higher elevations in the western mountains (Figure 28). There are specimens from Clinch Mountain (Laurel Bed, 3600 feet), Russell County; Salt Pond Mountain (3550 feet) and Big Mountain (4100 feet), Giles County; Fort Lewis Mountain (3000 feet), Roanoke County; Allegheny Mountain (3650-4000 feet), Highland County; and Elliot Knob (4100 feet), Augusta County. It has been taken at 3900 feet on Big Black Mountain, Harlan County, Kentucky (Barbour and Davis, 1974). Although most southern records of *Sylvilagus transitionalis* are from high elevations, the presence of extensive forest, without significant openings may be a more important limiting factor than elevation. It has recently been taken at 2100 feet on Allegheny Mountain, 2 miles southeast of White Sulphur Springs, Greenbrier County, West Virginia, and there are Virginia specimens from Thornton River (2100 feet), below Panorama, Rappahannock County, and 3 miles south of Haysi (about 1500 feet), Dickenson County.

Habitat and Mode of Life: In Virginia the New England cottontail has been found most often in mixed yellow birch-red maple forest, with glades of red spruce and rhododendron and small irregular shrubby openings. It has also been taken in and near areas of hemlock and rhododendron in oak-hickory forest. Chapman and Morgan (1973) found it in northern hardwood forest which contained "large tracts of conifers, rhododendron, and mountain laurel at the higher elevations." They found its habitat to be "extremely restricted and uniform" in western Maryland and adjacent West Virginia. There, it is associated with a "cool boreal environment" and is found "only within the confines of small pockets of rhododendron-heather-spruce habitat."

Sylvilagus transitionalis, unlike its close relative the eastern cottontail (*Sylvilagus floridanus*), is a "secretive rabbit rarely venturing into the open." It behaves differently when handled: it usually "struggles vigorously" and squeals frequently, whereas *Sylvilagus floridanus* tends to remain calm, quiet, and in fact often freezes when picked up (Chapman, 1975).

In the fall, the home range of this rabbit is from one-half acre to almost two acres. Males travel greater distances than do females. As the breeding season approaches, both males and females become more mobile. *Sylvilagus transitionalis* undergoes one molt per year, during the late summer and autumn. The pelage is in prime condition at the onset of the breeding season (Chapman, 1975). *Sylvilagus transitionalis* may be better adapted to cold weather than is *Sylvilagus floridanus* (Chapman et al., 1977).

Together, clovers and grasses comprised 56 percent of all food consumed by *Sylvilagus transitionalis* during summer months in Connecticut. Another 20 percent consisted of a great variety of herbaceous and shrubby plants and some mushrooms. The remaining 24 percent of food ingested could not be precisely identified, but consisted of herbage, twigs, buds, seeds and fruit pulp (Dalke, 1937). *Sylvilagus transitionalis* typically consumes more bait from traps and leaves more droppings than *Sylvilagus floridanus*. Like many other members of the rabbit family it is coprophagous.

Reproduction: Dalke (1937) examined the placement of a number of *Sylvilagus transitionalis* nests and reported "43 percent were in brush, 25 percent in woods, 16 percent in hayfields, 16 percent in grasslands other than hayfields." A typical nest of *Sylvilagus transitionalis* is a shallow depression in the ground, either a natural cavity or a hole excavated by the animal itself (Headstrom, 1951). Dalke (1942) described its nest as usually about 4 inches deep (although one was found 1-1/2 feet below ground level) by 5 inches wide. Nests were lined with fur from the female's coat, finely shredded leaves, and grass. The nest had a lid made of fur and dead grass; over this lid was a layer of sticks and leaves. Nest construction took place at night (Headstrom, 1951; Dalke, 1942).

In western Maryland and nearby West Virginia the breeding season of *Sylvilagus transitionalis* begins in early-to-mid-March and ends in early September. The peak of both male and female reproductive activity is between March and July (Chapman *et al.*, 1977). Males are not sexually active until the breeding season following the one in which they were born, but juvenile females born early in the breeding season frequently become pregnant in the same season (Chapman *et al.*, 1977).

The gestation period is thought to be 28 days (Chapman, 1975) and 3 to 4 litters are produced per year (Asdell, 1964). Chapman *et al.* (1977) determined the mean litter size in the Maryland-West Virginia area to be 3.56, and found that first litters averaged smaller than subsequent ones. They estimated a female in that region could produce about 23 young per year. They stated: "The overall productivity of the eastern cottontail and New England cottontail was nearly identical. The eastern cottontail has larger litters and a shorter breeding season; the New England cottontail has a longer breeding season, substantial juvenile breeding, and small litters." A few instances of hybridization of *Sylvilagus transitionalis* and *Sylvilagus floridanus* have been described, but the frequency of hybridization must be low (Chapman, 1975).

Number in Captivity: No data.

Status: *Undetermined.* The status of the New England cottontail has been a subject of much concern for conservationists and wildlife managers for more than a decade, and it has stimulated significant studies in Maryland and in New England states. The status of this species unfortunately remains *Undetermined* in Virginia. On the basis of a two-year study which dealt mostly with *Sylvilagus floridanus*, Llewellyn and Handley (1945) believed that *Sylvilagus transitionalis* occurred in woods and brush on most of the peaks and ridges above 3000 feet in Virginia. This estimate was based on specimens from Roanoke, Giles, and Highland counties. *Sylvilagus transitionalis* had been taken earlier in Augusta County and has been found subsequently in Dickenson, Rappahannock, and Russell counties. Knowledge of its occurrence in Virginia, thus, is rather limited and dated.

The studies of cottontails in Maryland and West Virginia by Chapman and his associates (Chapman and Morgan, 1973; Chapman *et al.*, 1977) are extremely valuable in estimating the probable status of *Sylvilagus transitionalis* in Virginia. These studies have shown that originally *Sylvilagus transitionalis* and *Sylvilagus floridanus* probably were ecologically segregated in this region. Clearing for agriculture and other land use has reduced habitat suitable for the former species while creating and improving habitat for the latter. The two species appear to compete for living space where they occur together, and *Sylvilagus floridanus* seems to outcompete the smaller and less aggressive *Sylvilagus transitionalis* in altered habitats. *Sylvilagus floridanus* rapidly displaces *Sylvilagus transitionalis* on cleared and cultivated

land, and even is invading the preferred forest habitat of *Sylvilagus transitionalis*. *Sylvilagus floridanus* is abundant and spreading while *Sylvilagus transitionalis* has suffered a recent and rapid decline in distribution and abundance. There can be little doubt of the scarcity of *Sylvilagus transitionalis* over much of its former range in Maryland and West Virginia, and it has completely disappeared from many areas in New England. The simultaneous northward and eastward expansion of the range of *Sylvilagus floridanus* in New England is well documented. It may not be too early to guess that *Sylvilagus transitionalis* is sinking toward extinction because of habitat alteration and increasing competition with *Sylvilagus floridanus*.

Sylvilagus transitionalis has not been found recently in some places in Virginia where it would be expected to occur, and it seems to have declined and been largely replaced by *Sylvilagus floridanus* where it was abundant thirty to forty years ago in Giles County. *Sylvilagus floridanus* now occurs to the tops of the highest mountains in Virginia (e.g., at 5400 feet on Whitetop Mountain).

It seems probable that the status of these two cottontails has changed in Virginia in much the same ways that have been documented elsewhere in their ranges. However, at least one factor which may be significant in the deteriorating status of *Sylvilagus transitionalis* almost everywhere else within its range may be absent in Virginia. Earlier in this Century, and particularly during the interval 1920-1950, hundreds of thousands of exotic *Sylvilagus floridanus*, mostly from Kansas and Missouri, but also from many other states, were released in Maryland, West Virginia, Pennsylvania, and New England in an effort to augment cottontail populations to higher levels for hunting purposes. Chapman and Morgan (1963) have suggested that a possible result of this unfortunate episode was alteration of the gene pool of the native *Sylvilagus floridanus* and creation of an intergrade population with increased genetic variability ("hybrid vigor"). They speculated that the intergrade population, thanks to its genetic variability, had a broader ecological tolerance and thus was able to colonize habitats unfavorable to the native population it replaced. In this way the habitat selection of *Sylvilagus floridanus* broadened, even to include the niche of *Sylvilagus transitionalis*.

If the status of these two cottontails has changed in Virginia as suspected, it probably has happened without the addition of "hybrid vigor" to the population of *Sylvilagus floridanus*. Llewellyn and Handley (1945) observed: "So far as we know, there have never been any introductions [of cottontails] into Virginia from other states, and even the transplantations within the state have been small and insignificant. Virginia is one of the few remaining eastern states where the natural distribution of cottontails has yet been little disturbed by artificial stocking..."

Protective Measures Proposed:

- 1) High priority should be given to study of the status of *Sylvilagus transitionalis* in Virginia. Distribution and abundance need to be determined throughout its range in the state. Are there areas free of *Sylvilagus floridanus* where *Sylvilagus transitionalis* occurs? Does the habitat preference of *Sylvilagus transitionalis* in areas where it is the only cottontail present differ from its preference in areas where the eastern cottontail occurs? Is it possible to create *Sylvilagus transitionalis* habitat?
- 2) With the knowledge gained in these studies it may be possible to develop forest management practices that will favor *Sylvilagus transitionalis* and not *Sylvilagus floridanus*. Where *Sylvilagus transitionalis* is found, an effort should be made to maintain large blocks of forest without significant openings.

- 3) It is not possible for hunting regulations to distinguish between the two cottontails. Even so, it is doubtful that hunting has much effect on the status of *Sylvilagus transitionalis* anyway. Because of its habitat preferences it probably is not subject to much hunting pressure. Nevertheless, if studies show that *Sylvilagus transitionalis* is in trouble in Virginia, some centers of abundance might be set aside as preserves for it.
- 4) The hypotheses of Chapman *et al.* (1973; 1977) regarding genetic enhancement of *Sylvilagus floridanus* as a competitor through introduction of exotic stock should be tested in Virginia, where theoretically there have been no introductions and thus no genetic alteration. The interactions of *Sylvilagus transitionalis* and our genetically unaltered *Sylvilagus floridanus* should be carefully observed and evaluated.

Remarks: Another vernacular name is woods rabbit.

Authors: Charles O. Handley and Linda K. Gordon.

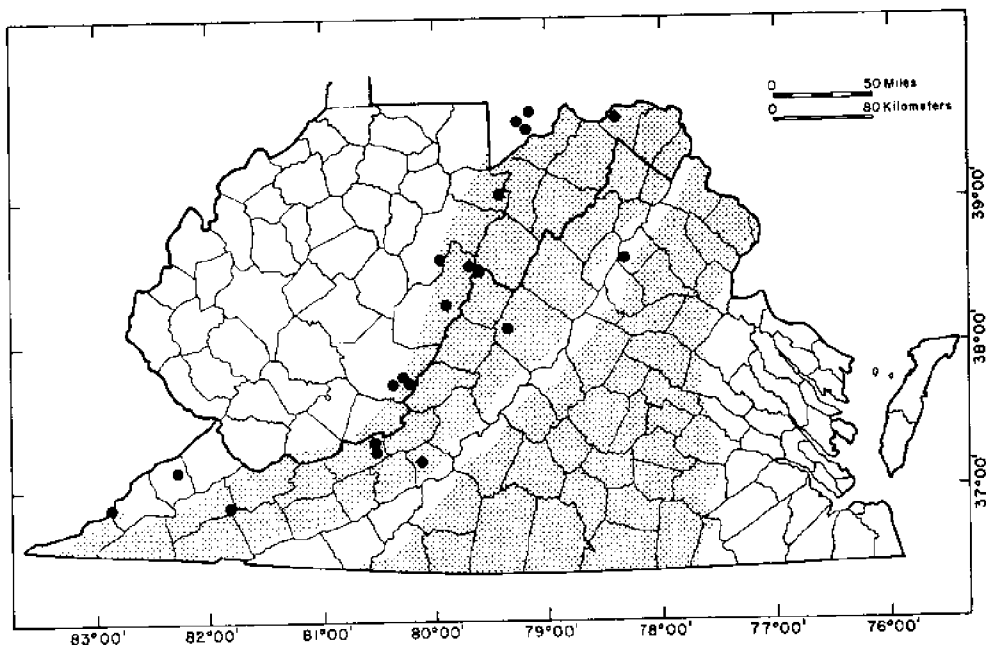


Figure 28. Distribution of New England Cottontail (*Sylvilagus transitionalis*) in Virginia and West Virginia

3. COTTON MOUSE

Peromyscus gossypinus gossypinus
LeContePhylum: Chordata
Class: MammaliaOrder: Rodentia
Family: Muridae

Description: *Peromyscus gossypinus* is a mouse with large, naked ears; large blackish eyes; long vibrissae; medium length, indistinctly bicolored tail (a little less than half the total length); narrow feet; smooth-lying orange-brown dorsal pelage; white underparts, sharply defined from orange of flanks; and white hands and feet. Measurements (in millimeters) of 14 adults from the Dismal Swamp (average and extremes): total length 183 (175-195), tail vertebrae 81 (70-88), hind foot 23 (22-25).

The cotton mouse is very much like its close relative, *Peromyscus leucopus* Rafinesque, except in size. It has a stockier build, larger body (head and body usually longer than 100 millimeters), and larger feet (average 23 vs. 21 millimeters). The only other similar mammal in Virginia, *Ochrotomys nuttalli* Harlan, has a brighter dorsum, not sharply demarcated from cream-colored underparts; smaller eyes; and shorter, broader feet.

Present Range: The cotton mouse is found in the lowlands of the southeastern United States from southeastern Virginia to Florida, west to Texas, and north in the Mississippi Valley to Oklahoma, Missouri, Illinois, and Kentucky. The subspecies *Peromyscus gossypinus gossypinus* occurs in the Piedmont and Coastal Plain from southeastern Virginia to northern Florida and Louisiana.

Distribution in Virginia: *Peromyscus gossypinus* is known in Virginia from the Dismal Swamp and Suffolk northwestward along the Blackwater and James rivers almost to Richmond: Blackwater River, near Zuni, Isle of Wight County (Dice, 1940); Blackwater River, 2.8 miles northeast of Waverly, Sussex County; Otterdam Swamp, 3.8 miles northeast of Waverly, Surry County; north bank of Appomattox River, across from Hopewell, Chesterfield County (Ulmer, 1963); and Presquile, 5 miles north-northeast of Hopewell, Chesterfield County (Jackson *et al.*, 1976) (Figure 29).

Habitat and Mode of Life: The preferred habitat of the cotton mouse is swamps and river-bottom forest subject to periodic flooding. In the Dismal Swamp it has been trapped in patches of cane, in hummocks of dense undergrowth in cypress, and in buildings (Dice, 1940; Handley and Patton, 1947; Handley, in press). Near Hopewell, Ulmer (1963) caught one under tree roots in green-brier, honeysuckle, sweet bay, and black gum at the edge of swampy river-bottom forest. Jackson *et al.* (1976) found it abundant in periodically flooded swamp with fallen trees, stumps, and exposed roots in thickets of ironwood beneath a canopy of ash, tupelo, black gum and cypress. A few were caught along a shrubby escarpment under honeysuckle, *Clematis*, trumpet creeper, *Smilax*, and grape, where hackberry, red cedar, chestnut oak, Spanish oak, hickory and winged elm were the dominant trees.

Nest sites of the cotton mouse may be in or under fallen logs, in moss on floating logs, in stumps, under the bark of decaying trees, or in brush piles. This species sometimes makes elevated nests, as much as six meters above the ground. Nest materials such as palm and palmetto fibers and cotton (hence the vernacular name) have been reported (Hamilton, 1943; Golley, 1962; Wolfe and Linzey, 1977).

Howell (1921) guessed that the diet of *Peromyscus gossypinus* would be similar to that of *Peromyscus leucopus*: berries, nuts, seeds, insects, and occasionally meat. Wolfe and Linzey (1977) concluded that it is an opportunistic omnivorous feeder. Predators of the cotton mouse are various snakes

and probably raccoon, mink, and owls (Hamilton, 1943; Pournelle, 1952). *Peromyscus gossypinus* is primarily terrestrial but it climbs like a gray squirrel and it swims well (Pournelle, 1950).

Reproduction: In the northern part of its range *Peromyscus gossypinus* has been found with embryos from March to October. It exhibits post-parturition heat and successive litters are produced during the breeding season. The gestation period is about 23 days. Litter size varies from 1 to 7 young (average, 4). Young are naked and blind at birth. They are sexually mature and capable of fertile matings at ages as young as 70 days. Longevity averages from less than two months to almost two years. Apparently, ages of more than one year are unusual (Wolfe and Linzey, 1977).

Number in Captivity: Present numbers are unknown. Dice (1940) reported successful maintenance of *Peromyscus gossypinus* (from the Dismal Swamp) in captivity.

Status: *Undetermined.* The cotton mouse was first encountered in this state in the Dismal Swamp, where it was one of the more common small mammals in the 1890's. It seemed to be absent there in the early 1900's, but it was found again in the 1930's. Now it has vanished once more. Trapping surveys of the Swamp in the 1950's and 1970's revealed an abundance of *Peromyscus leucopus*, but no *Peromyscus gossypinus*.

The Dismal Swamp once was thought to be the northern extreme of the range of *Peromyscus gossypinus*. Now we know that this mouse occurs in other swamps along the Blackwater River and along the James to within a dozen miles of Richmond. At least at the locality near Richmond (Presquille), it is abundant and apparently is the only *Peromyscus* present.

It may be that post-Pleistocene migrations have only relatively recently brought the closely related *Peromyscus gossypinus* and *Peromyscus leucopus* into contact on the Atlantic Seaboard. If this is true, the two species may at this moment be in the process of adjusting behaviorally to one another (Handley, 1971 and in press). This could possibly account for the apparent variations in abundance and spotty distribution of *Peromyscus gossypinus*. In some other areas of sympatry there seems to be competitive exclusion in *Peromyscus gossypinus* and *Peromyscus leucopus* (Hooper, 1968; Wolfe and Linzey, 1977).

Protective Measures Proposed: The status of *Peromyscus gossypinus* in Virginia must be determined. It may be more abundant and widespread than is supposed, or it may be quite local and subject to unsuspected environmental pressures. Probably southeastern Virginia would be an unusually rewarding area to study the natural history of *Peromyscus gossypinus* and its interactions with *Peromyscus leucopus*.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

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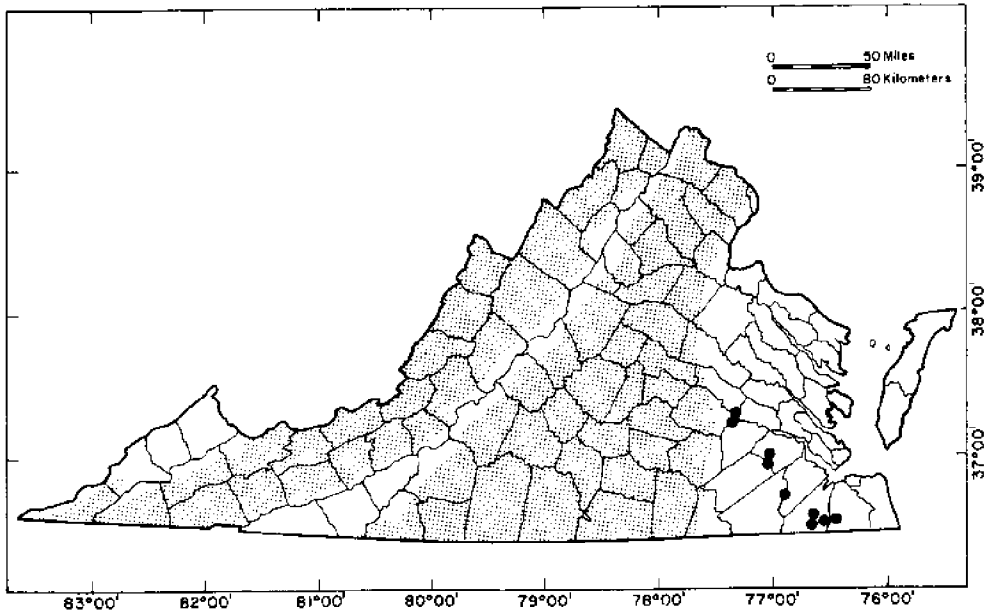


Figure 29. Distribution of Cotton Mouse (*Peromyscus gossypinus*) in Virginia

4. ROCK VOLE

Microtus chrotorrhinus carolinensis
Komarek

Phylum: Chordata
Class: Mammalia

Order: Rodentia
Family: Muridae

Description: The rock vole is a small-eyed, short-tailed (about a quarter of the total length), shaggy-haired mouse. Its long fur is overlaid by coarse guard hairs that partially conceal its hairy ears. Coloration above is brown, often with an orangish cast; the sides of the snout are bright orange rufous; underparts are grayish-white; feet are grayish-brown; and the tail is indistinctly bicolored. The skull is rather fragile, the second upper molar has one extra enamel triangle, and the third upper molar is long and has an unusually large number of enamel triangles (five). Measurements in millimeters (Kirkland, 1977a) of 25 adult males and 28 adult females (range in parentheses) from West Virginia: total length, males 157.4 (140-175), females 150.4 (137-165); tail vertebrae, males 43.4 (37-51), females 40.5 (31-49); hind foot, males 19.9 (18-22), females 20.2 (19-22); and weight in grams, males 35.8 (25.7 to 44.2), females 34.3 (24.6 to 50.9). The subspecies *Microtus chrotorrhinus carolinensis* is characterized by dark coloration, large skull, long tooththrows, and heavy zygomata (Komarek, 1932). Color illustration: Burt and Grossenheider (1976, plate 17).

Microtus chrotorrhinus is most like *Microtus pennsylvanicus* but it is slightly brighter colored overall, has the orange nose spot much larger, clearer and brighter (always dull yellowish and smaller or absent in *Microtus pennsylvanicus*), and it has five enamel triangles on the upper third molar, rather than three. It is not likely to be found together in the same habitat with *Microtus pennsylvanicus* in Virginia and West Virginia, although elsewhere the ecological ranges of the two species do overlap slightly. However, *Microtus chrotorrhinus* consistently shares its rocky habitat with another microtine, the red-backed vole, *Clethrionomys gapperi*. This species has slightly less shaggy fur, almost always has the dorsum darker and differing from the flanks in coloration, and never has the sides of the snout orange.

Present Range: The species ranges from Labrador across Canada to northeastern Minnesota, and is found at higher elevations in the Gaspé Peninsula, New Brunswick, New England, New York, and northeastern Pennsylvania. An isolated population in the Great Smoky Mountains of North Carolina and Tennessee constitutes the subspecies *Microtus chrotorrhinus carolinensis*. Another isolated population in eastern West Virginia (Figure 30) has smaller teeth than typical *Microtus chrotorrhinus carolinensis*, but otherwise resembles that subspecies more than it does *Microtus chrotorrhinus chrotorrhinus*.

