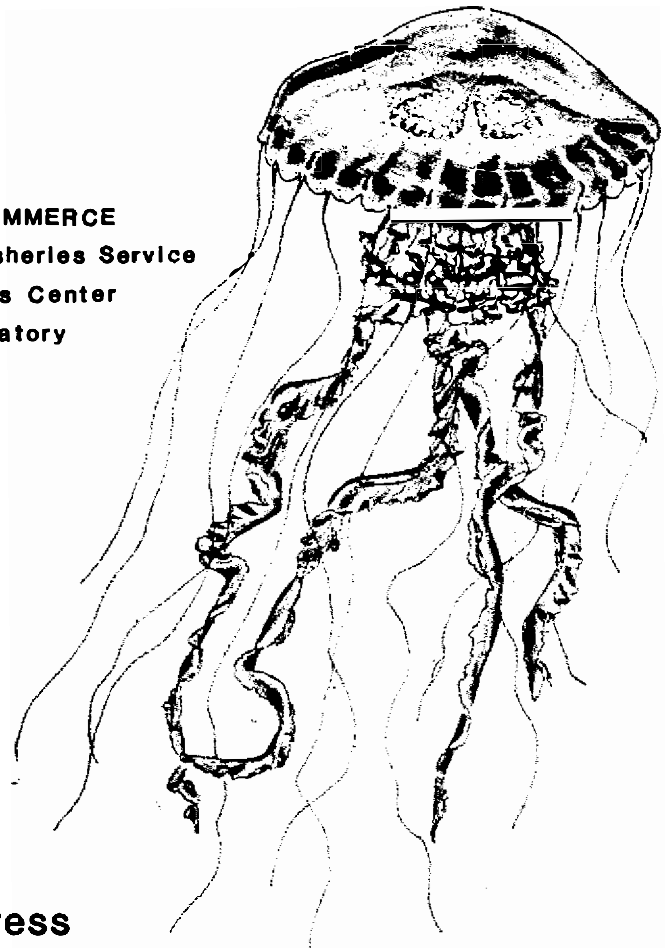
RECEIVED

JELLYFISH OF THE NEW YORK BIGHT

A REVIEW



U.S. DEPT. OF COMMERCE
National Marine Fisheries Service
Northeast Fisheries Center
Sandy Hook Laboratory

By
Dorothy Jeffress

Report No. SHLR 84-22

INTRODUCTION

With man's increasing use of the sea, there are often contacts between the public and some of the common marine organisms that are considered a "problem". The problem is usually that some organism does not fit into the plan of how man wants to use the sea, e.g., for recreation or occasionally for commercial purposes. The jellyfish is one of these organisms that the public considers a problem. Every summer, as the public makes its annual migration to the shore, they find they have to share the waters with its natives, some of which are deemed undesirable (perceptually or in reality). When the public comes in contact with jellyfish, they express a variety of questions and concerns such as: Why are they there? Are they increasing because of pollution? What does one do if stung? This review is intended to: 1) summarize some facts about jellyfish that may interest the public and 2) address some of these perennial questions.

"Jellyfish" is the name that is commonly given to any organism that is pelagic and contains mostly water. However, there are several different types of organisms that are included in this rough classification. Included are: siphonophores, true medusa types, and "sea walnuts" or ctenophores. This review will concentrate on the latter two groups.

TRUE JELLYFISH

Many true jellyfish or scyphozoa are semitransparent and glassy, but often with brilliantly colored tentacles, radial canals, and egg sacs. Each tentacle of a jellyfish has millions of tiny stinging cells called nematocysts. The jellyfish has an unusual life cycle characterized by alternation of generations. Every other generation is asexual, budding like a plant, while intervening generations reproduce sexually. In one part of its life cycle, the released jellyfish larva called a planula, derived from the jellyfish egg, settles on the bottom, commonly attached to seaweed or other hard surfaces, and becomes a miniature polyp. The polyps feed, bud new polyps, can contract into button-sized organisms as the water gets colder, and overwinter on the bottom this way. As the weather begins to warm, and after a period of growth, the polyps sprout from 4 to 10 ring-like disks, stacked upon each other, a process called strobilization. Each of the disks then detaches as a small free-swimming jellyfish called an "ephyra" which develops into the adult or the medusa life stage. When the medusae mature, sperm from the male enter the digestive cavity of the female and fertilize the eggs held there.