Distribution in Virginia: The rock vole was more widespread and abundant in the Southern Appalachians in the Late Pleistocene than it is now. It is known from several cave deposits of that age in Virginia. At Clark's Cave in Bath County, Guilday *et al.* (1977) found remains of at least 292 individuals. Although there has been considerable effort in recent years to find living rock voles in Virginia, none has turned up. Habitat seemingly suitable for it persists on Whitetop and Mount Rogers. Before the spruce was cut in Highland, Giles, Tazewell and Russell counties, the rock vole almost certainly occurred there, but there were no prelogging mammalogical investigations there to find it. The rock vole is still fairly common today in the Great Smokies and in West Virginia as little as 10 miles from the border of Highland County. Kirkland (1977a; 1977b) found it to be one of the commoner small mammals in eastern West Virginia. Of particular interest, he found it commoner in recent (less than three years old) clearcuts in spruce than in undisturbed habitats. However, it was decidedly uncommon in older clearcuts in spruce and in mixed spruce and northern hardwood forest, both cut and uncut. This suggests the fate of the rock vole in Virginia, where all spruce was cut and the areas were burned. Forest regeneration was with northern hardwoods and an insignificant scattering of spruce -- a habitat unfavorable for rock voles, if any had survived the clearcutting and burning. Present indications are that the rock vole has been *Extirpated* in Virginia. If the species survives here, undiscovered, it must be rare and local.

Habitat and Mode of Life: Typical habitat of the rock vole is cool, moist talus, or areas strewn with mossy boulders and logs. Running water is usually no more than a few feet distant, within the rock slide or nearby in the form of streams, springs, or seeps. Areas inhabited by rock voles include mature undisturbed forest with closed canopy; open, even heavily browsed forest; recent clearcuts; open road fills; the transition zone between open boulder field and forest; and grassy balds adjacent to forest. The voles have been found in red spruce; mixed red spruce and northern hardwoods (beech, maple, birch); and mixed hemlock, oak, birch and basswood forests. They are most abundant at higher elevations, from 4000 feet to the mountain tops, but they have been taken as low as 2650 feet in the Great Smoky

Mountains, and as low as 2000 feet in West Virginia (Komarek, 1932; Kellogg, 1937; Roslund, 1951; McKeever, 1952; Martin, 1965 and 1971; Linzey and Linzey, 1971; Kirkland, 1977a).

In West Virginia, Kirkland (1977a) found the rock vole always associated with *Clethrionomys gapperi* (see also Martin, 1971 and Timm *et al.*, 1977) and *Peromyscus maniculatus*, and usually with *Sorex fumeus* and *Blarina brevicauda*. In captivity the rock vole displays nonaggressive behavior but it, nevertheless, seems to be dominant over sympatric microtines. *Microtus pennsylvanicus* may be competitively excluded from rock vole habitat. Known predators of the rock vole include bobcat, rattlesnake and copperhead. It may also be preyed upon by *Blarina brevicauda*. It is active both day and night, but much of its activity may be confined to the labyrinths of its rocky habitat where it is sheltered both from predators and the vagaries of the surface climate. Stomachs of three specimens from the Great Smoky Mountains contained 99.7 percent vegetation and 0.3 percent fungus (*Endogone*). Supposed foods of the rock vole in New England and Minnesota include blueberry leaves, stems, and fruits; foliage of Clinton's lily, wild lily-of-the-valley and bunchberry; the fruit of raspberry and blackberry; and mushrooms. Grasses and sedges may be of lesser importance as food items. Fecal pellets are deposited in special "toilet" areas (Martin, 1971; Linzey and Linzey, 1971 and 1973; Timm *et al.*, 1977).

Reproduction: The rock vole is reproductively active from early March to mid-October. In West Virginia, 8 or 12 females were reproductively active in July but only 2 out of 13 were active in October. In Minnesota, 11 of 13 were active in August. A female may produce young before she is fully grown, in her first year, if she is born early in the season; but for a microtine, *Microtus chrotorrhinus* has a low reproductive rate. An adult female probably produces no more than 2 or 3 litters in a summer. Litter size varies from 1 to 7 young, with reported averages of 2.88 in West Virginia, 3.5 in Minnesota, 3.71 in New England, and 3.91 in Ontario. The largest litters usually are produced in June (Martin, 1965 and 1971; Timm *et al.*, 1977; Kirkland, 1977a).

Number in Captivity: No data.

Status: *Undetermined*. The rock vole was common in Virginia at the end of the Pleistocene, and probably was still present when the red spruce was cut around 1900. It is not known to occur in Virginia today, but it still occurs nearby in West Virginia, North Carolina and Tennessee. If it does occur in Virginia it must be rare and local in distribution.

Protective Measures Proposed: In the case of the rock vole, the first step in protecting surviving isolated relict populations should be to locate them. Virginia needs a systematic, intensive survey of its mountainous counties to locate rock voles, northern flying squirrels, snowshoe hares, New England cottontails, rare shrews, etc. When populations have been located, research should be initiated, both in relict sites and in places in other parts of the range of the species where it is commoner, to determine ecological needs as precisely as possible. Existing information on the rock vole is contradictory. It has been found most often in a rather stereotyped cool, moist, rocky environment. However, it has been taken also in sterile-looking rocky road fills, and it may benefit, at least temporarily, from timber harvest. It may be possible to create new environment and to manage existing habitat for the benefit of the rock vole.

Remarks: Other common names: yellow-nosed vole, orange-nosed vole.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

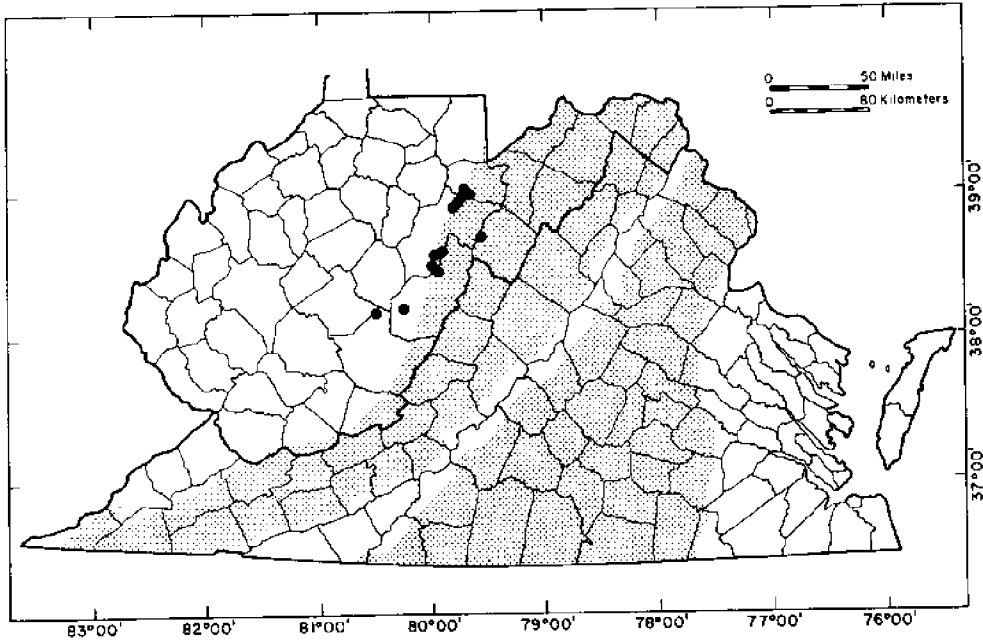


Figure 30. Distribution of Rock Vole (*Microtus chrotorrhinus carolinensis*) in Virginia and West Virginia

5. SOUTHERN LEMMING VOLE

Synaptomys cooperi helaletes
Merriam

Phylum: Chordata
Class: Mammalia

Order: Rodentia
Family: Muridae

Description: The lemming vole is a small, chunky rodent with long, shaggy fur, short ears, and a very short tail. A mixture of black, gray, and yellowish-brown gives its upperparts a bright grizzled appearance, merging without sharp demarcation with the grayish-white of the underparts. Tail and feet are fuscous, the former slightly paler beneath (Figure 31). The anterior face of each of the broad upper incisors is scored by a conspicuous longitudinal groove. The subspecies *Synaptomys cooperi helaletes* is characterized by its large, heavy skull, comparatively wide rostrum and zygomatic arches, and relatively short, narrow nasals. Measurements (in millimeters) of 10 adults from the Dismal Swamp (Wetzel, 1955): total length 125.4, tail vertebrae 20, hind foot 19.6. Color illustration: Burt and Grossenheider (1976, plate 17).

The pine vole, *Microtus pinetorum* LeConte, has a tail almost as short (mean, 23 millimeters) as that of the lemming vole, but it has shorter, smoother fur, smaller eyes and ears, and narrower, ungrooved incisors. The meadow vole, *Microtus pennsylvanicus* Ord, has similarly long, coarse fur and

similar eyes and ears, but it is not so conspicuously grizzled, its tail is longer (mean, 46 millimeters), and its incisors are ungrooved.



Figure 31. Southern Lemming Vole (*Synaptomys cooperi helaletes*)

Present Range: The species ranges from eastern Quebec (north shore of the Gulf of Saint Lawrence) and Nova Scotia westward north of the Great Lakes to southeastern Manitoba, and south to Kansas, Arkansas, the valleys of the Ohio and Potomac rivers, the Eastern Shore of Maryland, and in the Appalachians to North Carolina and Tennessee. There are isolated, endangered populations in the Dismal Swamp, southeast Virginia and northwest North Carolina (*Synaptomys cooperi helaletes* Merriam), southwest Kansas (*Synaptomys cooperi apludis* Hibbard and Rinker), and southwest Nebraska (*Synaptomys cooperi relictus* Jones).

Distribution in Virginia: *Synaptomys cooperi helalates* is known only from the Dismal Swamp (Figure 32). Most specimens were taken on the west and north-west shores of Lake Drummond, the type locality of the subspecies.

Habitat and Mode of Life: In 1895, A. K. Fisher found *Synaptomys cooperi helalates* "common in all cane patches bordering the lake [Lake Drummond, Dismal Swamp]." It has also been found in sphagnum bogs near the lake (Handley, in press). Two specimens were taken "in a patch of *Juncus setaceus* in a damp piece of open ground bordering pine woods at Chapanoke (North Carolina) on March 11, 1897. The runways were filled with cut stems of *Juncus*, on which they had evidently been feeding" (Rhoads and Young, 1897). Poole (1943) found the closely related *Synaptomys cooperi stonei* in deep sphagnum in the cypress swamps of the Pocomoke River on the Eastern Shore of Maryland. In the New Jersey Pine Barrens the preferred habitat of the lemming vole is open treeless sphagnum bogs with leatherleaf, huckleberry, and sedge (Connor, 1959).

The lemming vole constructs both surface runs and subterranean tunnels. Its surface runways are narrower ($3/4$ inch to 1 inch vs. 1 inch or larger) and deeper than those of *Microtus pennsylvanicus* and may pass over as well as beneath patches of prostrate grass or sedge. It also uses the runways of other small mammals such as *Microtus pennsylvanicus* and *Condylura cristata*. Droppings found in runways may distinguish the occupants. Those of the lemming vole usually are green (buff or yellowish when dry), while those of *Microtus pennsylvanicus* are dark brown or blackish. Grass and sedge clippings associated with runways tend to be in more even lengths and often in larger piles when made by *Synaptomys cooperi* (Richmond and Roslund, 1949; Roslund, 1951; Mumford and Handley, 1956; Connor, 1959).

Pine Barrens lemming voles subsist mostly on leaves and other parts of sedge, supplemented in winter and early spring with leaves and buds of turkeybeard and leatherleaf, and in summer with fruits of blueberries and huckleberries (Connor, 1959). In addition to plant material, Hamilton (1941) found insect remains and numerous spores of a fungus (*Endogone*) in New York lemming voles. *Synaptomys cooperi* is both diurnal and nocturnal, so it is not surprising that it is preyed upon by both hawks and owls, as well as weasels, foxes, and snakes. In the Pine Barrens in October, home range varied from one-tenth to one-fourth of an acre (Connor, 1959).

Reproduction: A lemming vole captured 11 March 1897 in the Dismal Swamp contained four well advanced embryos (Handley, in press). The breeding season may be long, for Barbour (1956a) found *Synaptomys cooperi* in Kentucky pregnant January 10 to March 21; one collected 24 October 1941 in Augusta County, Virginia, contained five embryos (Stewart, 1943); and Poole (1942) caught a lactating female on the Eastern Shore of Maryland on 30 November 1941. Gestation is about 23 days and litters may follow one another in quick succession. Connor (1959) trapped several individuals in the Pine Barrens that were both lactating and pregnant, and a female in his laboratory colony mated successfully within a few hours after parturition. She produced 6 litters in 6 months. However, litter size is small, ranging from 1 to 4 and averaging only 3 (Adell, 1964).

A lemming vole nest that A. K. Fisher found in a dry clump of grass in a bog at the northwest corner of Lake Drummond was made of coarse fibers and was lined with finer material (Handley, in press). Nests that Barbour (1956a) found in Kentucky were about 5 inches in diameter, were on the ground, and were concealed by tangles of grass. In the New Jersey Pine Barrens nests were most often situated in the top of hummocks of sphagnum, or were just under the surface (Connor, 1959).

Number in Captivity: No *Synaptomys cooperi helaletes* are in captivity, but other subspecies have been successfully maintained and even bred in captivity (Connor, 1959).

Status: *Undetermined.* The coastal lowland population (*Synaptomys cooperi helaletes*) of the lemming vole is at least *Endangered* and perhaps it is *Extinct*. Next to *Microtus chrotorrhinus*, the lemming vole is the least numerous microtine in Virginia. Nevertheless, the interior subspecies, *synaptomys cooperi stonei*, is widespread and not rare in the mountain counties west of the Blue Ridge. There seem to be no records for the Blue Ridge itself, but that may be due to lack of extensive collecting rather than to lack of voles. There are old records for Fairfax (1888) and Campbell (1901) counties in the Piedmont. The subspecies *synaptomys cooperi helaletes* was isolated in the Dismal Swamp, where in the 1890's it seemed to be as common as *synaptomys cooperi stonei* is today in the mountain counties. During that era it apparently was not difficult to trap, and it was taken by a number of collectors. However, it has not been seen since 1898. If it still exists and has been merely overlooked by recent collectors, it must be less numerous and more localized than formerly.

Synaptomys cooperi helaletes may be the victim of a long-term decline, only partly related to habitat destruction by man. Wetzel (1955) supposed that the range of the lemming vole must once have been more extensive and continuous in the coastal lowlands and in the uplands of the interior than it is now. The coastal population (*Synaptomys cooperi helaletes*) probably differentiated to the subspecific level after its connection with the interior population (*Synaptomys cooperi stonei*) was severed and it became isolated. Wetzel (1955) suggested that marine encroachment as well as habitat destruction by man might have been responsible for the shrinking range of the lemming vole in eastern Virginia. He judged by its slight differentiation from *Synaptomys cooperi stonei* that *Synaptomys cooperi helaletes* could not have been isolated very long. However, it is doubtful that there have been lemming voles in the Virginia coastal plain outside of the Dismal Swamp in historic times or that its distribution in the Piedmont has been much more extensive at any time in that period than it is today. Accounts of collecting *Synaptomys cooperi helaletes* emphasize its preference for sphagnum bogs. In fact, peripheral relict populations throughout the range of *Synaptomys cooperi* seem to be rather severely restricted to sphagnum bogs. It is possible that the drying up and overgrowth of sphagnum bogs in the Dismal Swamp may be responsible for the disappearance of *Synaptomys cooperi helaletes*.

Protective Measures Proposed: A concerted effort must be made to determine whether there is a surviving population of *Synaptomys cooperi helaletes*. If a population of these voles is found in the Dismal Swamp, then its ecological requirements there should be carefully studied so that habitat improvement and maintenance can be attempted. If, for example, the decline of *Synaptomys cooperi helaletes* were found to be correlated with the disappearance of extensive areas of open sphagnum bog, ways might be found to restore bogs to habitable condition.

There is hope that a remnant population of *Synaptomys cooperi helaletes* exists. If it does, it provides an unusually reasonable and real opportunity to bring an endangered mammal back from the brink of extinction.

Remarks: Other common names are southern bog lemming and lemming mouse.

Authors: Charles O. Handley, Jr. and Linda K. Gordon.

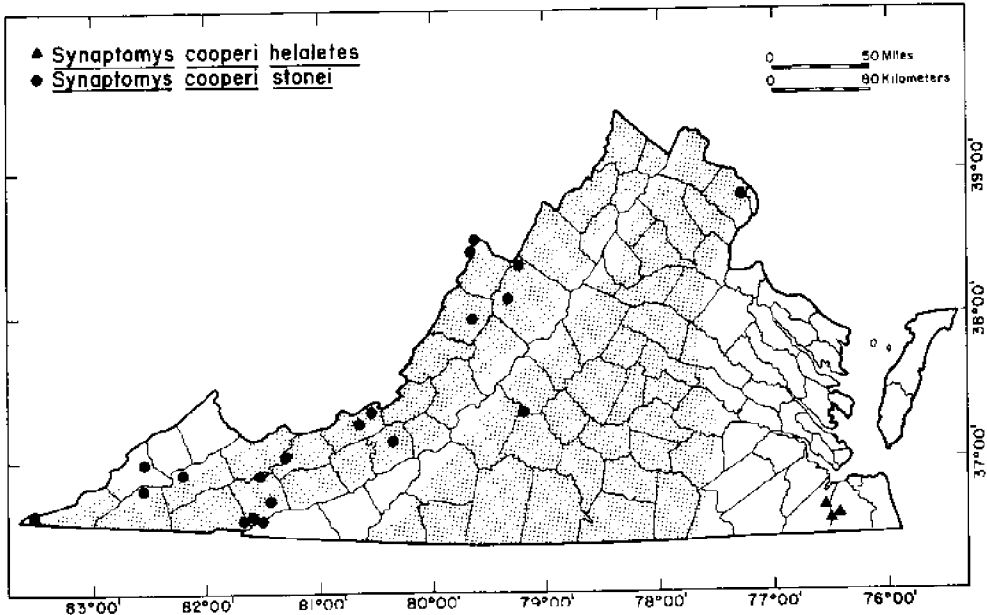


Figure 32. Distribution of Southern Lemming Vole (*Synaptomys cooperi*) in Virginia

6. LEAST WEASEL

Mustela nivalis allegheniensis
Rhoads

Phylum: Chordata
Class: Mammalia

Order: Carnivora
Family: Mustelidae

Description: The form of *Mustela nivalis* is typically weasel-like, with long slender body, short legs, and stubby tail; size is small, the smallest of all carnivores; coloration is rich dark brown throughout, except white on the chin, throat, chest, and lower belly; tail is entirely brown. In the North, least weasels are entirely white in winter, and some turn at least partly white as far south as Pennsylvania. Virginia specimens taken in November and January are colored as in summer. Mean and extreme measurements (in millimeters) of five males from Virginia and West Virginia: total length 196 (184-217), tail vertebrae 34 (28-42), hind foot 23 (22-25); weight in grams, 44 (34-64). Two females from the same area are smaller: total length 174-175, tail vertebrae 26-34, hind foot 18-20, and weight 24.9. Color illustration: Burt and Grossenheider (1976, plate 6, "*Mustela rixosa*").

Mustela nivalis can be recognized as a weasel by its slender form, short legs, and needlelike teeth. It is much smaller than any other Virginia weasel and has a shorter tail. The common long-tailed weasel, *Mustela frenata* Lichtenstein, has a black-tipped tail.

Present Range: The species is Holarctic, occurring across North America from Labrador to Alaska and in Eurasia from Siberia to the British Isles. The subspecies *Mustela nivalis allegheniensis* is found in the Appalachians from Pennsylvania to North Carolina and Tennessee, and westward, south of the Great Lakes, to Illinois and Wisconsin.

Distribution in Virginia: The least weasel is rare in Virginia, known by eight specimens from the upper Piedmont and mountains: four from Blacksburg, 2100 feet, Montgomery County; and one each from 1.7 miles north-northwest of Mountain Lake, 3825 feet, Giles County; Oak Grove Church, near Salem, Roanoke County; near Dayton, Rockingham County; and 2 miles west of Rectorville, Fauquier County (Figure 33).

Habitat and Mode of Life: Virginia and West Virginia specimens have been found at elevations between 1200 and 3825 feet in pastureland, brushy fence row, old field overgrown with dewberry and multiflora rose, in and around buildings, and deep within oak-hickory-hemlock forest. The home range of the least weasel probably is no more than one or two acres. Nests of this weasel, composed of grasses and mouse fur, have been found in holes in the walls of buildings, under corn shocks, and in shallow burrows.

The least weasel has a high metabolic rate and is a voracious feeder. Field voles, *Microtus pennsylvanicus* Ord, are probably its commonest prey. It most likely also catches house mice, *Mus musculus* Linnaeus; white-footed mice, *Peromyscus leucopus* Rafinesque; short-tailed shrews, *Blarina brevicauda* Say; small birds; and insects. It has been seen carrying earthworms. The least weasel itself is preyed upon by larger carnivores, including house cats, barn owls, and possibly snakes (Hamilton, 1943; Handley, 1949; Douthett *et al.*, 1966; Ewer, 1973).

Reproduction: This species is unusual among mustelids in having a normal reproductive cycle, without delayed implantation. Its gestation period is 35 days. It produces more litters (2 or more) and more young (3 to 6 or more per pregnancy) than any other American weasel. It may be reproductively active in every month, sometimes even producing young in the dead of winter. Least weasels commonly travel in pairs, and both parents assist in the care and feeding of the young. The young grow extremely rapidly. They are weaned and can kill mice by the time they are 6 to 7 weeks old; are as long as adults in 8 weeks; and reach adult weight in 12-15 weeks (Asdell, 1964; Heidt *et al.*, 1968; Heidt, 1970; Ewer, 1973).

Number in Captivity: No data. Maintenance in captivity has been described by Short (1961b) and Heidt (1970).

Status: *Undetermined.* The least weasel is thought to be rare throughout its range in the southeastern United States. Certainly there are very few locality records in that area: only five each in Virginia and West Virginia, four in North Carolina, and one in Tennessee (Patton, 1939; Llewellyn, 1942; McKeever, 1952; Barkalow, 1967; Tuttle, 1968). In 15 years of intensive trapping at Mountain Lake, Giles County, Virginia, and 10 years at Lewisburg, Greenbrier County, West Virginia, only one least weasel has been taken at each locality. On the other hand, purely fortuitously, four have been taken and another seen at Blacksburg, Montgomery County, Virginia, suggesting that it may be fairly common there. It seems to be not very discriminating about habitat, for it has been found as often in cultivated and urban areas as in forest and other wild places. It may be discontinuous and local in distribution, and may be rare in most places in spite of its acceptance of disturbed habitats. However, we are uncertain of its true status. Perhaps it

should not be included here at all, but the conservative course is to list it as of *Undetermined Status*, perhaps deserving *Special Concern*.

Protective Measures Proposed: An effort should be made to determine the true status of the least weasel.

Remarks: The least weasel is valuable because of its destruction of rodents. It has high esthetic value as the tiniest carnivore. This species was formerly known as *Mustela rixosa* Bangs in North America.

Author: Charles O. Handley, Jr.

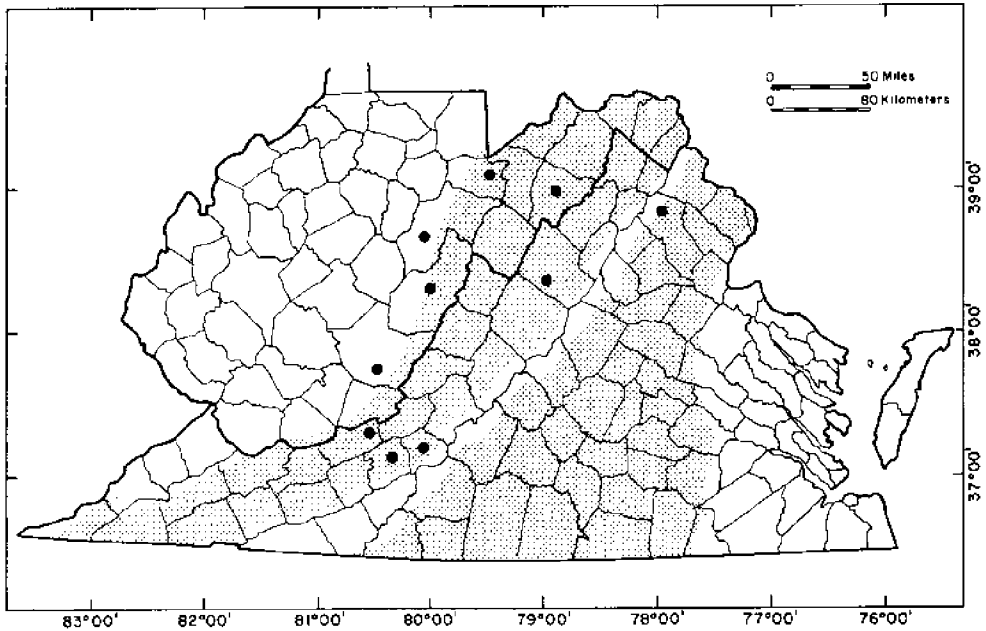


Figure 33. Distribution of Least Weasel (*Mustela nivalis*) in Virginia and West Virginia

RECENTLY EXTINCT or EXTIRPATED (6)

At least seven species of mammals have been *Extirpated* from Virginia in historic times. The bison was the first to disappear, as early as 1797, and the porcupine probably was gone by 1837. The last native elk was shot in 1855, and the Rocky Mountain elk, introduced in 1917 to replace it, disappeared in 1974. The fisher was *Extirpated* about 1890 in Virginia. It was restocked in West Virginia in 1969, and wanderers already have appeared in Virginia and Maryland. No manatee has been seen in Virginia since 1908, and the last wolf was shot in 1910. The last native beaver was trapped in 1911, but restocking, begun in 1932, has restored this species to a status of abundance in much of the state.

Seven other taxa may have been *Extirpated*, but we are not sure. They have been treated in detail in individual species accounts as *Endangered* or of *Undetermined Status*. The last native mountain lion may have been killed in 1882. If so, the mountain lions now being sighted in Virginia must have been established by restocking of animals from the western United States. On the other hand, the species may have survived in very low numbers, almost unnoticed, to the present day. The Dismal Swamp lemming vole has not been seen since 1898, and it may no longer exist. The rock vole has never been found in Virginia in historic times, but it must have occurred here. Perhaps it disappeared before it could be discovered. The habitats of both the lemming vole and the rock vole need to be thoroughly surveyed so that their status can be determined. Recent investigations on the Eastern Shore have found no surviving native fox squirrels (*Sciurus niger cinereus*) in Virginia. Efforts to establish a protected population of this squirrel on Assateague Island appear to be successful. Another subspecies, *Sciurus niger niger*, may have been *Extirpated* from Tidewater Virginia, since it has not been reported there in many years. There are no records of the eastern big-eared bat (*Plecotus rafinesquii rafinesquii*) in southwest Virginia, where it ought to occur. It may yet survive in some undiscovered, unmolested cave. The only known habitat of the water shrew in Virginia was dammed and flooded in 1977. Did that terminate the species in Virginia?

This brings us up to the present moment with the species which have certainly disappeared, and with those which may have disappeared from Virginia. Detailed discussions of six of the *Extirpated* species follow.

1. BEAVER

Castor canadensis canadensis Kuhl
Castor canadensis carolinensis Rhoads

Phylum: Chordata
Class: Mammalia

Order: Rodentia
Family: Castoridae

Distribution: The species originally ranged over the entire forested portions of North America from ocean to ocean and from the edge of the Arctic tundra to northern Mexico. *Extirpated* in the Seventeenth and Eighteenth centuries from much of the eastern portion of its range by trapping, it has now been restocked and restored in many areas. The subspecies that were found in Virginia, *Castor canadensis canadensis* and *Castor canadensis carolinensis*, once occupied the entire forested eastern and northern portions of North America, east of the Great Plains in the South, and east of the Rocky Mountains in the North (except for the upper and lower peninsulas of Michigan and the area east of New York and Ontario).

Former Distribution in Virginia: When Europeans arrived, beavers were found in abundance throughout the state. *Castor canadensis canadensis* probably occurred in the mountains, in the northern Piedmont, and perhaps in the Coastal Plain. The broad-tailed *Castor canadensis carolinensis* surely occurred at least in the Dan River and Roanoke River drainages in south-central Virginia, for its type locality was in Stokes County where the Dan dips into North Carolina for a short distance. All beavers were *Extirpated* from Virginia by 1911.

Causes of Extirpation: The beaver was the most important fur-bearing mammal of colonial America. Trapping the animal and trading its pelt helped shape the destiny of many states, provinces, and cities. Much of the exploration of the West was accomplished in search of new populations of beavers to exploit. Everywhere, beavers were trapped until the last one had been caught. Beavers had been *Extirpated* from West Virginia by 1825, from New Jersey by 1830, and from Pennsylvania by 1850. They persisted much later in south-central Virginia, being *Extirpated* there between 1885 and 1911. They disappeared from adjacent parts of North Carolina sometime after 1905 (Allen, 1942; Handley and Patton, 1947; Bailey, 1954; Doutt *et al.*, 1966).

Post-Extirpation Events: Given protection, water and forage, beavers were easy to reestablish where they had been *Extirpated*. Rate of annual increase averages 30 to 50 percent, and because of their social behavior beavers disperse rapidly. Between 1932 and 1938, the Virginia Game Commission purchased 35 beavers from Pennsylvania, New York, New Hampshire, Maine, and Michigan, and released them at eight localities in Virginia (Table 12). Redistribution of surplus or nuisance beavers from these nuclei to new areas began in 1943. Soon beavers were found once more in most counties in harvestable numbers. In the winter of 1976-77, the statewide harvest of beaver pelts was 5546, up from 3937 at the beginning of the decade (Figure 34).

Table 12. Beavers from Other States, Restocked in Virginia

Year	Origin	Number released	Release Point
1932	Pennsylvania	6 4	Big Levels Refuge (Augusta) Winfield's Mill Pond (Dinwiddie)
1933	Pennsylvania	3	R. D. Harris' Pond (Goochland)
1937	Michigan, New York, New Hampshire	2 4 2 2 3	Little Stony Creek (Giles) Swift Creek State Park (Chesterfield) Winston Lake (Cumberland) Big Levels Refuge (Augusta) Bailey's Creek, Camp Lee (Prince George)
1938	Maine, New Hampshire Pennsylvania	7 2	Barbour's Creek (Craig) Little Stony Creek (Giles)

2. PORCUPINE

Erethizon dorsatum dorsatum Linnaeus

Phylum: Chordata
 Class: Mammalia

Order: Rodentia
 Family: Erethizontidae

Distribution: The species occupies most of forested North America from the edge of the tundra to northern Mexico, but it is absent from the southeastern United States (Woods, 1973). The eastern subspecies, *Erethizon dorsatum dorsatum*, originally occurred south to Maryland (Mansueti, 1950), Virginia (Handley and Patton, 1947), West Virginia (McKeever, 1952), Tennessee (Kellogg, 1939b; Parmalee and Guilday, 1966), Alabama (Barkalow, 1961; Parmalee, 1963), and Indiana (Mumford, 1969). The Alabama and Tennessee records are from Indian sites, dated 6500-1000 B.C. The present limits of distribution of *Erethizon dorsatum dorsatum* are Quebec, Nova Scotia, Pennsylvania, Michigan, and Minnesota west to Alberta and the Mackenzie River, and north to the limit of trees.

Former Distribution in Virginia: Certainly the porcupine occurred at least in the mountainous portions of Virginia as late as the 18th Century and possibly later. In 1739, John Clayton of Gloucester County wrote: "...there has been two Porcupines killed here, but they are very scarce." Whether this refers to a locality in Virginia or to one in what is now West Virginia is not known. However, at such an early date, a Virginia locality is more likely (Handley and Patton, 1947).

A more precise Virginia reference came from Francesco Arese, who in 1837-38 made a trip to the interior of North America: "Between Charlottesville and Staunton I made a detour, leaving the stagecoach route to visit Weyer's Cave and the New Cave. The cave, or grotto, called Weyer's was discovered by him by chance while he was hunting a porcupine" (Evans, 1934). Weyer's Cave is in Augusta County, 14 miles northeast of Staunton.

Causes of Extirpation: Why the porcupine has disappeared from the Southern Appalachians is not clear. Suitable food plants are present and human persecution cannot have been more severe than in the West, where it occurs much farther south into Mexico. The sparcity of references to the porcupine in the Southern Appalachians in colonial times suggests that it was already uncommon or rare in the Southeast even at that early date.

Post-Extirpation Events: Today the southern limit of the range of the porcupine in the Appalachians is south-central Pennsylvania (Doutt *et al.*, 1966). It occasionally wanders farther south, to western Maryland (Alleghany County: Mansueti, 1940), and West Virginia (Cranberry Summit, Preston County: Goode, 1878; Monongalia County: McKeever, 1952; Spruce Knob, Pendleton County: Kellogg, 1937). There is no recent record for Virginia.

Author: Charles O. Handley, Jr.

3. GRAY WOLF

Canis lupus lycaon Schreber

Phylum: Chordata
 Class: Mammalia

Order: Carnivora
 Family: Canidae

Distribution: The species was widely distributed in Eurasia and was found in North America from the northernmost land to central Mexico (except in the southeastern United States, where it was replaced by the red wolf). The range of the subspecies *Canis lupus lycaon* formerly included southeastern Canada (Maritime Provinces, southern Quebec, and most of Ontario) and the northeastern United States (New England to eastern Minnesota and Illinois, and south an indeterminate distance). Remnant populations of this subspecies now occur in the Upper Peninsula of Michigan, northern Wisconsin, northeastern Minnesota, and Canada north of the Great Lakes and the Saint Lawrence Estuary (Mech, 1974).

Former Distribution: The gray wolf was statewide in distribution.

Causes of Extirpation: Wolves were found throughout the state when European colonists arrived, and most early accounts of Virginia mammals noted that they were abundant. Substantial bounties were paid for their extermination, and they were relentlessly hunted and trapped. Wolf populations dwindled as settlement advanced, and by the 1880's, few wolves survived in Virginia. The last was killed on Clinch Mountain in Tazewell County in the winter of 1909-10 (Handley and Patton, 1947; Handley, in press).

Post-Extirpation Events: Recent reports of wolves in Virginia all refer to wild dogs or coyotes. There are no remaining wild areas of sufficient extent in the state to support wolves.

Author: Charles O. Handley, Jr.

* * * * *

4. MANATEE (Figure 35)

Trichechus manatus latirostris
Harlan

Phylum: Chordata
 Class: Mammalia

Order: Sirenia
 Family: Trichechidae

Distribution: The species formerly occurred along the shores and rivers of the Gulf of Mexico, the West Indies, all around the Caribbean, south to Guiana and Brazil, and north to Georgia and occasionally to North Carolina and Virginia. Its populations are now reduced or it is *Extirpated* in much of its former range. Distribution of the subspecies has not been clearly delimited (Husar, 1978).

Former Distribution in Virginia: There is no evidence that the manatee was ever more than an accidental summer wanderer to Virginia waters. Only two instances of its occurrence here are known. McAtee (1950) quoted a passage from the *Philosophical Transactions of the Royal Society of London*, 20 June 1676, by Thomas Glover, describing an animal which may have been a manatee that he saw in the Rappahannock River, about 10 miles above its mouth:

"And now it comes into my mind, I shall here insert an account of a very strange Fish or Monster, which I happened to see in Rap-han-nock River about a year before I came out of the Country; the manner of it was thus:

"As I was coming down the forementioned River in a Sloop bound for the Bay, it happened to prove calm; at which time we were three leagues short of the rivers mouth; the tide of ebb being then done, the sloopman dropped his grap-line, and he and his boy took a little boat belonging to the sloop, in which they went ashoar for water, leaving me aboard alone, in which time I took a small book out of my pocket and sate down at the stern of the vessel to read; but I had not read long before I heard a great rushing and slashing of the water, which caused me suddenly to look up, and about a half a stones cast from me appeared a most prodigious Creature, much resembling a man, only somewhat larger, standing right up in the water with his head, neck, shoulders, breast, and wast, to the cubits of his arms, above water; his skin was tawny, much like that of an Indian; the figure of his head was pyramidal, and slick, without hair; his eyes large and black, and so were his eyebrows; his mouth very wide, with a broad, black streak on the upper lip, which turned upwards at each end like mustaches; his countenance was grim and terrible; his neck, shoulders, arms, breast and wast, were like unto the neck, arms, shoulders, breast and wast of a man; his hands, if he had any, were under water; he seemed to stand with his eyes fixed on me for some time, and afterward dived down, and a little after riseth at somewhat a farther distance, and turned his head towards me again, and then immediately falleth a little under water, and swimmeth away so near the top of the water, that I could discern him throw out his arms, and gather them in as a man doth when he swimmeth. At last he shoots with his head downwards, by which means he cast his tayl above the water, which exactly resembled the tayl of a fish with a broad fane at the end of it."

Allowing for Glover's being in a strange land, where he knew not what to expect, this description suggests very strongly that he saw a Manatee. The only other known stray to Virginia waters was reported by the *Washington Post* 23 September 1908:

"LIVE SEA COW CAPTURED. Manatee caught in seine of fishermen off Ocean View, Va., Sept. 22.--A live sea cow, or manatee, weighing 1,500 pounds, was hauled ashore today at Ocean View in the seine of the J. H. Parkerson fishery. The fishermen succeeded in getting the manatee alive in a pen, where it is being kept as a curiosity."

This event was also reported in *Forest & Stream* (71:532, 1908), and indirectly by Nelson (1918) and Handley and Patton (1947).

Campbell (1977) reported the manatee to be "...only an occasional seasonal visitor to North Carolina waters" but he suggested that "...the present paucity of data on this animal in North Carolina results more from lack of attention than lack of Manatees." Smith *et al.* (1960) listed North Carolina manatees from Wrightsville Beach, New Hanover County; Beaufort, Carteret County; and Currituck Sound, Currituck County. Brimley (1931) reported that the first of these was taken in Masonboro Sound on 11 September 1919, and Brimley (1945) reported that the latter was caught near Duck Island about the middle of October, 1934.

In view of the apparent rarity of the manatee on the Atlantic Coast north of Florida and its plight throughout its range, the changes of its ever being seen again in Virginia waters are slim. Consequently, it is regarded as *Extirpated* from this area.

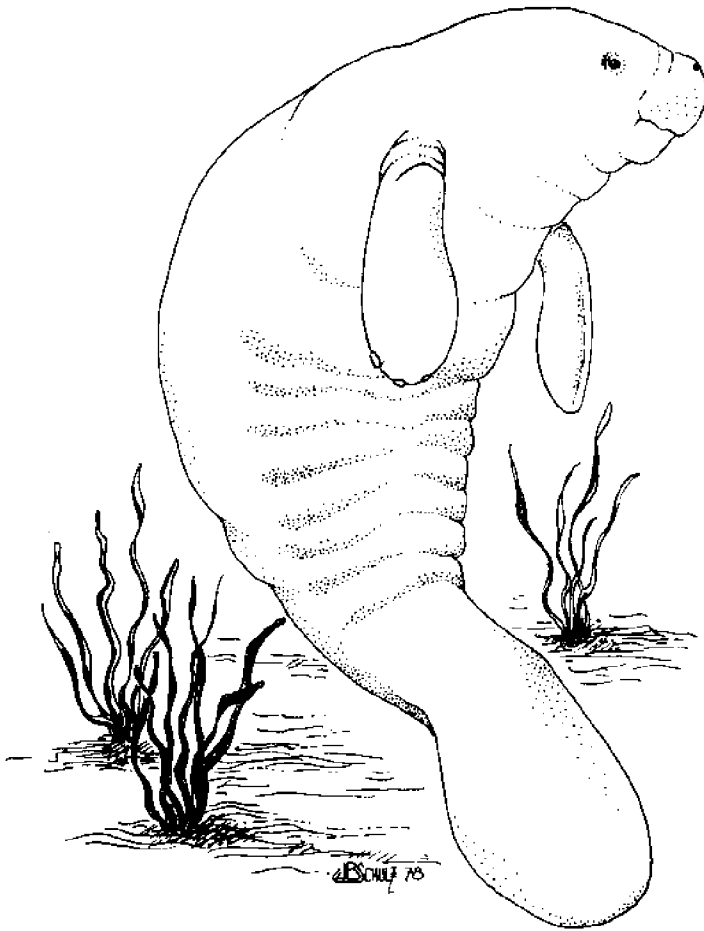


Figure 35. Manatee (*Trichechus manatus*)

Causes of Extirpation: In the warmer parts of its range, where it is a year-round resident, the manatee has been killed for human consumption, particularly in Latin America; drowned in fish nets; removed from the water because of its curious form; and shot simply because it is a large target. Accidental or purposeful harassment and wounding by power boats has been a significant cause of mortality in recent years. Very little of the manatee's habitat remains undisturbed, and its populations have dwindled alarmingly. The source of individuals which might wander into Virginia waters is going or gone.

Post-Extirpation Events: The manatee has been listed as *Endangered* by the U.S. Fish and Wildlife Service, and considerable effort is being made in Florida and in Latin America to save it. Elsewhere, as in Virginia where waters are too cold in the winter for it to be a resident, its plight should be well advertised so that strays will be recognized and protected.

Author: Charles O. Handley, Jr.

5. AMERICAN ELK

Cervus elaphus canadensis Erxleben
Cervus elaphus nelsoni V. Bailey

Phylum: Chordata
 Class: Mammalia

Order: Artiodactyla
 Family: Cervidae

Distribution: The species formerly occurred from coast to coast and from northern British Columbia, northern Ontario and New York south to South Carolina, Louisiana, New Mexico, and California. The eastern part of this range, east of the Rocky Mountains, was occupied by the now extinct subspecies, *cervus elaphus canadensis*.

Former Distribution in Virginia: When the Europeans arrived, the elk may have had an almost statewide distribution. Thomas Hariot apparently encountered only white-tailed deer along the coast in 1585. On the other hand, George Percy, writing in 1607, implied that both elk and white-tailed deer were found along the lower James River: "[There are] great store of Deere both Red and Fallow." On a visit to Tidewater Virginia in 1686, John Clayton found an "abundance of brave Red Deer," but by "Red Deer" he evidently meant white-tail, since he distinguished the "Elke" which he said occurred "beyond the Inhabitants." Writing in 1705, Beverly stated that it was necessary to go inland to the "Frontier Plantations," i.e., to the Piedmont, to find elk, and in 1739, another John Clayton wrote that elk could be found only "among the mountains and desert parts of the country where there are as yet but few inhabitants." Thomas Jefferson observed in 1781 that "in Virginia the elk has abounded much, and [still] exists in smaller numbers." The last native elk may have been killed in Clarke County in 1855 (Handley and Patton, 1947; Handley, in press).

Causes of Extirpation: The fact that elk congregated in herds may have led early writers in Virginia to overestimate its abundance. Like the bison, it may have been most numerous in the vicinity of infrequent natural openings and thus more vulnerable to hunting than the more widely distributed white-tailed deer. The meat and hide of the elk were useful to the European settlers in Virginia. Apparently they were relentless in their quest for the animal and soon hunted it to extinction.

Post-Extirpation Events: The Game Commission was determined to restore the elk to Virginia, and in 1917, imported 110 animals of the subspecies *Cervus elaphus nelsoni* from Yellowstone National Park. These were released in Russell, Washington, Bland, Giles, Pulaski, Montgomery, Roanoke, Botetourt, Warren, Cumberland, and Princess Anne counties. Not surprisingly, the Cumberland and Princess Anne releases failed, but those in the mountains did well, and by 1922 the elk population in Virginia was estimated at about 300 individuals. Already the Game Commission was saddled with numerous claims of elk damage to crops, primarily corn. This was a dilemma that would plague the Game Commission as long as the Yellowstone elk survived in Virginia. The Commission responded by opening a fifteen-day hunting season on bull elk. This was cut to three days, but by 1926 the elk had been reduced to two heads, one in Giles and Bland counties and the other in Botetourt County.

More elk from Yellowstone arrived in 1935. Six were added to the Botetourt-Bedford herd and 37 to the Giles-Bland herd. A 1940 estimate placed the Giles-Bland herd at about 100 animals, and the Botetourt-Bedford herd at 25. The annual three-day elk hunt continued until 1944, when crop losses to elk caused the Game Commission to attempt another herd reduction. It set a four-day season in which any elk, regardless of age or sex, was legal. More than sixty elk were killed. However, the Giles-Bland population rebounded

When the elk was reestablished in the Giles-Bland and Botetourt-Bedford ranges there were no white-tailed deer there. They had been *Extirpated* in the late 1800's. A total of 85 white-tailed deer were released in the Giles-Bland range during 1950-1956, and they thrived. Other releases had already established a deer population in the Botetourt-Bedford range. Later it was learned that these deer were infested with a nematode parasite, *Pneumostroylus tenuis*, which invades the lungs, brain and spinal cord. In 1963, 85 percent of the deer checked in Giles and 78 percent of those checked in Botetourt carried this round worm. It is lethal to elk. The first evidence of it in the Giles-Bland elk was found in 1958, and in the Botetourt-Bedford elk in 1962. The herds were doomed. The last elk was seen in the Botetourt-Bedford range in 1970, and in the Giles-Bland range in 1974. *Cervus elaphus nelsoni* has been *Extirpated* in Virginia. Once again there are no elk. (Handley and Patton, 1947; Gwynn, pers. comm., 1978; Coggin, pers. comm., 1978).