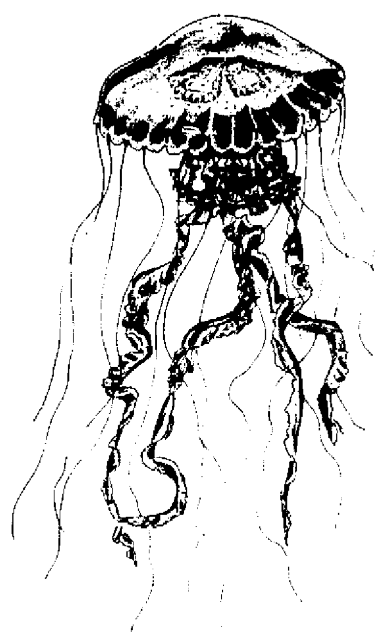
In the adult stage, nearly all jellyfish are free-swimming and are widely distributed throughout all seas, although some live on coral reefs or mud banks on the bottom of the ocean. Because their swimming ability is relatively weak, jellyfish are greatly influenced in their movement by currents, tides, and wind; they are found in or near powerful water currents or where neighboring currents converge.

Medusae are active carnivores and their presence in great numbers in plankton could have a serious effect on the recruitment of larval fish (Fraser 1969). Larval fish are important in the diet of most medusae; however, copepods and other small crustacea seem to be the dominant food. Some species will even eat other medusae, ctenophores, or siphonophores. During the summer, larvae of benthic or bottom dwelling organisms support the medusae populations. Medusae usually capture their prey with their tentacles and an organism touching a tentacle becomes attached to it, paralysed by the stinging cells or nematocysts; it is then transferred to the stomach. This transfer may be effected by the stretching capacity of the mouth reaching out for the food, tentacle contraction which draws the prey to the stomach, or by various combinations of these according to the structure of the medusa (Fraser 1969).

Jellyfish are currently of little value to man; however, some species are dried and eaten in the Orient, their only known commerical value. Most sea turtles feed heavily, if not entirely, on jellyfish; many turtles die by eating plastic bags misidentified as jellyfish.

The following are reviews of the life histories of the three most common medusae in the New York Bight.

<u>Chrysaora quinquecirrha</u> (sea nettle)



The sea nettle, or summer jellyfish, is the dominant and conspicuous jellyfish in coastal bays and estuaries of the east coast. This jellyfish is bell-shaped and pale white, ribbed with reddish markings that resemble numerous red wheels pulsating along the surface, with long tentacles around the edge of the bell. It is familiar to fishermen and swimmers, both for its painful sting and large populations during summer months (Cargo and Schultz 1966).

Most of the life cycle of <u>Chrysaora</u> is spent as a sessile polyp. The most common substrate on whi[illegible] occur naturally are oyster shells and usually on the underside of hard substrates (Cargo and Schultz 1966). It is thought that the occurrence of polyps on the underside of objects is necessary for their survival because settling sediments may cover the polyps to the extent that survival is impossible. In the natural environment, the polyps feed on a variety of small, microscopic invertebrates and larvae (Cargo and Schultz 1966) which they capture with stinging cells present in their tentacles.

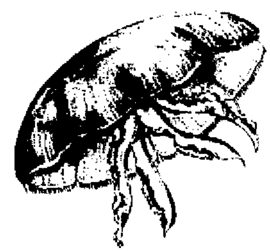
Chrysaora quinquecirrha are most common in summer, being abundant in the spring to late fall as medusae, occurring from Cape Cod south to the Caribbean. This species is tolerant of a wide range of salinities and temperatures.

The food of the sea nettle consists of small fishes, worms, oysters, and other shellfish larvae, ctenophores, and many kinds of small marine invertebrates and protozoa. Cargo and Schultz (1967) reported annelids in stomach of many medusae, indicating that these worms are important in the natural diet of the local sea nettle population.

A small eolid nudibranch (sea slug) is fond of feasting upon the sessile larvae of C. quinquecirrha. These nudibranchs actively seek the polyps and are able to detect them at a distance of several inches. Nudibranchs also feed on adult jellyfish, consuming and storing the stinging cells, and later using them for their own defense (Miner 1950).

Another common predator is a relative of the butterfish, the harvest fish, Peprilus alepidotus (Linnaeus). Juveniles of this species frequently accompany a medusa, swim in and out of the jellyfish tentacles with impunity, and feed heavily on the tentacles (Mansueti 1963). Larger fish may destroy whole medusae in minutes (Cargo and Schultz 1966). When a sea nettle and the associated fish are scooped up in a net or placed in a bucket, it becomes obvious that they are not all immune to the nematocysts. As soon as the fish are engulfed in the stinging slime, they stiffen and die almost instantly.

Aurelia aurita (moon disc)



Aurelia is the most common, larger oceanic jellyfish. The common name for *Aurelia* is "moon jelly" because it is translucent whitish or tawny. When found cast up on the seashore, it is readily recognizable by the four horseshoe-shaped colored bodies in the "bell." It is almost cosmopolitan in its distribution and is found in the western Atlantic from Greenland to the West Indies, being irregularly distributed south of Cape Cod (Gosner 1979). In mid-April they make their appearance, often in large numbers, as free-swimming medusae. They grow rapidly and by the end of June attain full size. Their eggs are discharged at the end of July.