Author: Charles O. Handley, Jr.

* * * * *

6. BISON

Bison bison bison Linnaeus

Phylum: Chordata
Class: Mammalia

Order: Artiodactyla
Family: Bovidae

Distribution: This subspecies formerly occurred on the Great Plains of north-eastern Mexico, United States and Canada, and east (south of the Great Lakes) to New York, Virginia, and Florida. It is now extinct in the wild. Another subspecies occurs in the forested area south of Great Slave Lake in north-western Canada.

Former Distribution in Virginia: The bison was first encountered by Coronado's exploring party in central Kansas in 1541 (Hershkovitz, 1957). Much later, in 1613, Sir Samuel Argoll found it for the first time in the forested East near the head of navigation on the Potomac River, possibly in Fairfax County, Virginia. Subsequently, there were numerous mentions in colonial literature of its occurrence in the interior of Virginia. Judging by these writings and by the distribution of place names of which "buffalo" is a part, the bison must have been widespread in Virginia, but probably did not occur in the coastal plain when the Europeans arrived (Handley and Patton, 1947).

Causes of Extirpation: The bison may have had a limited distribution in the forested East. In Virginia it was evidently found most often where there were natural openings with pasturage in the Piedmont and in the Shenandoah Valley. Its palatability was great but its numbers apparently were small and it was soon *Extirpated*. The last bison in this area are said to have been killed by Nathan Boone, a son of Daniel Boone, on the Kanawha River (West Virginia) in 1793; on New River (Virginia or West Virginia) in 1797; and on the Big Sandy River (Kentucky or West Virginia) in 1798 (Handley and Patton, 1947).

Post-Extirpation Events: Although the plains bison (*Bison bison bison*) is extinct in the wild, it thrives in captivity. There now are large numbers, including quite a few in Virginia, in fenced enclosures. Because of its penchant for migratory movements, it would be impractical to attempt to reestablish the bison as a wild mammal in Virginia.

Author: Charles O. Handley, Jr.

The Untroubled Fauna

Charles O. Handley, Jr.

Fortunately, most Virginia mammals are too abundant to fit any of the categories considered in this symposium. It can be assumed that most species not included in the foregoing accounts are at least uncommon and may be common to abundant within the state. Many of these commoner species thrive in disturbed habitats, and some such as opossum, short-tailed shrew, cottontail, gray squirrel, meadow vole, and white tailed deer actually may be more abundant now than they were four hundred years ago when the first European settlers arrived.

A few species omitted from consideration as *Endangered*, *Threatened*, etc., require special explanation. They have been thought by some authors to warrant inclusion among the rarer Virginia mammals.

1. Dismal Swamp short-tailed shrew, *Blarina telmalestes* Merriam. Until recently this short-tailed shrew was regarded as a relict, endemic in the Dismal Swamp. Actually it is common to abundant in southeastern Virginia and northeastern North Carolina, is not confined to the Dismal Swamp, and is a subspecies of the widespread and abundant *Blarina brevicauda* Say (Handley, 1971, Handley, in press).
2. Eastern long-eared myotis, *Myotis keenii septentrionalis* Troussart. Statewide in distribution. Although uncommon, the long-eared myotis makes up 35-50 percent of late summer populations of *Myotis* in Virginia caves.
3. Small-footed myotis, *Myotis leibii leibii* Audubon and Bachman. Wide-spread but uncommon in the Appalachians, the small-footed myotis once was thought to be rare in Virginia. Actually it makes up about 15 percent of the late summer populations of *Myotis* in Virginia caves. Because it roosts in rock falls on cave floors and under loose boulders outside of caves, it is not as often seen as species that hang exposed on cave walls and ceilings.
4. Silver-haired bat, *Lasionycteris noctivagans* LeConte. Tree hole roosts are favored by the silver-haired bat. It is known in Virginia as an uncommon migrant. There are no summer records.
5. Hoary bat, *Lasiurus cinereus cinereus* Palisot de Beauvois. The hoary bat roosts in foliage. It is known in Virginia as an uncommon migrant. There are no summer records.
6. Yellow bat, *Lasiurus intermedius floridanus* Miller. This bat roosts in Spanish moss, *Tillandsia usneoides*, in Gulf Coast and South Atlantic states north to Charleston, South Carolina. A male found at Westfield, New Jersey, 16 Oct. 1964, was a wanderer outside the normal range of the species (Barbour and Davis, 1969). A pregnant female taken at Willoughby Beach, near Norfolk, Virginia, 8 May 1954, may also have been a wanderer, but this is not certain (Rageot, 1955). Willoughby Beach is near the northern limit of Spanish moss, and it is possible that a breeding population of the yellow bat occurs that far north. For the present, however, it seems best to regard this bat as an accidental vagrant in Virginia.
7. Black-tailed jack rabbit, *Lepus californicus* Gray. This species is the most widespread and abundant of the jack rabbits. It occurs naturally over much of the western United States and northern Mexico and has been introduced at several

- places in the eastern United States. According to Clapp *et al.* (1976), six adult and two young jack rabbits from Kansas were released on Cobb Island, Northampton County, Virginia, about 1960, probably for sport shooting. Subsequently this hare has become established on Cobb Island and has been observed on Rogue and Hog islands to the north, on Little Cobb to the south, and on Castle Ridge to the west. Whether it is actually established on islands other than Cobb is unknown. Since these islands have come into the possession of The Nature Conservancy, hunting has ceased. Inasmuch as it is liable to become more widespread, there should be some concern over the effect of the jack rabbit on the native biota.
8. Red-backed vole, *Clethrionomys gapperi maurus* Kellogg. This rich, dark-colored subspecies, prone to melanism, has a limited distribution in southwestern Virginia and eastern Kentucky. It has been found in Bell and Harlan counties, Kentucky, at elevations of 2200 to 4150 feet (Kellogg, 1939a; Barbour, 1951; Davis, pers. comm., 1978). Because of habitat destruction by strip mining, it has been proposed for inclusion on the list of *Endangered* species in Kentucky (Davis, pers. comm., 1978). It is more widespread in Virginia, with specimens from Cumberland Gap National Historical Park, 2700 feet, Lee County (Davis, pers. comm., 1978); Black Mountain, 3600 feet and Roaring Branch, 1600 feet, 1 mile north of Big Stone Gap, Wise County (Howell, 1909; Hooper and Cady, 1941); and Clinch Mountain (Laurel Bed, 3600 feet and Mutter's Gap, 4200 feet), Russell County (USNM specimens). The red-backed vole is abundant on Clinch Mountain, and probably elsewhere in southwest Virginia where there is suitable cool, montane talus.
 9. Cotton rat, *Sigmodon hispidus virginianus* Gardner and *Sigmodon hispidus longreki* Gardner. Unknown in Virginia until it was collected in Mecklenburg County in 1940 (Patton, 1941), the cotton rat is rapidly expanding its range northward. It is now abundant all across the southern portion of the state, from the Dismal Swamp (Meier, pers. comm., 1976, and USNM specimens) almost to Cumberland Gap, Lee County (USNM specimens, 1962), and north to a point north of the James River in Henrico County (Pagels, 1977).
 10. Coyote, *Canis latrans* Say. Historically, the coyote has been a mammal of the Great Plains and the West. Within this century it has invaded the East (Bekoff, 1977). Since 1900 it has moved eastward through the Great Lakes region to occupy all of Ontario and southern Quebec, New York (current population estimate 10,000 to 15,000), and New England. Now it is moving south through Pennsylvania, and there are a few records for West Virginia. Another invasion from the Southwest came into Louisiana about 1950 and has reached Florida, Georgia and Tennessee (Nowak, pers. comm., 1978). The coyote has been reported several times in Virginia, but to date all of these records have pertained to coyote-like dogs or to coyotes that had been released in Virginia (Coggin, pers. comm., 1978). Apparently the coyote cannot at present be considered to be a member of the Virginia fauna, although it may be only a matter of time until it will reach this state.
 11. Marten, *Martes americana americana* Turton. A number of publications have suggested that the marten once occurred in Virginia. However, I have not found any evidence to substantiate its former occurrence south of Pennsylvania. See Hagemeyer (1957) for a summary of distributional information.

The Marine Fauna

Charles W. Potter

Virginia's marine mammal fauna includes 17 species of cetaceans in five families, two species of seals, and one sirenian. At least nine other species, one family of cetaceans and two other seals occur in Virginia waters¹ but have not been reported. The records presented in the following text and tables are from published accounts, records compiled by the Scientific Event Alert Network (SEAN) of the Smithsonian Institution, and specimens in the U.S. National Museum of Natural History (USNM).

Many marine mammals are thought to be *Rare* or *Endangered*. However, they hardly can be said to be *Endangered* in the waters of Virginia, nor is there much that Virginia can do individually on their behalf. They are *Endangered* in the ocean at large and all of the states collectively must protect them. That is the rationale of the Marine Mammal Protection Act. The individual states can document the occurrence of marine mammals in their waters and can make their citizens aware of them. That is the value of this paper.

Our knowledge of the marine fauna stems largely from strandings, not always an accurate record of the diversity and abundance of marine mammals. Some stranding records represent strays and not members of the regular fauna. It should also be recognized that the stranding frequency of a species (*i.e.*, the number of strandings of a particular species in a given period of time) is dependent upon a number of factors: (1) The accident of discovery. Unless there is a systematic watch, most strandings go undiscovered. (2) Not all strandings are reported in the literature. More exotic or rare species are reported more often than those that are common. (3) Species that inhabit inshore habitats strand more often than those that live offshore. (4) Some that are difficult to identify have been synonymized until recently with more common taxa (*i.e.*, the short-snouted, striped dolphin, *Stenella clymene*, and the dwarf sperm whale, *Kogia simus*).

Whales, Dolphins, and Porpoises

Family Ziphiidae

Beaked whales (Table 13)

Only two species (dense-beaked whale, *Mesoplodon densirostris* Blainville and goosebeaked whale, *Ziphius cavirostris* G. Cuvier) of this little-known family have been found in Virginia. Two additional species of beaked whales which must occur in Virginia waters but which are not represented in the stranding record are the Antillean beaked whale (*Mesoplodon europaeus* Gervais) and True's beaked whale (*Mesoplodon mirus* True). Virtually nothing is known about the natural history of beaked whales except that they are offshore animals that feed primarily on cephalopods. Because of their rarity and the lack of knowledge about this group, any encounters with them should be recorded with as much detail as possible and reported to qualified workers immediately.

¹In this account, Virginia waters include Chesapeake Bay adjacent to Virginia, the coves and bays formed by the barrier island system, the coastal waters, and the offshore waters to the Gulf Stream.

Family Physeteridae

Sperm whales (Table 14)

All three living members of the family Physeteridae are found in Virginia waters. They are the sperm whale, *Physeter catodon* Linnaeus; pygmy sperm whale, *Kogia breviceps* Blainville; and dwarf sperm whale, *Kogia simus* Owen. The stranding of pregnant females and calves of all three species indicates that Virginia waters host these animals at or about the time calving occurs. Although the sperm whale has been recorded only twice while the pygmy sperm whale and dwarf sperm whale have been reported four times each, it should not be assumed that sperm whales are less abundant than *Kogia*. The offshore habits of *Physeter* are probably responsible for its lower stranding frequency.

Family Delphinidae

Dolphins (Table 15)

The Delphinidae or dolphin family is the largest among the living cetaceans. It is also the group occurring most commonly in the Virginia stranding record. The dolphin species which have stranded in Virginia are the rough-toothed dolphin, *Steno bredanensis* Lesson; striped dolphin, *Stenella coeruleoalba* Meyen; saddleback dolphin, *Delphinus delphis* Linnaeus; grampus, *Grampus griseus* G. Cuvier; bottlenosed dolphin, *Tursiops truncatus* Montague; Atlantic white-sided dolphin, *Lagenorhynchus acutus* Gray, short-finned pilot whale, *Globicephala macrorhyncha* Gray; and long-finned pilot whale, *Globicephala melaena* Traill. The only occurrence of Atlantic white-sided dolphins in Virginia was on 27 May 1978 (USNM 504764). This should be considered a stray as white-sided dolphins are cold temperate cetaceans.

The false killer whale, *Pseudorca crassidens* Owen, has been observed at sea off the coast of Maryland, but the only stranding record for this cetacean north of North Carolina is a specimen (USNM 11320) which is listed in the museum records as received from the Nantucket Athenaeum around 1870. The locality for this specimen is recorded as "N.E. Coast." It is impossible to determine whether this specimen was actually collected on the New England (or Northeast) coast. There is a reasonable chance that it was collected farther south and donated to the Nantucket Athenaeum by New England whalers.

The bottlenosed dolphin is by far the most common cetacean in the waters of Virginia and in the stranding record. (Because of the large number of records, individual *Tursiops* strandings are not presented in tabular form.) Its predominance in the stranding record (approximately 2/3 or 45 of 69 delphinid records) reflects the abundance and inshore habitat of the bottlenose. These dolphins are reported to have stranded in Virginia waters in all seasons, but it is generally recognized that they regularly occur in Virginia waters only during the summer months. Records of bottlenosed dolphins stranded here in the winter reflect strays or abnormal distribution of this species. *Tursiops* are thought to arrive off Virginia in late spring and to leave these waters sometime in late fall. At present there are not enough data to accurately predict their seasonal movements.

The only dolphin to mass-strand in Virginia is the rough-toothed dolphin, *Steno bredanensis*. In October 1976, 13 *Steno* stranded at Sandbridge, Virginia (two others stranded just across the North Carolina border at the same time). Both species of pilot whales, *Globicephala melaena* and *Globicephala macrorhyncha*, mass-strand but are only known from single strandings in Virginia. The only other cetaceans known to mass-strand and which occur off Virginia are the sperm whale, Atlantic white-sided dolphin, and false killer whale.

Dolphins that probably occur off Virginia but are yet to be represented in the stranding record are the short-snouted striped dolphin, *Stenella clymene* Gray; spotted dolphin, *Stenella plagiodon* Cope; and killer whale, *Orcinus orca* Linnaeus. These species have stranded north and south of Virginia and must be at least occasional visitors in Virginia's waters.

Family Phocoenidae

Porpoises (Table 16)

The harbor porpoise, *Phocoena phocoena* Linnaeus, is the only member of the Phocoenidae found in the North Atlantic. It is a more northern cetacean and should be regarded as no more than an occasional visitor to Virginia's waters. Recent data suggest that harbor porpoises found off Virginia and farther south are predominantly yearlings and are most commonly found in these waters during severe winters such as that of 1976-77, when a large number stranded in North Carolina over a three-month period.

Families Balaenopteridae
and Balaenidae

Baleen whales (Table 17)

Of the six species in the family Balaenopteridae, four have been recorded from Virginia in the stranding record: minke whale, *Balaenoptera acutorostrata* Lacépède; Bryde's whale, *Balaenoptera edeni* Anderson (The only specimen of the Bryde's whale from Virginia has been reported extensively in the literature as a sei whale. This error has been corrected by Mead [1977]); fin whale, *Balaenoptera physalus* Linnaeus; and humpback whale, *Megaptera novaeangliae* Borowski. Of this group, the fin whale is the most common (8 records) and humpback the second most common (? records). Minke whale and Bryde's whale are represented by one record each. Neither the sei whale, *Balaenoptera borealis* Lesson, nor the blue whale, *Balaenoptera musculus* Linnaeus, is present in the stranding record but both have been found stranded north and south of Virginia and should be considered part of Virginia's cetacean fauna. The absence of these two species, as well as the northern right whale, *Eubalaena glacialis* Muller, reflects the failure of the stranding record to represent the cetacean fauna rather than the actual absence of whales.

Seals and Sealions

Family Phocidae

Earless seals

The seal fauna of Virginia is limited. The only species to occur regularly in Virginia waters is the harbor seal, *Phoca vitulina* Linnaeus. Harbor seals are reported each winter as far south as North Carolina, but records south of New Jersey are almost without exception yearlings. It appears that adults do not normally move farther south than Long Island. The only other Atlantic pinniped that has been reported as stranding in Virginia is the harp seal, *Phoca groenlandica* Erxleben (Goodwin, 1954).

The hooded seal, *Cystophora cristata* Erxleben, has been reported from Maryland (Cope, 1865) and North Carolina (C. S. Brimley, 1945; Goodwin, 1954; and Moore, 1953), but not from Virginia. However, its presence in Maryland and North Carolina establishes the possibility of its being found in Virginia waters. Both the harp and hooded seals are extreme vagrants and most assuredly not part of the normal fauna of Virginia. Another pinniped that on rare occasions may be found as far south as Virginia is the gray seal, *Halichoerus grypus* Fabricus. Gray seal pups have been reported in southern New Jersey in fall and winter the past few years and should be watched for as possible strays in Virginia waters at those seasons.

Family Otariidae

Eared seals

Any feral California sea lion, *Zalopus californianus* Lesson, found along the Virginia coast should not be confused with the marine mammal fauna of Virginia. It would have escaped or been released from display facilities.

Sea Cows (Sirenians)

Family Trichechidae

Manatees

The only Virginia specimen of Sirenia was a West Indian manatee, *Trichechus manatus* Linnaeus, captured off Ocean View, Virginia, on 22 September 1908 (Forest and Stream 71:532, 1908; Nelson, 1918; Handley and Patton, 1947).

Table 13. Virginia Records of Ziphiidae

Location	Date	Sex	Length (cm)	Source
Dense-beaked whale				<i>Mesoplodon densirostris</i>
Assawoman Island	30 Sep 1973	?	?	USNM 484996
Goosebeaked whale				<i>Ziphius cavirostris</i>
False Cape	28 Aug 1944	F	cir. 680	USNM 276656
Parramore Island	?	?	?	USNM 395713

Table 14. Virginia Records of Physeteridae

Location	Date	Sex	Length (cm)	Source
Sperm whale				<i>Physeter catodon</i>
Fishermans Island	27 Dec 1977	?	366	SEAN 2432
Green Run Inlet	Dec 1891	F	?	Paradiso (1969)*
*This whale has been reported for both Virginia and Maryland since Green Run Inlet (no longer in existence) was on the Virginia-Maryland boundary.				
Pygmy sperm whale				<i>Kogia breviceps</i>
Bavon Beach	12 Apr 1974	F	237	USNM 504001
Capohosic	23 Oct 1975	M	316	USNM 504314
Virginia Beach	12 Dec 1975	F	260	USNM 504319
Dam Neck Mills	Feb 1887	M	?	Piers (1923) Allen (1941) Bailey (1946) Handley & Patton (1947)
Dwarf sperm whale				<i>Kogia simus</i>
Sandbridge	Oct 1956	?	?	USNM 304512
Assateague Island	15 May 1978	M	213	USNM 504759
False Cape	?	?	?	Handley (1978)
Cape Henry	21 Apr 1939	1M 1F	? (calf) 221	Allen (1941) Barbour (1943) Bailey (1946)

Table 15. Virginia Records of Delphinidae

Location	Date	Sex	Length (cm)	Source
Rough-toothed dolphin				<i>Steno bredanensis</i>
Sandbridge	12 Oct 1976	8M	204-233	USNM 504486-504497
Norfolk	18__	?	?	Handley & Patton (1947) Moore (1953)
Striped dolphin				<i>Stenella coeruleoalba</i>
Virginia Beach	1939	?	?	Bailey (1946) Barbour (1943)
Chincoteague	18 Apr 1977	?	221	SEAN 2216
Chincoteague Point	11 May 1978	M	176	SEAN
Chincoteague Point	11 May 1978	?	?	SEAN
Saddleback dolphin				<i>Delphinus delphis</i>
Assateague Island	3 Apr 1970	?	?	USNM 395923
Back Bay National Wildlife Refuge	16 May 1977	?	204	SEAN 2237
Cobb Island	?	?	?	USNM 22528
Dam Neck Mills	?	F	?	USNM 22560
Parramore Island	13 Jan 1976	M	236	USNM 504323
Parramore Island	?	?	?	Bailey (1946) Handley & Patton (1947) USNM 21732
Grampus				<i>Grampus griseus</i>
Assateague Island	Nov 1973	M	298	USNM 504126
Assateague Island	30 Nov 1974	F	280	USNM 504131

(continued)

Location	Date	Sex	Length (cm)	Source
Atlantic white-sided dolphin				<i>Lagenorhynchus acutus</i>
Assateague Island	27 May 1978	F	238	USNM 504764
Short-finned pilot whale				<i>Globiocephala macrorhyncha</i>
Cape Henry	18__	?	?	USNM 21752
Dam Neck Mills	1887	?	?	Handley and Patton (1947)
Parramore Island	1957	?	?	Handley (pers. comm., 1978)
Long-finned pilot whale				<i>Globiocephala melana</i>
Assateague Island	May 1956	?	505	Paradiso (1958) USNM 303018
Assateague Island	30 July 1973	?	425	USNM 484974
Chincoteague Island	Feb 1937	?	?	USNM 261110
Dam Neck Mills	?	M	?	USNM 22561
Parramore Island	?	?	?	USNM 395712
Smith Island	3 July 1935	?	?	USNM 259706

Table 16. Virginia Records of Phocoenidae

Location	Date	Sex	Length (cm)	Source
Harbor porpoise				<i>Phocoena phocoena</i>
Assateague Island	1 Apr 1977	F	153	SEAN 2214
Metomkin Island	?	?	?	USNM 504120
Ocean View	13 Apr 1976	F	103	USNM 504342

Table 17. Virginia Records of Balaenopteridae

Location	Date	Sex	Length (cm)	Source
<i>Balaenoptera acutorostrata</i>				
Minke whale				
Onancock	28 July 1977	M	422	USNM 504674
<i>Balaenoptera edeni</i>				
Bryde's whale				
Walnut Point	18 Mar 1923	M	800	USNM 239307 Miller (1927) Bailey (1946) Handley & Patton (1947) Kellogg (1928) Mead (1977)
<i>Balaenoptera physalus</i>				
Fin whale				
Cedar Island	8 Oct 1976	M	530	USNM 504485
Cobb Island	16 Apr 1976	F	658	USNM 504344
Cobb Island	188_	?	2100	Handley & Patton (1947)
Little Creek	3 Apr 1947	?	cir. 1800	Bailey (1948)
Mobjack Bay	11 Aug 1858	M	1400	True (1904)
Portsmouth	3 Apr 1947	M	1636	USNM 504070
<i>Megaptera novaeangliae</i>				
Humpback whale				
Virginia Beach	25 Feb 1975	F	1800	USNM 504216
"taken in Virginia"	?	M&F	?	Stone (1908) Bailey (1946)

The Changing Scene

John F. Pagels

It is well established that the plants and animals present on earth today represent but a small fraction of all the forms that have ever existed. We know also that a number of kinds of mammals have disappeared from Virginia since European settlement and that the ranges and presumably the abundance of many other forms have changed in this same relatively short interval.

A variety of factors has led to the changes; indeed in most cases a combination of factors has led to the demise of some kinds and the present success of others. First, in our discussions and thoughts of sensitive biota we must not lose sight of natural forces that have influenced the mammalian fauna of Virginia. Numerous large mammals became extinct in late Pleistocene and in early historic times, and the ranges of many recent mammals have shifted northward. Guilday (1971) and Handley (1971), respectively, provided reviews of Pleistocene and Recent mammals of the southern Appalachians. On the other hand, post-Pleistocene to Recent climatic shifts and concomitant faunal and flora shifts aside, we cannot help but be impressed by the influences, both direct and indirect, that man has had in this scheme.

This paper discusses 38 species of mammals that in some way have evidenced the changing composition of the mammalian fauna of Virginia. Sixteen of the species perhaps represent "the other side of the coin" of what has been discussed at this symposium. What I hope to develop is that although the composition of Virginia mammals has changed, the absolute number of kinds of mammals in Virginia is the same or possibly greater than "a few years ago." Secondly, I will briefly examine and conjecture on some of the forces that have precipitated these changes.

In the discussions that follow I have slightly manipulated certain check lists of Virginia mammals, including the published work of Handley and Patton (1947) and unpublished lists of Joseph R. Merritt and one of my own. I have included in my discussion the yellow-nosed vole, *Microtus chrotorrhinus*, and the coyote, *Canis latrans*. The former has undoubtedly occurred in Virginia in post-Columbian times but there are no records. Conversely, the coyote, if not already present, is on the verge of entering Virginia, but again there are no documented records. Except for the prairie deer mouse, *Peromyscus maniculatus bairdii*, which is treated herein as a separate "species," all compilations relating to numbers of mammals of Virginia refer to whole species.

If we were to go back about 400 years to when the first Europeans were reaching the shores of Virginia, a complete list of the biota of Virginia would have included 71 species of native terrestrial mammals. As time went by, a total of nine species were lost, some of which formerly had statewide distributions. An examination of a 1978 list does not reveal 62 species, but instead, a nearly startling 74 species. What happened? Figure 36 presents a chronology of change in the number of species.

Figure 37 depicts the ranges of 22 species of mammals that are known or thought to have occurred in Virginia within historic times as well as several kinds whose ranges have been greatly reduced. Three of the species -- the beaver, *Castor canadensis*; gray wolf, *Canis lupus*; and mountain lion or puma, *Felis concolor* -- once had statewide distributions but were extirpated. The elk, *Cervus elaphus*, and bison, *Bison bison*, were apparently once common west of the Coastal Plain. The black bear, *Ursus americanus*, and the bobcat, *Felis rufus*, are still supposedly relatively

common where they are found but no longer enjoy a statewide distribution. The star-nosed mole, *Condylura cristata*, is still statewide but has become localized in distribution.

Most of the other species in Figure 36 had limited ranges throughout historic times. Natural forces may have been of importance in reducing the ranges of some of these species, but the encroachment of man and subsequent habitat modification and other activities have certainly affected many, if not all. Most of these species were discussed at this symposium and the various factors that have led to their decline will not be pursued now. It was loss of many of the species cited on Figure 37, however, that could have reduced the number of terrestrial mammals of Virginia from 71 to 62.

Figure 38 presents the recent ranges of 16 other species, including those forms that I earlier suggested may represent the other side of the coin; those forms that helped to elevate to 74 the number of species on modern check lists. As in the former group, the increases in the ranges and/or relative abundance of these latter species reflect, I feel, man's strong influence on the composition of Virginia mammals. Six of the species are the result of introductions, and two of these, the Sika deer, *Cervus nippon*, and the black-tailed jackrabbit, *Lepus californicus*, were intentional introductions. Another, the nutria, *Myocastor coypus*, was at least "quasi"-intentional. De Vos, Manville and Van Gelder (1956), in a review of introductions of mammals in much of the world, stated that "Although the majority of introductions of mammals have failed, most of those which succeeded have proved detrimental to man's interests..."

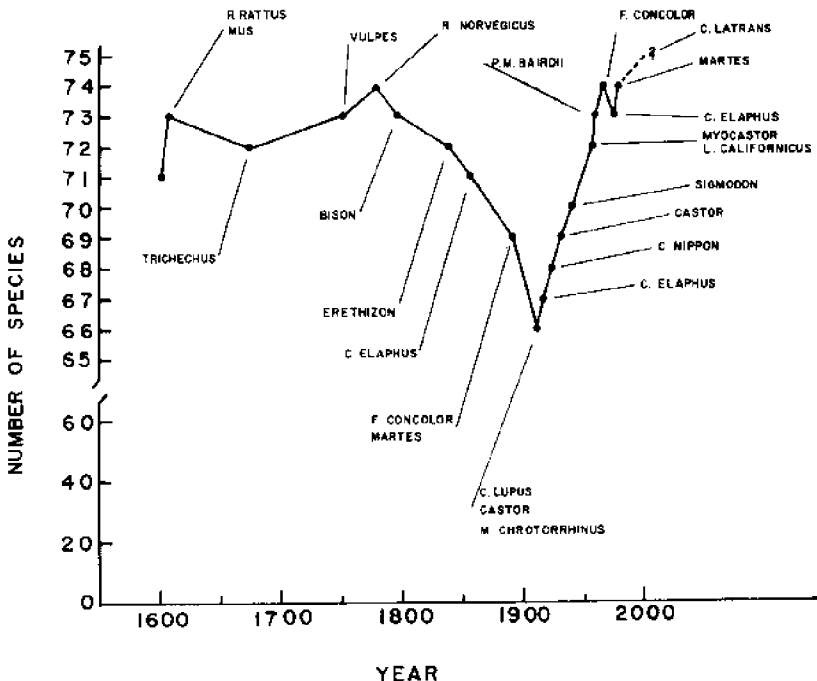


Figure 36. A chronology of change in the number of species of mammals occurring in Virginia in post-Columbian time. The present number of 74 species includes *Peromyscus maniculatus bairdii*, but does not include *Canis latrans*.

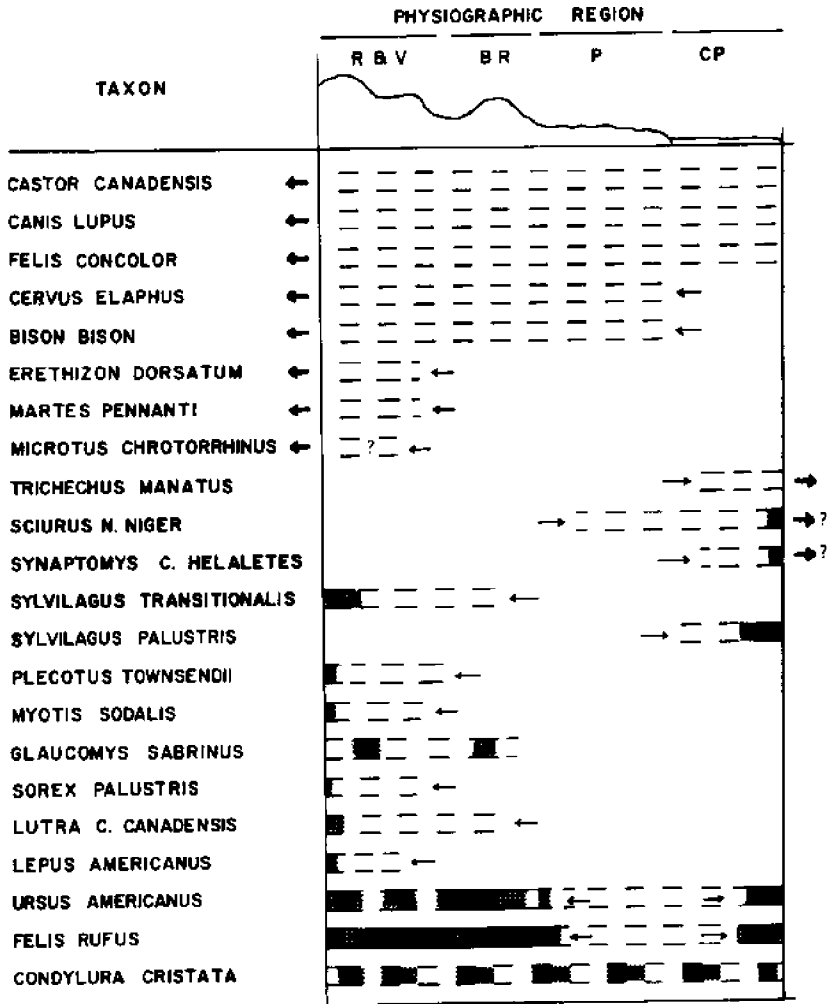


Figure 37. Scheme depicting approximate post-Columbian ranges and present ranges of Extirpated and Sensitive species of Virginian mammals. Dashed areas indicate former ranges and shaded areas indicate present ranges. Heavy arrows indicate Extirpated species and small arrows designate direction of shrinkage of ranges. R & V = Ridge and Valley; BR = Blue Ridge; P = Piedmont; and CP = Coastal Plain.

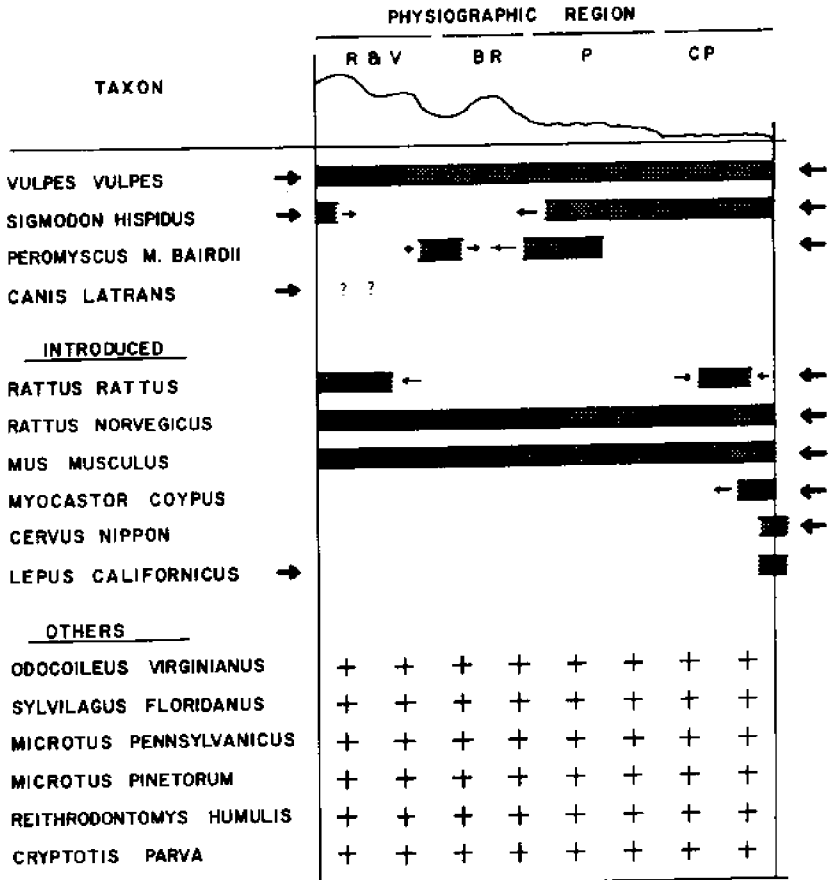


Figure 38. Scheme depicting approximate ranges and/or relative abundance of certain less-sensitive Virginia mammals. Heavy arrows indicate species that have reached Virginia within historic times. Small arrows indicate direction of range expansion, and plus symbol designates species that have likely become more abundant in Virginia within historic times. R & V = Ridge and Valley; BR = Blue Ridge; P = Piedmont; and CP = Coastal Plain.

Only the Sika deer, of the six species introduced in Virginia, with a small and somewhat fragile existence on Assateague Island, seems to have had little adverse effect on us or our native wildlife. The nutria, found in freshwater marshes in southeastern Virginia and around the Chesapeake Bay, presumably could spread and become a pest to man, and possibly to our native muskrat (Evans, 1970). The jack-rabbit on the Eastern Shore has also proven to be an unwelcome addition to the fauna.

The black rat, *Rattus rattus*, and the house mouse, *Mus musculus*, were early additions to the fauna (Godin, 1977). Although the black rat may be of limited importance to us and our native animals, the house mouse and the Norway rat, *Rattus norvegicus*, a later arrival (Hinton, 1931), are of great importance. These unintentionally introduced species are largely restricted to areas already too disturbed to support native species, but seriously "...affect man's economy by eating and contaminating food, and they also carry epidemic diseases and parasites." (de Vos *et al.*, 1956).

Just as loss of forest habitat may have led to or expedited the demise of certain species, it has created suitable habitat and avenues for range expansion of other North American mammals. It is unlikely that the red fox, *Vulpes vulpes*, now found throughout the state, was present until well after the arrival of early colonists (Churcher, 1959). It is also unlikely that our red fox is the descendent of European stock that was introduced, but instead the result of range expansion by American foxes as has been evident in much of the eastern and southern United States (see for example, Paradiso, 1969). I feel that a similar case could be made for the coyote, *Canis latrans*, which is on the verge of invading Virginia. Both the red fox and the coyote are at home in the open woods, edge and field habitats, and unlike their larger cousin, the gray wolf, *Canis lupus*, seemingly flourish near the environs of man.

The prairie deer mouse (the name tells the story), *Peromyscus maniculatus bairdii*, was first collected in the Piedmont of northern Virginia in 1960 (Peacock and Peacock, 1962), and has since been collected in the Great Valley near Harrisonburg (Hensley, 1976). Fifty-one years before the captures in northern Virginia, this mouse was known only as far east as central Ohio (Osgood, 1909). It has emigrated to the Eastern Seaboard through man-made openings.

The hispid cotton rat, *Sigmodon hispidus*, is also a recent arrival. First collected in southern Virginia less than forty years ago (Patton, 1941), it has since been collected north of the James River in Henrico County, as far north as Powhatan County, and to the west in Appomattox County (Pagels, 1977). Cotton rats have also been taken by Handley and Peacock in extreme southwestern Virginia in Lee County (2 miles west-southwest of Ewing, 20-22 June 1962, USNM specimens 330865-330867). The hispid cotton rat has moved northward in much of North America (see for example, Cockrum, 1948; Genoways and Schlitter, 1967), so factors in addition to the availability of suitable habitat and avenues for expansion have facilitated the northward movement. On the other hand, if the alleged sensitivity of the cotton rat to extremes of winter are taken into consideration (see for example, Kirksey, Pagels, and Blem, 1975), the opportunity for continued success in Virginia would be much greater than in early times. I know of numerous sites in central Virginia where the cotton rat now occurs. If for some reason the cotton rats are completely decimated at 95 percent of the sites, there will still remain centers for repopulation.

For many of the mammals considered at this symposium whose ranges or relative abundance is now precarious as the result of, for example, loss of marshy habitat, spruce-conifer forests, dense woodland, undisturbed caves, or excessive exploitation, or indeed, even climatic shifts, the same "principle" is operating. Following natural or man-induced catastrophes, however, there are many fewer repopulation centers and many fewer areas to repopulate.

Along the same lines, a perusal of literature containing data on reproduction, e.g., Asdell (1964) and Burt and Grossenheider (1976), shows that the reproductive potential of most of the species listed on Figure 38 is much greater than in the more troubled species noted on Figure 37. Many of the successful forms present today demonstrate or approach the r-selection reproductive strategy, but many of the troubled kinds demonstrate or approach the k-selection strategy. Many of the troubled species have single litters per year with one or few young per litter; most of the less sensitive species have more than two litters per year and several young per litter. There are, admittedly, numerous factors that must be considered when discussing reproductive strategies and other life history phenomena. However, the reproductive patterns of the mammals I herein consider now more successful are the kinds of patterns characteristic of prey mammals and of mammals living in seral situations; populations and situations that are subject to relatively rapid change. With that in mind, consider the state of much of our natural heritage.

Included in Figure 38 are six forms that I refer to as "others." The white-tailed deer, *Odocoileus virginianus*; the eastern cottontail, *Sylvilagus floridanus*; and the eastern meadow vole, *Microtus pennsylvanicus*, are species that would have been on an early check-list, but, excepting areas of heavy concentrations of people, are probably more abundant now than before. The reasons for their recent successes are somewhat different among them, but for all, man's role is evident.

Similar to the prairie deer mouse, the very name, meadow vole, can be suggestive of why I feel that it may be more abundant now than in early times. Meadows and grass-shrub habitats in which the meadow vole thrives abound in all regions of the state, including the suburbs and agricultural areas and in places that are still generally forested but otherwise disturbed in some way. Thickets, bogs, balds, and wet meadows are all part of the native scene. However, in the mountainous portions of the state alone we cannot ignore the additional habitat suitable for the meadow vole that has been created by logging activity and clearing for fire trails, roads, power lines, impoundments, agriculture, housing developments, and even wildlife clearings. Other animals with habitat requirements similar to the meadow vole can be mentioned in the same context. The least shrew, *Cryptotis parva*; harvest mouse, *Reithrodontomys humulis*; and pine vole, *Microtus pinetorum*; all are potentially more common now. I do not know of supporting evidence for this, but neither has the opposite been suggested.

The eastern cottontail is abundant in farmlands and brushlands, and this important game species and otherwise aesthetically pleasing member of our mammal fauna is often an uninvited guest in our gardens. Unfortunately, perhaps part of the success of the eastern cottontail has been at the expense of the marsh rabbit, *Sylvilagus palustris*, in southeastern Virginia, and the New England cottontail, *Sylvilagus transitionalis*, in formerly heavily forested areas in the mountains.

The success of the white-tailed deer in Virginia can be related to habitat modification; the results of the edge effect and improved forage are well demonstrated. There is more to the deer story, and man's roles have been many. As discussed in Handley and Patton (1947), the deer was exterminated in many of the Piedmont and mountain counties by 1905, but between 1926 and 1943, nearly 1300 deer obtained from outside Virginia were released in mountain counties. Handley and Patton noted in 1947 that "deer are once again found in 80 of Virginia's 100 counties." This restocking, along with improved habitat and modern game management practices, including controlled predation in the form of bag limits and hunting seasons, have helped to reestablish the whitetail again in all parts of Virginia.

In the same category, but even more dramatic in terms of recovery than in the case of the deer, the beaver was completely extirpated in Virginia by 1911 (Handley and Patton, 1947). Following restocking and similar controlled predation, the beaver is again abundant in most of Virginia.

Another species, the elk, *Cervus elaphus*, was extirpated as early as 1855 (Handley and Patton, 1947) and was later restocked. In this instance the program eventually failed. Additionally, the fisher, *Martes pennanti*, has been restocked; the puma, *Felis concolor*, if again present is likely the result of introductions; and very low numbers of native snowshoe hares, *Lepus americanus*, have been supplemented with transplanted stock. Careful protection and numerous considerations are necessary if any of these sensitive species are to again become noticeable members of our mammal fauna.

Realizing that there are more kinds of mammals in Virginia now than in the past, should we feel a little better about our effect on Virginia mammals? Maybe, but consider the following items (the list could be much longer):

- (1) In much of Virginia, the most notable predator in the vacant field and lots and highway rights-of-way is the house cat, and in many instances the cat may be hunting in disturbed plant communities characterized by weedy species, including often the introduced pest species, Japanese honeysuckle.
- (2) In a very recent "island" study of vacant lots that extend from downtown Richmond into the suburbs, only 491 small mammals were captured in 9158 trapnights; 343 were house mice (M. Goehle, manuscript in preparation).
- (3) The old-field where the cotton rat was first found in Chesterfield County in 1969 (Pagels and Adleman, 1971), and where I collected the first and only meadow jumping mouse (*Zapus hudsonius*) in nine years of small mammal sampling, became part of an apartment complex in 1972.
- (4) A site in northwestern Bath County, the only place where the water shrew, *Sorex palustris*, has ever been collected in Virginia (Pagels and Tate, 1976), has become the upper reservoir for a pump-storage electrical generating facility.

A question which should generate many questions must be asked. Have the gains equalled the losses?

Acknowledgment and Comment:

I am very grateful to Charles O. Handley, Jr., for the opportunity to write this paper and for the information and advice that he so generously and graciously provided. I, of course, take responsibility for errors of omission or commission. My original intention was that this be more of an exercise on the versatility of mammals. The certain degree of sourness that may at times be evident resulted from my being forced to more than casually examine our mammal fauna of the past and present, and where it seems to be going. To many, the organisms discussed at this symposium (and in this paper) represent primarily stumbling blocks to our modern society and its growth. My hope is that some of the information included herein will assist in alleviating some of the frustrations facing our native mammals.



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GEOGRAPHIC AREAS OF SPECIAL CONCERN

Alicia V. Linzey

Introduction

Legislative efforts to protect plants and animals have historically employed two approaches. One has been aimed at promoting the welfare of individual species as isolated entities; the other has viewed habitat conservation as a means of ensuring the survival of individual species as well as entire biotas. An increasing awareness of the complexity of interactions within ecosystems has led to an increasing emphasis on the latter approach; *i.e.*, the ultimate protection of living organisms can only be achieved through protection of ecosystems of which they are a part. This realization is reflected in the emphasis given to identification of critical habitats of species coming under the auspices of the Endangered Species Act of 1973.

While many areas are worthy of protection simply because they are rich in biological diversity, we must give our attention first to those unique biotic communities in imminent danger of losing species. A perusal of localities given in the various committee reports reveals that a number of habitats have been mentioned repeatedly. This repetition indicates two things: one, that such areas presently support a richness that renders them worthy of special recognition; and, two, they face the very real possibility of lowered species richness. The task of this committee was to identify areas within the state that merit special consideration, particularly in order to protect those forms listed as *Endangered*, *Threatened*, or of *Special Concern*.

While there may be general agreement that a given species can only be preserved by protecting its habitat, there are few precedents for deciding what and how much habitat is necessary. The federal program requires that a "critical habitat" be designated for most listed species. The North Carolina endangered and threatened species symposium recognized "cluster areas," or specific geographic areas where several listed species were known to occur. We have chosen to focus primarily on habitats and secondarily on specific geographic areas. It was our general philosophy that if a habitat type (*e.g.* wooded swamps) is important, then it should be recognized that this is an important habitat wherever it occurs, and impacts on this habitat should be mitigated whenever possible. We also recognize that it is not possible to conserve, in the narrow sense of the word, all representatives of a given habitat (*e.g.*, all wooded swamps); therefore, we have designated specific geographic areas that best exemplify these habitats (*e.g.*, Great Dismal Swamp). In essence, these named geographic areas are already known to support significant numbers of listed plants and animals. In addition to this broad approach, we also recognized that there are a few specific areas that are absolutely critical to the survival of perhaps as few as a single species. These also were identified as priorities for preservation. In a few cases it was difficult, or even undesirable, to single out specific locales. For example, cave ecosystems are deemed worthy of preservation wherever they occur. Coastal wetlands are an essential habitat for numerous listed species; but further study is needed in order to delineate absolutely critical areas.

The organization of this report is based on physiographic provinces as described by Hoffmann in this volume. Two provinces are combined (Blue Ridge and Ridge and Valley) because their habitats and biota have much in common. Some rivers occur in all province categories and are considered separately in each. This is justified in that a mountainous portion of a river provides a distinctly different habitat than a coastal portion of the same river. In general, it appears that two widely separated areas of the Commonwealth -- the western mountains and the watery coastal areas -- are of greatest concern.

In the minds of those who participated in this symposium, the question of why we should strive to preserve other forms of life is no longer considered worthy of discussion. Among those not so dedicated, the question remains open to debate. It often becomes necessary to justify the existence of other species by assigning economic value or citing potential future uses in medicine or agriculture. Such justifications represent but a faint reflection of the basic underlying motivation of those committed to the perpetuation of our biota. Beyond all rationalization lies a reverence for life that must be communicated to others if other species are to maintain their rightful place on earth.

Blue Ridge/Ridge and Valley

Rivers

Rivers draining these provinces are associated with two major eastern United States drainage basins -- the Atlantic Slope and the Ohio Basin. Atlantic Slope streams originating here descend through the Piedmont, consolidating into major coastal rivers in Virginia, North Carolina and South Carolina. The New River, Big Sandy River tributaries, and upper portions of streams comprising the Tennessee River drainage are part of the Ohio Basin system. Threats to these systems include dams, pollutants, and watershed alterations that result in siltation. Representatives of four faunal groups are directly dependent on riverine habitats: molluscs, insects, fishes, and amphibians. Although a given species may inhabit only a small segment of a particular river, it should be emphasized that water quality alteration upstream will affect lower portions of a watershed. Hence, areas of special concern may have to be rather large when dealing with aquatic organisms.

Atlantic Slope

Within these physiographic provinces, streams providing waters to coastal areas include the upper James River and upper Roanoke River. Of particular significance and deserving of protective measures is the portion of the Roanoke River above Salem, including the North and South Forks, in Roanoke and Montgomery counties. These areas support a particularly rich endemic fish fauna, including two candidates for federal listing (Orangefin Madtom, Roanoke Logperch). Similarly, the Craig Creek system including Johns Creek (Botetourt and Craig counties) contains nearly all upper James River drainage fishes, including the Orangefin Madtom and all known populations of the Roughhead Shiner.

THREATENED

Fish

- Noturus gilberti*, Orangefin Madtom Roanoke River and
Craig Creek (James River)
- Percina rex*, Roanoke Logperch Roanoke River

SPECIAL CONCERN

Insects

- Calopteryx angustipennis*, Damselfly Cowpasture River

Fish

- Semotilus margarita margarita*, Pearl Dace . . . Potomac-Shenandoah drainage
streams in Augusta, Clark,
Frederick and Warren counties
- Cottus cognatus*, Slimy Sculpin Potomac-Shenandoah drainage
streams in Highland, Page and
Augusta counties
- Notropis semperasper*, Roughhead Shiner Upper James River and tribu-
taries
- Moxostoma hamiltoni*, Rustyside Sucker Upper Dan River (Roanoke River)
- Hybopsis hypsinotus*, Highback Chub Yadkin River tributaries in
Carroll County

<i>Hybopsis labrosa</i> , Thicklip Chub.	Yadkin River tributaries in Carroll County
<i>Percina crassa</i> , Piedmont Darter.	Yadkin River tributaries in Carroll County
<i>Moxostoma robustum</i> , Smallfin Redhorse.	Yadkin River tributaries in Carroll County

Ohio Basin

A group of rivers originating in southwest Virginia flow into the Tennessee River and thence into the Ohio. These include the Powell, Clinch, and the North and South Forks of the Holston River. Also in the basin is the New River, which joins the Kanawha River in West Virginia and the Big Sandy River tributaries. The Tennessee drainage rivers contain rich fish and mollusc fauna, with a large number of species considered *Endangered* from both a federal and state perspective. These rivers have been heavily stressed by industrial and agricultural pollution and by siltation and acidification from coal mining operations.

Protection of riverine species can only be gained through preservation of portions of these rivers accompanied by measures to prevent further pollution. The North Fork Holston has already been designated as Critical Habitat for the Spotfin Chub from the Tennessee line to the Washington-Smyth County line. This stretch of the river includes a number of other listed species as well, although extending protection to above Saltville would be desirable for both molluscs and fishes. The Clinch River from Tennessee through Russell County and the Powell River from Tennessee to the Lee-Wise County line are both named as Critical Habitats for the nationally *Threatened* Slender Chub. This designation also protects numerous other species, including numerous *Endangered* molluscs. Copper Creek, a tributary of the Clinch River, contains nine listed species -- two of which are considered *Threatened* on a national level. It has been designated as Critical Habitat for the Yellowfin Madtom. Finally, in addition to endorsing (and in one case, extending) designations already recognized, protection should be extended to the Smyth and Washington county portions of the South Fork Holston River -- habitat of the Sharphead Darter (*Endangered*).

ENDANGERED

Molluscs

Pelecypoda

<i>Actinonaias pectorosa</i> , Mucket.	Clinch River, Powell River, North Fork Holston River
<i>Conradilla caelata</i> (=Lemoix rimosus) Birdwing Pearly Mussel.	Clinch River, Powell River
<i>Cyprogenia irrorata stegaria</i> , Fan Shell.	Clinch River
<i>Dromas dromas</i> , Dromedary Mussel.	Clinch River, Powell River
<i>Dynomia</i> (=Epioblaema) <i>brevidens</i>	Clinch River, Powell River
<i>Dynomia capsaeformis</i>	Clinch River, Powell River, North Fork Holston River
<i>Dynomia florentina walkeri</i>	South and Middle Forks, Holston River
<i>Dynomia haysiana</i>	Clinch River, Powell River, North Fork Holston River
<i>Dynomia torulosa gubernaculum</i>	Clinch River, Powell River North Fork Holston River

<i>Fusconaia barnesiana</i> (complex)	Clinch River, Powell River, North Fork Holston River
<i>Fusconaia cuneolus</i>	Clinch River, Powell River, North Fork Holston River
<i>Fusconaia edgariana</i> (=F. cor)	Clinch River, Powell River, North Fork Holston River
<i>Laemigona holstonia</i>	Clinch River, Powell River
<i>Lastena</i> (=Hemistena) <i>lata</i>	Clinch River, Powell River
<i>Lexingtonia dolabelloides</i>	Clinch River, Powell River, North Fork Holston River
<i>Medionidus conradicus</i>	Clinch River, Powell River, North Fork Holston River
<i>Pegias fabula</i>	Powell River, North Fork Holston River
<i>Pleurobema oviforme</i>	Clinch River, Powell River, North Fork Holston River
<i>Ptychobranchus subtentum</i>	Clinch River, Powell River, North Fork Holston River
<i>Quadrula cylindrica strigellata</i> , Rabbits Foot	Clinch River, Powell River, North Fork Holston River
<i>Quadrula intermedia</i> , Cumberland Monkeyface	Powell River
<i>Quadrula sparsa</i> , Appalachian Monkeyface	Powell River
<i>Villosa perpurpurea</i>	Clinch River, Powell River, North Fork Holston River
<i>Villosa vanuxemensis</i>	Clinch River, Powell River, North Fork Holston River

Gastropoda

<i>Anculosa subglobosa</i>	Clinch River, Powell River, North Fork Holston River
<i>Io fluviialis</i> , Spiny River Snail	Clinch River, Powell River
<i>Pleurocera unciata</i>	Clinch River, Powell River, North Fork Holston River

Fish

<i>Hybopsis monacha</i> , Spotfin Chub	North Fork Holston River
<i>Etheostoma acuticeps</i> , Sharphead Darter	South Fork Holston River
<i>Noturus flavipinnis</i> , Yellowfin Madtom	Copper Creek (Clinch River), North Fork Holston River, Powell River
<i>Etheostoma tippecanoe</i> , Tippecanoe Darter	Clinch River, including Copper Creek
<i>Etheostoma</i> sp., Duskytail Darter	Copper Creek

SPECIAL CONCERN

Insects

Ophiogomphus howei, Dragonfly. New River

Fish

- Notropis stramineus stramineus*, Sand Shiner. . East River (New River, Giles County)
- Polyodon spathula*, Paddlefish. Clinch River
- Notropis ariommus*, Popeye Shiner North Fork Holston River, Clinch River including Copper Creek, Powell River
- Notropis atherinoides*, Emerald Shiner. Powell River, Clinch River
- Notropis whipplei*, Steelcolor Shiner Clinch River including Stock Creek
- Penacobius crassilabrum*, Fatlips Minnow. . . . South Fork Holston River including Laurel Creek
- Moxostoma carinatum*, River Redhorse. South and Middle forks Holston River, Clinch River, Powell River
- Labidesthes sicculus sicculus*
Brook Silverside. Clinch River, Powell River
- Etheostoma camurum*, Bluebreast Darter. Clinch River including Copper Creek, North Fork Holston River
- Etheostoma chlorbranchium*, Greenfin Darter. . Laurel Creek (South Fork Holston River)
- Etheostoma jessiae*, Blueside Darter. North Fork Holston River
- Percina aurantiaca*, Tangerine Darter North Fork Holston River, Clinch River including Copper Creek and Guest River, Powell River
- Percina burtoni*, Blotchside Logperch North Fork Holston River, Clinch River including Copper Creek and Little River
- Percina copelandi*, Channel Darter Clinch River, Powell River
- Percina macrocephala*, Longhead Darter Middle and North Forks Holston River, Copper Creek and Little River (Clinch River)

Mountaintop Islands

High elevation areas (above 3000 feet elevation) of these provinces have long been recognized as sanctuaries for a distinct assemblage of plants and animals (Figure 1). Many of these species are at the edges of their ranges (either north or south) in the southern Appalachians. Others are endemic to these mountainous regions. The general habitats provided by the vegetation of these areas varies with elevation. Up to about 4500 feet, oak-hickory (formerly oak-chestnut) predominates, although mixed with cove hardwood elements and pine stands at some elevations and aspects (Braun, 1967). At the higher altitudes, northern hardwoods (sugar maple, yellow birch, beech and buckeye) predominate. Only at a few locations do elevations reach heights necessary to support the spruce and fir forests extant at Mount

Rogers and Whitetop. Other distinctive features of these areas include rocky cliffs, talus slopes, and sphagnum bogs. The latter are of special interest because of their rarity and uniqueness.

Within the northern Blue Ridge Province, high elevation habitats largely lie within the protective confines of the Blue Ridge Parkway and Shenandoah National Park. The southern Blue Ridge and mountains in the Allegheny range of the Ridge and Valley Province are also largely in public ownership, being included within the George Washington and Jefferson National Forests. Such protection cannot be regarded as a guarantee that species harbored in these areas will continue to survive, because of recreational development and forest management practices. Proposals for extensive development at the Mount Rogers National Recreation Area attest to this situation.

While these high elevation areas are of interest wherever they occur, some specific places emerge as being worthy of protection because of concentrations of listed species that occur there. The majority are those mountains referred to as Canadian Zone peaks, primarily because of the occurrence of high, cool, evergreen forests (spruce, fir) and associated boreal biota. The portion of Shenandoah National Park in Page and Madison counties is inhabited by at least 10 listed species, including eight plants, a beetle, and a salamander. The Mountain Lake area (Giles County) and wilderness areas of Highland County (Allegheny Mountain) contain significant numbers of listed forms. Other areas that are outstanding examples of mountaintop islands are: Black Mountain (Wise County), Clinch Mountain (Tazewell and Russell counties), Beartown Mountain (Russell County), and Buffalo Mountain (Floyd County). Small bogs are present in a number of these localities. Finally, one additional pair of peaks must be singled out as worthy of protection. Rising to elevations over 5500 feet and capped with spruce-fir forests, the Mount Rogers-Whitetop area provides a refuge for more listed species than any other single example of mountaintop island habitat. In the listing that follows, species known to occur at Mount Rogers and/or Whitetop are designated by an asterisk.

ENDANGERED

Plants

- Dryopteris campyloptera x marginalis*
Spreading Marginal Wood Fern Giles County (Mountain Lake)
- Botrychium multifidum*, Leather Grapefern . . . Page and Madison counties
(Shenandoah National Park)
- Ophioglossum pseudopodium*
Northern Adder's Tongue Highland County
- Osmunda x ruggii*, Interrupted Royal Fern . . . Craig County (Jefferson National
Forest)
- Cypripedium reginae*, Queen Lady's-Slipper. . . Rockingham, Shenandoah, and
Warren counties
- Iliamna corei*, Peter's Mountain Mallow Giles County (Peter's Mountain)

Mammals

- Sorex palustris*, Water Shrew Bath County
- Lepus americanus*, Snowshoe Hare. Highland County (Allegheny
Mountain)

- **Glaucomys sabrinus fuscus*
Northern Flying Squirrel Smyth County (Whitetop Mountain)
- Martes pennanti pennanti*, Fisher Rockingham and Highland counties
(Allegheny Mountain)
- Felis concolor couguar*, Mountain Lion Recent reports from 11 southwest
Virginia counties.

THREATENED

Plants

- Lycopodium porophyllum*, Cliff Clubmoss Giles County (Mountain Lake)
- Lycopodium selago* var. *appressum*
Fir Clubmoss Floyd County (Buffalo Mountain)
- **Abies fraseri*, Fraser's Fir Grayson-Smyth counties
(Mount Rogers)
- Juncus trifidus* var. *monanthos*
One-Flowered Rush Page County (Shenandoah National
Park)
- Lilium grayi*, Gray's Lily Six southwest Virginia counties
- Corallorhiza trifida*, Early Coral Root Albemarle County (Shenandoah
National Park)
- **Prenanthes roanensis*, Rattlesnake Root Grayson-Smyth counties
(Mount Rogers)
- **Diphylleia cymosa*, Umbrella Leaf Grayson, Smyth, and Washington
counties (Mount Rogers, Whitetop
Mountain)
- Vaccinium macrocarpon*, Large Cranberry Augusta, Giles, and Carroll
counties
- **Potentilla tridentata*
Three-toothed Cinquefoil Seven southwest counties with
largest populations at Whitetop
Mountain and Shenandoah National
Park
- Heuchera hispida*, Rough Alumroot Craig, Pulaski, and Wythe coun-
ties
- Saxifraga careyana*, Carey Saxifrage Tazewell, Grayson, Smyth, and
Washington counties
- Saxifraga caroliniana*, Carolina Saxifrage Tazewell, Grayson, Smyth, and
Washington counties

Birds

- **Thryomanes bewicki aetus*, Bewick's Wren Grayson County (Mount Rogers,
Whitetop Mountain)

SPECIAL CONCERN

Plants

- Lycopodium x habereri*, Haberer's Running Pine Giles County
- Lycopodium lucidulum x selago* var. *appressum*
Shining-Fir Clubmoss Hybrid Floyd and Page counties

- *Botrychium simplex*, Little Grapefern Giles and Grayson counties
(Mountain Lake, Whitetop Mountain)
- Abies balsamea* var. *phanerolepis*, Balsam Fir . Madison and Page counties (Sky-
line Drive)
- Cinna latifolia*, Wood Reed Grayson, Highland and Smyth
counties
- Deschampia caespitosa* var. *glauca*
Tufted Hairgrass Giles and Page counties
- Melica nitens*, Melic Grass Frederick and Shenandoah counties
- Muhlenbergia glomerata*, Muhly Fauquier and Page counties
- Poa saltuensis*, Blue Grass Augusta and Rockingham counties
(Elliott Knob)
- Schizachne purpurascens*, Schizachne Highland County
- *Ilex collina*, Long-stalked Holly Giles and Grayson counties
(Whitetop Mountain)
- Cornus canadensis*, Dwarf Dogwood Albemarle, Bath and Rockingham
counties
- Arctostaphylos uva-ursi*, Bear Berry Page County (Shenandoah National
Park)
- *Hypericum mitchellianum*, St. John's Wort . . . Grayson County (Whitetop Mountain)
- Clematis glaucophylla*, Leatherflower Floyd and Lee counties
- Sanguisorba canadensis*, Canada Burnet Grayson and Madison counties
- *Ribes glandulosum*, Gooseberry Grayson, Smyth and Washington
counties

Insects

- Sphaeroderus schauvi shenandoah*
Ground Beetle Page, Bedford, and Botetourt
counties (Stony Man Mountain,
Apple Orchard Mountain)

Amphibians

- *Desmognathus wrighti*, Pygmy Salamander Grayson County (Mount Rogers,
Whitetope Mountain)
- *Leurognathus marmoratus*
Shovel-nosed Salamander Grayson County (Whitetop Moun-
tain)
- Plethodon nettingi hubrichti*
Peaks of Otter Salamander Bedford, Botetourt, and Rockbridge
counties (Blue Ridge Parkway)
- Plethodon nettingi shenandoah*
Shenandoah Salamander Madison and Page counties
(Shenandoah National Park)
- *Plethodon welleri*, Weller's Salamander Grayson County (Mount Rogers,
Whitetop Mountain)
- Plethodon punctatus*, Cow Knob Salamander . . . Augusta, Rockingham, and Shenan-
doah counties)

Reptiles

Clemmys mühlenbergi, Bog Turtle Floyd, Carroll and Grayson counties (Blue Ridge Parkway)

Mammals

**Sorex dispar*, Big-tailed Shrew Bath (Warm Springs Mountain), Giles (Mountain Lake), Russell (Clinch Mountain, Mutter's Gap), and Smyth (Whitetop Mountain) counties

Ursus americanus americanus, Black Bear . . . Many counties, but declining numbers

Cave Ecosystems

Caves in Virginia are confined primarily to regions west of the Blue Ridge Mountains (Figure 2). More than 2300 natural caves have been recorded from the state (Holsinger, 1975), mostly in the limestone and dolomitic rocks of the Ridge and Valley physiographic province. Also, karst landforms are particularly well-developed in western Virginia (Figure 3). Karst topography is characterized by irregular terrain that develops through the action of water on limestone to form distinctive features such as sinkholes, large springs and subsurface drainage systems involving caves and cave passages. Major karst areas include Powell Valley and upper Clinch Valley (Holsinger, 1970).

The combination of intricate cave systems and abundant subsurface water provides habitats for a rich and unusual fauna. Because caves have always been vulnerable to human impacts, a large percentage of their fauna faces an uncertain future. Groups particularly impacted are aquatic invertebrates and bats, with a total of forty forms listed here as endangered, threatened or of special concern. Although our focus is on present life forms, the additional value of caves as paleontological and archeological resources should not be overlooked.

The potential for disturbance to fragile cave ecosystems ranges from obviously destructive measures to highly subtle influences. The most visible of these disturbances has been the physical "improvement" of caves destined to become tourist attractions. Thoughtless vandalism has frequently resulted in destruction of cave formations, pollution of subsurface waters, and death or disruption to bats during a critical period in their yearly cycle. The greatest threat to aquatic invertebrates lies in the possibility of groundwater pollution. In bats, the mere presence of humans in the vicinity of hibernating individuals can cause arousal. The physiological effect of this increased metabolic activity is to withdraw energy from bodily stores at a higher than normal rate, reducing the animal's chance of surviving the long period of food deprivation. Bats also tend to be narrowly adapted to very specific temperature and humidity conditions within caves, and alteration of surrounding habitats and/or groundwater flow patterns may render a cave unsuitable for habitation by a particular species.

Caves deserving of special mention are those located in the Clinch and Powell Valleys (particularly Lee, Wise, and Scott counties), Burkes Garden (Tazewell County), Augusta County (Madison's Saltpetre Cave), and Highland-Bath counties (Sinking Creek caves). However, because of the large numbers of listed species inhabiting cave ecosystems and because of their particular susceptibility to disturbance, it is believed that all caves must be given blanket protection. Even with such protection, these habitats will be subject to indirect threats from groundwater pollution.

ENDANGERED

Planarians

Sphalloplana virginiana,
Cave Planarian. Rockbridge County

Mammals

Myotis grisescens, Gray Myotis Scott and Lee counties
Myotis sodalis, Social Myotis. Lee, Shenandoah, Montgomery,
 Wise, Bath, and Giles counties
Plecotus townsendii virginianus
 Western Big-eared Bat Highland, Bath, Tazewell, and
 Rockingham counties

THREATENED

Isopods

Lirceus culveri, Rye Cove Cave Isopod. Scott County
Antrolana lira, Madison Cave Isopod. Augusta County

Amphipods

Stygobromus biggersi, Biggers' Cave Amphipod . Frederick County
Stygobromus hoffmani
 Alleghany County Cave Amphipod. Alleghany County
Stygobromus abditus, James Cave Amphipod . . . Pulaski County
Stygobromus pseudospinosus
 Luray Caverns Amphipod. Page County
Stygobromus stegerorum, Madison Cave Amphipod Augusta County

Diplopods

Pseudotremia tuberculata, Millipede. Tazewell County

SPECIAL CONCERN

Isopods

Pseudobaicalasellus holsingeri
 Valley Cave Isopod. Bath County
Pseudobaicalasellus henroti,
 Henrot's Cave Isopod. Giles and Pulaski counties
Caecidotea incurva, Incurved Cave Isopod . . . Smyth County
Lirceus usdagalun, Lee County Cave Isopod . . Lee County
Caecidotea pricei, Price's Cave Isopod . . . From Rockbridge County north-
 east to Frederick County
Caecidotea recurvata,
 Southwestern Virginia Cave Isopod Lee, Wise, Scott, Russell, and
 Smyth counties

- Pseudobaicalasellus vandeli*
 Vandei's Cave Isopod Giles and Montgomery counties
 northeast to Bath and Botetourt
 counties
- Amerigoniscus henroti*
 Powell Valley Terrestrial Cave Isopod . . . Lee County
- Miktoniscus racovitzai racovitzai*
 Racovitzai's Terrestrial Cave Isopod Page, Rockbridge, Botetourt,
 Shenandoah, and Alleghany counties

Amphipods

- Crangonyx antennatus*
 Appalachian Valley Cave Amphipod Lee, Wise, and Scott counties
- Stygobromus mundus*, Bath County Cave Amphipod Bath and Alleghany counties
- Stygobromus spinoeus*
 Blue Ridge Mountain Amphipod. Albemarle and Augusta counties
 northeast to Warren County
- Stygobromus conradi*
 Burnsville Cove Cave Amphipod Bath County
- Stygobromus estesi*, Craig County Cave Amphipod Craig County
- Stygobromus cumberlandus*
 Cumberland Cave Amphipod. Scott, Lee, and Wise counties
- Stygobromus ephemerus*, Ephemeral Cave Amphipod Giles County
- Stygobromus fergusonii*
 Montgomery County Cave Amphipod Montgomery County
- Stygobromus leensis*, Lee County Cave Amphipod. Lee County
- Stygobromus mackini*
 Southwestern Virginia Cave Amphipod Russell, Scott, Tazewell, Wise,
 Bland, Smyth, and Giles counties
- Stygobromus morrisoni*
 Morrison's Cave Amphipod. Bath County
- Stygobromus baroodyi*
 Rockbridge County Cave Amphipod Rockbridge County
- Stygobromus gracilips*
 Shenandoah Valley Cave Amphipod Rockingham County to Franklin
 County, Pennsylvania

Diplopods

- Plusiocampa* sp. A, Dipluran Scott County
- Plusiocampa* sp. B, Dipluran Scott County
- Plusiocampa* sp. B ssp. B, Dipluran Tazewell County
- Plusiocampa* sp. B ssp. C, Dipluran Tazewell County
- Plusiocampa* sp. C, Dipluran. Smyth, Wythe, Pulaski, and
 Montgomery counties

Planarians

- Sphalloplana consimilis*
 Powell Valley Cave Planarians Lee County

Shale Barrens

The term "shale barrens" is used to refer to exposed bare slopes composed of fragments of shale and siltstone. These areas are found from the low hills of western Virginia and eastern West Virginia northward to central Pennsylvania (Keener, 1970). This habitat is of significance primarily because it supports a number of endemic and near endemic plant species, several of which are included on the Virginia list.

Shale barrens generally occur on low hills (1000-2000 feet), have a southern exposure, a steep slope (more than 20°), a stream at their base, and sparse scrubby vegetation growing on a thin layer of rock flakes. The soils are acidic (4.8 to 5.6) and lack a B horizon (Keener, 1967). Confined to the Ridge and Valley Province, they are found in western counties paralleling the Virginia-West Virginia line from Wythe and Bland counties northeastward (Figure 4). The sparsity of vegetation is apparently due to high temperature and low moisture conditions at the ground surface. Studies of endemic plants of the shale barrens reveal that these species require high light intensity, a substrate adequate for extensive root systems, and a low level of competition (Platt, 1951). The barrens provide a unique combination of soil and light conditions that allow growth of these endemics, while excluding potential competitors unable to survive in this severe environment.

The shale barrens comprise a unique and geographically distinct habitat. Platt (1951) listed 28 species that are absolute or preferential shale barren endemics. Ten plants on the Virginia list are confined primarily or exclusively to this habitat. The primary threat to shale barren habitats appears to be road building. Consideration should be given by the Highway Department to routing of roads around these easily identifiable areas. Preservation of specific shale barrens is needed, particularly those supporting endangered plant species in Roanoke, Montgomery, Bath and Rockbridge counties.

ENDANGERED

- Cheilanthes castanea*, Chestnut Lip-Fern. Roanoke and Montgomery counties
- Clematis viticaulis*, Leatherflower Bath, Rockbridge, and Augusta counties

SPECIAL CONCERN

- Allium oxiphilum*, Wild Onion Bath, Highland, Patrick, and Roanoke counties
- Pseudotaenidia montana*, Mountain Pimpernel Augusta, Bath, Page, Rappahannock, and Shenandoah counties
- Echinacea laevigata*, Purple Coneflower Montgomery and Roanoke counties
- Hieracium traillii*, Devil's Paint Brush. Augusta, Bath, and Highland counties
- Solidago harrisii*, Shale-Barren Goldenrod. Shenandoah County
- Trifolium virginicum*, Virginia Clover. Augusta, Bath, Frederick, and Shenandoah counties
- Clematis albicoma*
White-haired Leatherflower. Alleghany, Augusta, Bath, Botetourt, Craig, Highland, Montgomery, Roanoke, and Rockbridge counties

Clematis coactilis, Leatherflower. Botetourt, Craig, Montgomery,
Pulaski, and Roanoke counties

Cressy Creek Floodplain (Smyth County)

This habitat is singled out because it represents the only known locality for *Betula uber*, the Virginia round-leaf birch. While the habitat of this endemic species seems secure at present, the greatest danger is from collectors. Efforts to protect the remaining plants should continue.

PIEDMONT

Mature Pine Forests

Mature pine forest habitat is critical for a single *Endangered* bird, the red-cockaded woodpecker (*Dendrocoptes borealis*). This bird will only nest in living pines greater than 70 years old and afflicted by red heart disease. Logging continues to destroy remaining nesting habitat in areas presently occupied by this species. While red-cockaded woodpeckers have recently been observed in Isle of Wight, Sussex and Prince George counties, nesting has only been observed in Sussex County. Sanctuaries including large blocks of mature pines are needed in areas that presently contain these birds, especially encompassing known nesting sites in Sussex County.

Rivers

Segments of several rivers crossing the Piedmont harbor listed species of fishes and mussels. Those in the Roanoke River drainages also occur in the Blue Ridge and Ridge and Valley portions of the system. Of particular importance is Stony Creek, a tributary of the Nottoway River (Dinwiddie and Sussex counties), which is inhabited by a disjunct population of the Roanoke Logperch, as well as the Roanoke Bass.

ENDANGERED

Mollusks

Pelecypoda

- Canthyria (=Elliptio) collina* James River
- Elliptio lanceolatus*. James River
- Lampsilis cohongoronta*. Potomac River
- Lexingtonia subplana*. James River
- Villosa (=Micromya) constricta*. James River

THREATENED

- Noturus gilberti*, Orangefin Madtom Big Chestnut Creek, North Fork South Mayo River, and Dan River (Roanoke River drainage streams)
- Percina rex*, Roanoke Logperch. Pigg River, Staunton River, Town Creek, and Stony Creek (Roanoke River drainage streams)

SPECIAL CONCERN

- Ambloplites cavifrons*, Roanoke Bass. Stony Creek, North Meherrin River, Falling River, Pigg River, Blackwater River, and Town Creek (Roanoke River drainage streams)

Brunswick County Granite Outcrop

A single granite outcrop in Brunswick County above Lake Gaston is inhabited by two plants considered to be *Endangered* in Virginia. This particular habitat is threatened by quarrying and road building. Further damage must be prevented in the area occupied by these plants if they are to remain part of Virginia's flora.

ENDANGERED

- Diamorpha smallii*, Small's Stonecrop. . . . Brunswick County
Portulaca smallii, Small's Purslane Brunswick County

Coastal Plain

Barrier Islands

Virginia's barrier islands lie to the ocean side of the Eastern Shore. Their truly distinctive sandy beach and dune habitats are vital to a number of listed species. Also, "upland" portions of one island (Assateague) are inhabited by the federally *Endangered* Delmarva fox squirrel. Nearly all of these islands are part of the Virginia Coastal Reserve and are under the protection of the Nature Conservancy. Their continued preservation is essential. Although not a barrier island, the Atlantic coastline of the City of Virginia Beach constitutes a similar habitat and is frequented by many of the same species.

ENDANGERED

Reptiles

Caretta caretta, Loggerhead Accomack and Northampton counties, City of Virginia Beach

Birds

Falco peregrinus, Peregrine Falcon Accomack and Northampton counties (Introduced)

Mammals

Sciurus niger cinereus
Delmarva Fox Squirrel Accomack County

THREATENED

Plants

Lechea maritima var. *virginica*
Virginia Pinweed City of Virginia Beach, Lancaster County, Accomack County

Birds

Pandion haliaetus carolinensis, Osprey Accomack and Northampton counties

Charadrius melodus melodus, Piping Plover Accomack and Northampton counties, City of Hampton

Charadrius wilsonia wilsonia, Wilson's Plover Accomack and Northampton counties

Gelochilidon nilotica, Gull-billed Tern Accomack and Northampton counties

Sterna albifrons antillarum, Least Tern Accomack and Northampton counties, City of Hampton

Mammals

Condylura cristata parva, Star-nosed Mole Accomack and Surry counties

SPECIAL CONCERN

Plants

- Aristida tuberculosa*, Seabeach Needlegrass . . . Accomack and Northampton counties
- Iva imbricata*, Iva Cities of Chesapeake, Hampton, and Virginia Beach
- Hudsonia tomentosa*, Beach Heath. City of Virginia Beach, James City; Accomack, Lancaster, Mathews, and Northampton counties
- Quercus virginiana*, Live Oak. Mathews and Northampton counties; cities of Chesapeake, Hampton, and Virginia Beach
- Physalis viscosa maritima*, Ground Cherry. City of Virginia Beach

Marine Invertebrates

- Ocyrode quadrata*, Ghost Crab Accomack and Northampton counties; cities of Hampton and Virginia Beach

Birds

- Thalasseus maximum*, Royal Tern Accomack and Northampton counties
- Thalasseus sandvicensis*, Sandwich Tern Northampton County

Mammals

- Cervus nippon*, Sika Deer Accomack County

Coastal Wetlands

Coastal wetlands in Virginia include salt marshes, brackish marshes, and freshwater wetlands (Figure 5). Salt marshes are largely confined to the region between the Barrier Islands and the Eastern Shore, while brackish marshes are concentrated on the Chesapeake Bay side of the Eastern Shore (Accomack and Northampton counties). Freshwater wetlands are extensively developed along the coastal rivers, as well as in the Back Bay-North Landing River area. It has been estimated that tidal wetlands alone total 212,000 acres in the Commonwealth (Silberhorn, 1976). The importance of these areas cannot be overestimated. These marshes act as a source of organic material for adjacent estuaries, absorb flood waters, trap sediments, buffer shoreline erosion, and help maintain water quality. The biota of these wetland habitats includes a large number of species of concern that represent a broad spectrum of plants and animals. In addition to the species listed here there are a number of birds that feed in the marshes but nest on beach habitats (see Barrier Islands).

Coastal zone species have long borne the brunt of human activities, as these areas have the longest histories of occupation and development. The recognition that coastal wetlands have a vital ecosystem function has led to attempts to lessen detrimental impacts. The Virginia Wetlands Act (1972) has been instrumental in slowing the pace of wetland destruction. Ownership of barrier island marshes by the Nature Conservancy lessens the possibility of physical destruction. Still to

contended with are the effects of pollution and siltation, the sources of which may be remote from the wetlands themselves.

ENDANGERED

Plants

- Panicum hemitomon*, Maiden Cane City of Chesapeake; Isle of Wight and Sussex counties
- Panicum mundum*, Panic Grass. Cities of Chesapeake and Virginia Beach; Sussex County
- Puccinellia fasciculata*, Alkali Grass. Accomack County

Birds

- Haliaeetus leucocephalus leucocephalus*,
Southern Bald Eagle Along coastal rivers

THREATENED

Plants

- Thelypteris simulata*, Massachusetts Fern Accomack, New Kent, and Northampton counties
- Leersia hexandra*, Cut Grass. Sussex County

Birds

- Pandion haliaetus carolinensis*, Osprey Along coastal rivers, Eastern Shore, Bay and Barrier Islands

SPECIAL CONCERN

Plants

- Chamaecyparis thyoides*, Atlantic White Cedar Accomack and Southampton counties; cities of Suffolk and Chesapeake
- Eleocharis baldwinii*, Baldwin's Spike Rush Isle of Wight County; cities of Chesapeake, Suffolk, and Virginia Beach
- Eleocharis equisetoides*, Spike Rush. Accomack County
- Rhynchospora alba*, Beak Rush Accomack County; City of Virginia Beach
- Juncus megacephalus*, Large-headed Rush City of Virginia Beach
- Cardamine longii*, Long's Bitter Cress. Caroline, Charles City, King and Queen, King William, New Kent, and Prince George counties
- Ranunculus flabellaris*, Yellow Water Crowfoot. Middlesex and Southampton counties
- Ranunculus hederaceus*, Buttercup Fairfax, Prince George, and Westmoreland counties; cities of Chesapeake, Hampton, and Virginia Beach

Marine Invertebrates

Petricola pholadiformes, False Angel Wing. . . Lower Bay

Insects

Problema bulenta, Rare Skipper New Kent County

Birds

- Ardea herodias*, Great Blue Heron Throughout Tidewater
- Florida caerulea*, Little Blue Heron. Accomack and Northhampton counties
- Caeserodius albus*, Great Egret Accomack and Northhampton counties
- Nycticorax nycticorax hoactli*
Black-crowned Night Heron Accomack-Northhampton counties
- Flegadis falcinellus falcinellus*, Glossy Ibis. Accomack and Northhampton counties
- Sterna forsteri*, Forster's Tern. Accomack and Northhampton counties
- Cistothorus platensis*,
Short-billed Marsh Wren Accomack County, City of Virginia Beach

Mammals

- Sylvilagus palustris palustris*, Marsh Rabbit . Cities of Virginia Beach, Chesapeake, and Suffolk; Surry County
- Cervus nippon*, Sika Deer Accomack County

Eelgrass Communities

The eelgrass communities of Chesapeake Bay and its associated coastal rivers are among the most interesting and productive habitats to be found in Virginia. Eelgrass itself (*Zostera marina*) is primarily a northern species and seems to wax and wane in response to natural conditions such as climate and salinity. Eelgrass beds harbor tremendous numbers of marine invertebrate species that feed on larvae and adults of other organisms concentrated there because the eelgrasses act as current traps. Other species, such as waterfowl and some marine turtles (green turtle, loggerhead) utilize eelgrass directly as food.

The discussion in the section on Marine Invertebrates details the changes in abundance and distribution of eelgrass in recent years. Remaining eelgrass beds must be given full protection. Because eelgrass is impacted by conditions beyond man's control, it is even more essential that the additional stress of human impacts be minimized.

ENDANGERED

Marine Invertebrates

- Amphiporus rubropunctus*, Ribbon-Worm.York River off Mumfort Island
- Tetrasterma jeani*, Ribbon-Worm. York River off Mumfort Island

<i>Lysilla alba</i> , Polychaete	Gloucester Point
<i>Anachis avara</i> , Greedy Dove-Shell	Lower Chesapeake Bay
<i>Hermea cruciata</i> , Cruciate Hermes	York River
<i>Argopecten irradians</i> , Bay Scallop.	Eastern Shore (seaside)
<i>Lemboe smithi</i> , Amphipod.	Hog Island Bay, Gloucester Point

(Reptiles)

<i>Caretta caretta</i> , Loggerhead Turtle	Chesapeake Bay and Atlantic Coast
<i>Chelonia mydas</i> , Green Turtle	Chesapeake Bay and Atlantic Coast

THREATENED

<i>Tetrastemma vermiculus</i> , Ribbon-Worm.	York River
<i>Parahesionia luteola</i> , Polychaete.	York, James, and Elizabeth rivers
<i>Phyllaplysia engeli</i> , Gastropod	Cherrystone Creek
<i>Paracerceis caudata</i> , Isopod.	Chesapeake Bay

SPECIAL CONCERN

<i>Mycale ceccilia</i> , Sponge	York River
<i>Amphiporus ochraceus</i> , Ribbon-Worm.	Mumfort Island
<i>Tetrastemma candidum</i> , Ribbon-Worm.	York River
<i>Tetrastemma elegans</i> , Ribbon-Worm	Mumfort Island, Gloucester Point
<i>Zygonemertes virescens</i> , Ribbon-Worm.	Mumfort Island
<i>Brania clavata</i> , Polychaete	Gloucester Point, Mumfort Island, Chesapeake Bay, Cape Charles
<i>Eumida sanguinea</i> , Polychaete	Kiptopeke, York, and James rivers
<i>Platynereis dumerilli</i> , Polychaete.	--
<i>Crepidula convexa</i> , Convex Slipper-Shell.	Lower rivers and adjacent shores and bays
<i>Diastoma varium</i> , Variable Bittium.	--
<i>Elysia catulus</i> , Kitty Cat Elysia	--
<i>Stiliger fuscatus</i> , Dusky Stiliger.	Lower Bay and Eastern Shore
<i>Triphora nigrocincta</i> , Black-lined Trifora.	Lower rivers and adjacent bay shores
<i>Amygdalum papyrium</i> , Paper Mussel	--
<i>Solemya velum</i> , Common Atlantic Awning Clam	Lower Chesapeake Bay
<i>Cylindrolaberis mariae</i> , Ostracod	--
<i>Sarsiella texana</i> , Ostracod	--
<i>Sarsiella zostericola</i> , Ostracod.	York River
<i>Loxoconcha impressa</i> , Ostracod.	Rappahannock and York rivers

<i>Mysidopsis bigelowi</i> , Opossum Shrimp.	Mobjack Bay, York and Wachapreague rivers
<i>Cyclops varicans</i> , Cumacean.	York and Elizabeth rivers
<i>Edotea triloba</i> , Isopod	--
<i>Erichsonella attenuata</i> , Isopod	Lower rivers and along adjacent shores
<i>Idotea balthica</i> , Isopod.	--
<i>Ampithoe longimana</i> , Amphipod	--
<i>Colomastix haliohondriae</i> , Amphipod	--
<i>Cymadusa compta</i> , Amphipod.	Lower rivers
<i>Rudilemboides naglei</i> , Amphipod	York River
<i>Hippolyte pleuracantha</i> , Eelgrass Shrimp. . . .	Chesapeake Bay
<i>Botryllus schlosseri</i> , Compound Ascidian. . . .	Gloucester Point

Swamps

Swamps have long been considered forbidding, inhospitable places useful to man only when drained or filled. Only in relatively recent times have the beauty and usefulness of swamps been appreciated. The distinction between swamps, bogs and marshes is unclear to many. In general, swamps are wet areas with woody plants covering more than half their area, while bogs (remnants of ancient lakes) are not dominated by woody plants but instead by herbaceous species and mosses. Water in bogs may not be obvious until you step on the surface. Marshes, coastal or inland, lack trees or shrubs and are covered by grasses, rushes, sedges and other herbaceous plants. They are usually underlain by soil having high salinity or alkalinity.

Typical sphagnum bogs are relatively rare in Virginia and are confined to the extreme eastern and western portions of the state. Of particular importance because of their scarcity and small sizes are mountain bogs. These are generally found at high elevations and are included in the section on mountaintop island habitats. Small swamps are more generally distributed in the state, and care should be taken to mitigate adverse impacts on them wherever they occur. Undoubtedly there are many such small areas that are worthy of preservation. There is, of course, one large swamp in Virginia that is the embodiment of swamp wilderness. The Great Dismal Swamp covers about 750 square miles in Virginia and North Carolina. Not only is it located at a biological crossroads for northern and southern species, but it also includes a number of endemic forms. About 49,000 acres are included in the Great Dismal Swamp National Wildlife Refuge. Historically, man's greatest impact on the Dismal Swamp has been through timbering. Virgin stands of cypress, cedar, and gum have largely been replaced by second growth forest species. Outside of the Refuge, timbering continues. Because of the Refuge, the future of at least this portion of the Dismal Swamp seems secure. Encroachments that would diminish the integrity of the preserved area should be guarded against.

ENDANGERED

Plants

Lilium catesbaei var. *longii*, Long's Red Lily. .City of Suffolk

- Panicum hemitomon*, Maiden Cane City of Chesapeake; Isle of Wight and Sussex counties
- Panicum mundum*, Panic Grass. Cities of Chesapeake and Virginia Beach; Sussex County

Mammals

- Lutra canadensis*, River Otter. Many localities, but declining

THREATENED

Plants

- Helonias bullata*, Swamp Pink Augusta, Nelson and Henrico counties
- Arethusa bulbosa*, Bog Rose. Augusta and Patrick counties; City of Virginia Beach
- Sarracenia flava*, Trumpets Dinwiddie and Prince George counties; City of Suffolk

Mammals

- Sorex longirostris fisheri*
Dismal Swamp Shrew. Cities of Suffolk and Chesapeake
- Condylura cristata parva*, Star-nosed Mole. . . Patrick, Surry, and Accomack counties; Great Dismal Swamp

SPECIAL CONCERN

Plants

- Chamaecyparis thyoides*, Atlantic White Cedar. Cities of Chesapeake and Suffolk; Accomack and Southampton counties
- Tillandsia usneoides*, Spanish Moss Isle of Wight, Northampton, and York counties; cities of Chesapeake, Hampton, Suffolk, and Virginia Beach

Insects

- Euphyes dukei*, Duke's Skipper Cities of Virginia Beach and Chesapeake

Amphibians and Reptiles

- Clemmys mühlenbergi*, Bog Turtle. Floyd, Carroll, and Grayson counties
- Crotalus horridus atricaudatus*
Canebrake Rattlesnake Prince George and Southampton counties; cities of Virginia Beach, Chesapeake, Hampton, Newport News, and Suffolk

Fishes

- Erneacanthus chaetodon*, Black-banded Sunfish. Nottoway and Blackwater river systems

Birds

- Buteo lineatus lineatus*, Red-shoulder Hawk . . . Statewide but declining
Dendroica virens waynei
 Wayne's Black-throated Green Warbler. . . . Great Dismal Swamp environs

Mammals

- Flecotus rafinesquii macrotis* Cities of Chesapeake and Suffolk
 (Dismal Swamp)
Sylvilagus palustris palustris, Marsh Rabbit . . . Southeastern Virginia to Surry
 County
Ursus americanus, Black Bear Many localities, but rare in the
 Great Dismal Swamp
Felis rufus floridanus, Bobcat Cities of Chesapeake and Suffolk
 (Great Dismal Swamp)

Chesapeake Bay Estuary/Coastal Rivers

Estuaries are defined as places reached by tides and are formed as a result of invasion of coastal river valleys by the sea. The embayments thus formed, together with their associated rivers, provide a transitional habitat between fresh water and salt water. Estuarine habitats are characterized by measurable salinity, although the concentrations of salt water may vary considerably. The Chesapeake Bay is the largest estuary in the United States. Among distinctive habitats within the Bay is the eelgrass community, which has been discussed separately. Other associated habitats, such as coastal wetlands and beaches, have also been treated individually. Hence, the species considered under this habitat are primarily those living in the water or in bay sediments. Others listed include species that depend on bay waters for food, such as the Southern Bald Eagle and the Osprey.

Man's impact on Chesapeake Bay and its biota has included dredging, filling, chemical and thermal pollution, introduction of exotic species, and overharvesting of native forms. The effects of pollution have been the most insidious because of the multiplicity of sources, persistence, and types of contaminants. Furthermore, the effects of a pollutant may be geographically remote from its source.

The entire Bay ecosystem may be regarded as a habitat of critical importance, although it is true that some regions have been impacted more severely than others. For example, areas such as Hampton Roads, the Elizabeth River, and Little Creek have witnessed severe declines in species numbers. On the other hand, productivity of shellfish remains high in some areas. Improvement of water quality can only occur through continued upgrading of industrial and domestic discharges into the Bay itself and in the contributing river systems.

ENDANGERED

Marine Invertebrates

Twenty-eight (28) species in addition to those inhabiting eelgrass beds (please refer to the section on Marine Invertebrates).

Fishes

Acipenser brevirostrum, Shortnose Sturgeon . . Potomac River

Reptiles

Dermochelys coriacea, Leatherback. Mobjack Bay to Severn River
Caretta caretta, Loggerhead. Several localities in Chesapeake Bay
Lepidochelys kempi, Ridley Chesapeake Bay and into the Ware and York Rivers
Chelonia mydas, Green Turtle Chesapeake Bay

Birds

Haliaeetus leucocephalus leucocephalus
 Southern Bald Eagle Several coastal rivers

THREATENED

Marine Invertebrates

Fifteen (15) species in addition to those inhabiting eelgrass beds (please refer to the section on Marine Invertebrates).

Fishes

Acipenser oxyrinchus oxyrinchus,
 Atlantic Sturgeon Potomac, Rappahannock, York, and James rivers

Birds

Pandion haliaetus carolinensis, Osprey Eastern Shore, Bay and coastal rivers except James River
Sterna albifrons antillarum, Least Tern. . . . Feeds in Bay estuary

SPECIAL CONCERN

Marine Invertebrates

At least 33 species in addition to those inhabiting eelgrass beds (please refer to the section on Marine Invertebrates).

Fishes

Fundulus confluentus, Marsh Killifish. . . . York River, Gloucester Point, Lynnhaven Inlet

Birds

Ardea herodias herodias, Great Blue Heron. . . Throughout Tidewater area
Florida caerulea caerulea, Little Blue Heron . Feeds in estuary
Casmerodius albus egretta, Great Egret Feeds in estuary
Nycticorax nycticorax hoactli
 Black-crowned Night Heron Feeds in estuary

Plegadis falcinellus falcinellus, Glossy Ibis. Feeds in estuary
Sterna forsteri, Forster's Tern. Feeds in estuary
Thalasseus maximus maximus, Royal Tern. . . . Feeds in estuary

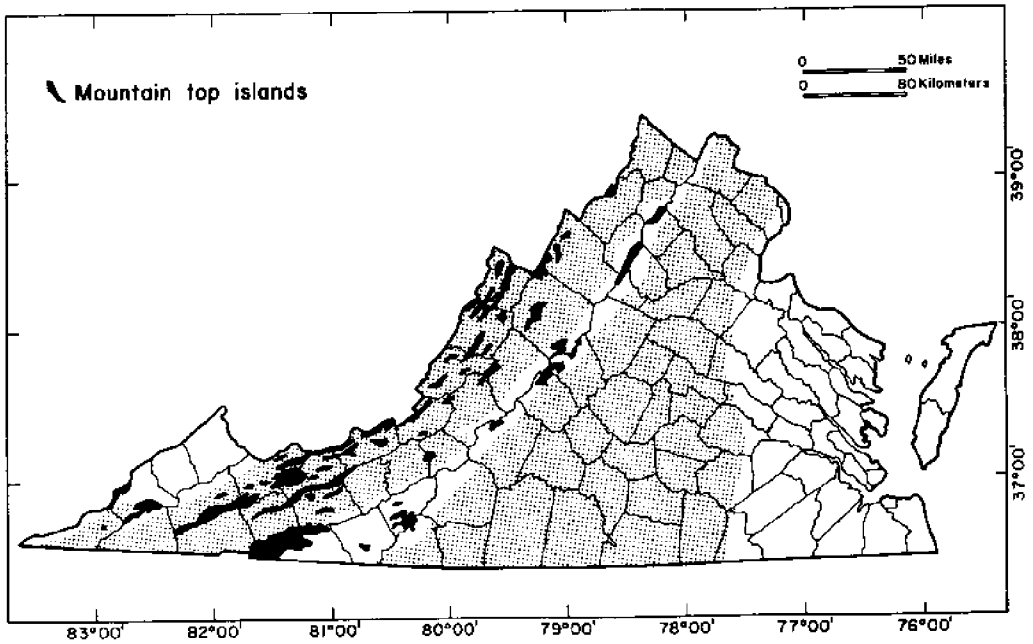


Figure 1. Areas above 3000 feet elevation in Virginia

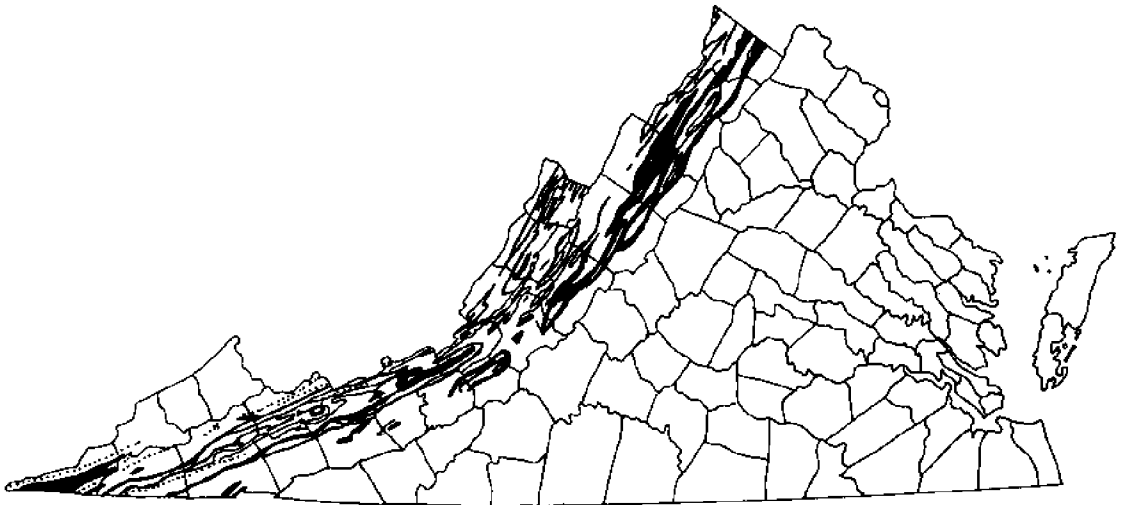


Figure 2. Distribution of cave-bearing rocks in Virginia
(Modified after Holsinger, 1975)

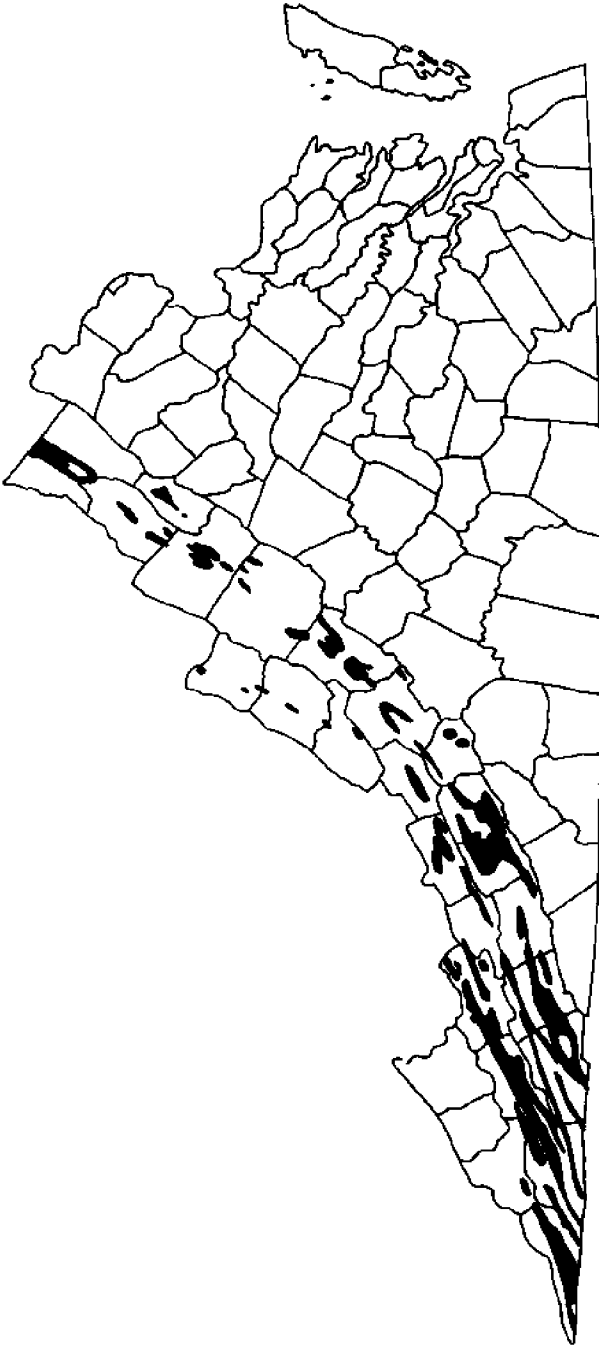


Figure 3. Karst areas of Virginia (Modified after Holsinger, 1975)

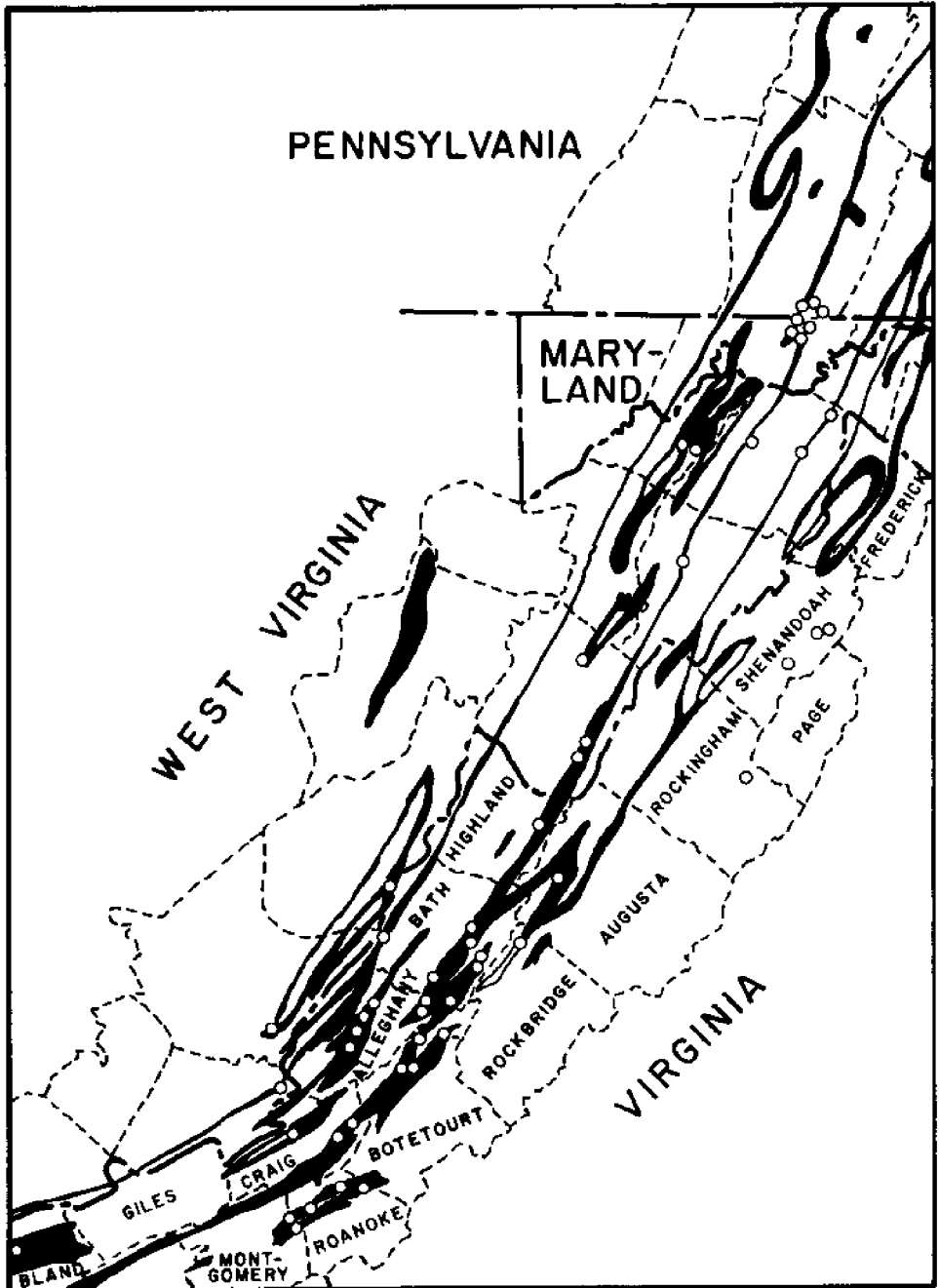


Figure 4. Shale outcrops in western Virginia (after Platt, 1951)

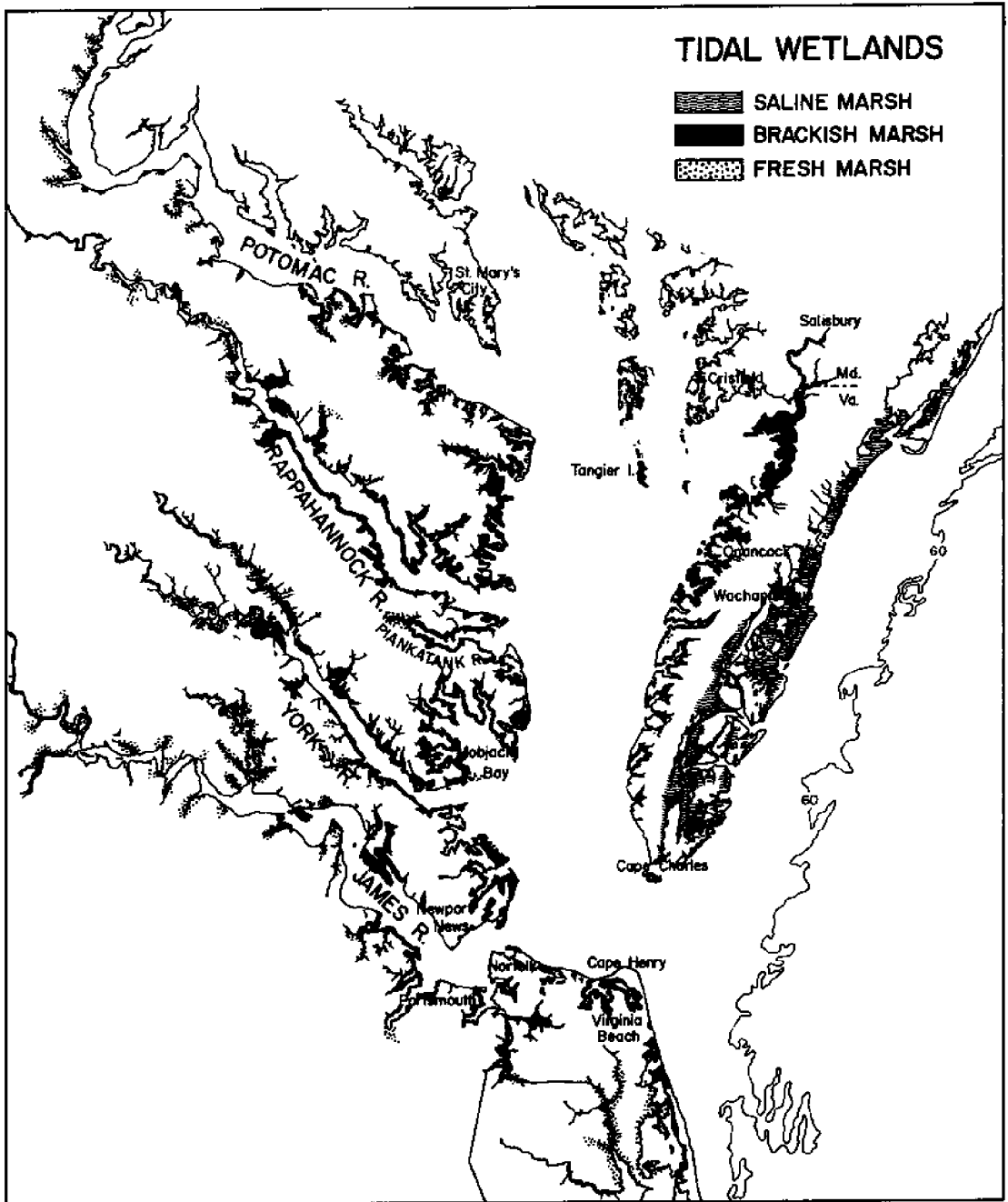


Figure 5. Tidal wetlands of Virginia

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APPENDIX A
Charge to Committee Chairmen

Each Committee Chairman will select a committee to:

I. Consider taxa (species and subspecies) of its assigned biotic group with respect to determining and reporting on their status as:

A. Endangered

A plant or animal whose prospects for survival are in immediate jeopardy; in danger of extirpation and/or extinction throughout all or a significant portion of its range in Virginia. Also includes those plants and animals on, or being considered for inclusion on, the *U.S. List of Endangered Fauna and Endangered and Threatened Plant Species of the United States*, as provided under the Endangered Species Act of 1973 (Public Law 93-205).

B. Threatened

A plant or animal which is likely to become *Endangered* within the foreseeable future throughout all or a significant portion of its range in Virginia. Includes forms which have exhibited a considerable decrease in numbers beyond the limits of normal fluctuation, or documented range contraction, but not yet considered *Endangered*. Also includes those plants and animals listed under the provisions of Public Law 93-205.

C. Special Concern

A plant or animal which should be continually monitored (a) because it exists in only one or a few small geographic areas and/or is rare (low population density) over a relatively broad range; (b) because its existence may become endangered due to the destruction, drastic modification, or severe curtailment of the habitat; (c) because certain characteristics or requirements make it especially vulnerable to specific pressures; or (d) because of other reasons identifiable by experienced researchers.

D. Status Undetermined

A plant or animal that has been suggested as possibly *Threatened* or *Endangered* but about which there is insufficient data to accurately determine its status.

E. Recently Extinct or Extirpated

A plant or animal which recently occurred in Virginia but no longer exists in the state, as determined by historical documents and/or knowledge of committee members. (Each committee shall establish its own definition of "recently").

II. Consider demes or ecotypes of taxa within its assigned group with respect to determining and reporting on their significance within a physiographic or other unit, or other importance.

- III. Prepare a preliminary "in-committee" report of its findings on each species, etc., which will be brought to the first day Committee Workshop for finalization.
- IV. Prepare a 15- to 20-minute presentation indicating its findings to be delivered by the Chairman at the second day General Assembly. Since this Assembly will be open to the public, various agency representatives, and other interested parties, the presentation should largely be geared for a non-technical audience. Illustrative materials showing species, maps, interesting or unique habitats, problems, etc., would be useful.
- V. Provide the Coordinator of the Symposium (Chairman of the Steering Committee) with the final reports (arranged in publishable format) and all desired illustrative materials, shortly after the Symposium.

Committee size, composition, functioning, and work schedules are at the discretion of the Chairman. Some may decide that Subcommittees are desirable for operating purposes. The Chairman may opt to write all of the species accounts himself or he may assign species accounts on the basis of individual experience and expertise. In the latter case, the Chairman would be responsible for editing each account. Some Committee members might be assigned 5 or 6 species, while others might be assigned a fewer number with which they are more conversant than anyone else. It is desirable that Committee members be able to attend the Symposium, but an investigator living in a distant state or Canada and unable to get away should not be ignored if he or she is the obvious authority on some forms and their status in Virginia. Single member committees would defeat part of the purpose of the Symposium.

Working deadlines should probably be established by each Committee Chairman. A possible schedule might be:

1. Select members of Committee by December 31, 1977.
2. Assign species investigations (if desired) by mid-January, 1978.
3. Hold an organizational meeting (if desired) by the end of January.
4. Formulate preliminary reports by early April.
5. Handle last-minute details by mid-April.

All claims made in Committee reports are to be as fully documented as possible.

The Symposium is designed to address biological concerns.

The Chairman of the Steering Committee would appreciate being kept informed of the progress of each Committee. If species accounts are being assigned to Committee members, please send a list of assignments.

APPENDIX B
Format for Species Accounts

COMMON NAME *Scientific Name* and Authority

Division/Phylum
Class

Order
Family

Description: one or more descriptive statements that might allow identification; where appropriate, include comments about species with which the form under consideration could easily be confused; include reference to a good source for identification (key, illustration, etc.).

Present Range: total range of the species or subspecies.

Distribution in Virginia: self-explanatory; include map if appropriate.

Habitat and Mode of Life: brief description of areas inhabited; periods of activity (nocturnal, crepuscular, etc.); hibernator; feeding habits; roosting sites; home range; behavior; etc.

Reproduction: breeding season in the wild; number of litters per year; number of young per litter; age at sexual maturity; gestation period; appearance of young; length of time young remain with female; delayed implantation; delayed fertilization; mode of vegetative reproduction; etc.

Number in Captivity: known groups of living Virginia plants or animals in scientific or commercial institutions (arboreta, museums, zoos, laboratories, etc.).

Status: *endangered, threatened*, etc. Give reasons for this decision. Endemic; relict; disjunct population; estimated numbers in the wild; efforts at captive propagation (although this is not a viable alternative to protection, it would be interesting to know if breeding in captivity, artificial insemination, etc., is easy, difficult, impossible, untried, or highly unlikely). Protective measures in effect.

Protective Measures Proposed: establishment of refuges to protect habitat; cessation of detrimental activities (water pollution, siltation, clear cutting, etc.); specific research studies needed; management suggestions; etc.

Remarks: other common names; value such as scavenger, insectivorous bird; unique plant under pressure by collectors; etc.

References: especially those pertinent to the species in Virginia.

Author: name of Committee member who wrote account (if applicable).

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