The adult *Aurelia* usually feeds on plankton collected by ciliary currents along the rim of its bell. They are suspension feeders and feed on all types of small animals. Because most medusae are small, distribution of food materials and respiratory exchange takes place by means of diffusion with the assistance of ciliary currents and body movement. Fraser's (1969) studies of *Aurelia* indicated that they feed largely by filtering water through the tentacles while swimming. As the tentacles sweep down, food is trapped. Delap (1907) found *Aurelia* preferred to eat other medusae and sometimes small copepods and ctenophores, e.g. *Pleurobrachia.* They also eat young fish and crab zoeae (Lebour 1922). Moller (1984) documented a major decline in herring larvae caused by the feeding of large numbers of this jellyfish in the Kiel Fjord of the western Baltic Sea.

Aurelia aurita is a boreal species adapted to warmer waters. It is also an inshore species able to live in brackish water conditions in estuaries; however, it is tolerant to a wide range of salinities, but the salinity limit for successful reproduction for the sessile polyps must be relatively higher than the adult *Aurelia* tolerate.

Swarms of *Aurelia* are brought about by wind and tide action and these swarms may occur in the form of windrows often miles in length where two currents meet. They can be a nuisance to fishermen (clogging nets) and to bathers. The sting of *Aurelia* is not noticeable to humans. Russell (1970) reported a curious use of *Aurelia* cited by Weill (1934): neuralgia and rheumatic pains of patients were treated by the direct application of the medusae to the affected area.

Young fish are occasionally found in association with *Aurelia*, and Bowman et al. (1963) recorded the occurrence of the amphipod, *Hyperia galba*, with *Aurelia aurita* in Narragansett Bay. In some medusae it was common to find the gastric pouches filled with *Hyperia* feeding on the tissues.

Cyanea capillata (lion's mane)

The genus *Cyanea* contains the largest medusae known, some measure 12 feet across the disc and have tentacles about 100 feet long. They are yellowish brown or reddish in color and have a saucer-shaped umbrella with fairly thick jelly. They are commonly called the lion's mane jelly or sea blubber.

Cyanea capillata is a northern boreal species. It occurs in North Atlantic and Pacific waters and along the northeast seaboard of America. *Cyanea* is usually solitary, seldom seen in company with others. Their occasional occurrence in large swarms was first thought to be for breeding purposes by L. Agassiz in the late 1800s, but later other researchers realized that swarms were carried and concentrated by winds and tides. Their main period of abundance is March to September. They become scarce in October, but a few larger specimens may linger over the winter in deep water.

Even a small *Cyanea* can raise huge welts on the arms or legs of humans unfortunate enough to contact them, and the monster blue *Cyanea* of the North Atlantic can be a real danger to swimmers.

The young of cod, haddock, whiting, and horse mackerel commonly associate with this medusa and take shelter under its umbrella and among the voluminous folds of the oral arms. The medusae, in the coastal area, may be carried more than 250 miles offshore and young fish may accompany them.

CTENOPHORA (COMB JELLIES)

A typical ctenophore is spheroidal and transparent, but some are compressed and elongated. Some are colored pink, others orange. They have eight rows or plates of cilia that radiate from the aboral pole and extend toward the oral end of the animal. The cilia are arranged in rows, like teeth in a comb, across the plates. Because of these ciliated plates and gelatinous nature of their bodies, ctenophores are commonly known as "comb jellies" or "sea walnuts". The comb rows are highly iridescent and luminesce.

Comb jellies are not true jellies; they are gelatinous, fragile, and have a body plan somewhat similar to that of a medusa. Their nervous system is more developed than that of medusae and they do not have stinging cells.

All ctenophores are hermaphroditic, both male and female organs are found in the same individual. They do not have distinctive larval and sessile stages, as most jellyfish do, and there is no alternation of generations. The sperm and eggs are dicharged through the mouth into seawater, where fertilization occurs. The ability to luminesce begins shortly after the fertilized egg starts to divide and lasts life long.

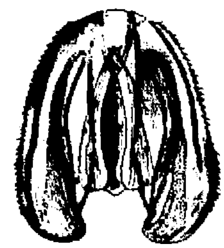
Ctenophores are not powerful swimmers; they are carried about by water currents and tides so that they often accumulate in vast numbers in various coastal areas. They entrap animals with their tentacles and feeding lobes, aided by the ciliated plates which create currents to carry particles along the mouth. Prey is captured and held by means of adhesive cells which are sometimes located on a pair of tentacles, as in *Pleurobrachia.* The tentacles of *Pleurobrachia* can trail out far into the water. These tentacles are provided with numerous short branches that increase the surface area and the chances of prey coming in contact with them.

Ctenophores complete their life cycle in the plankton and are among the greatest enemies of copepods and meroplanktonic larvae in the water column (Fraser 1962).

The most common species in the New York Bight are *Beroe ovata, Pleurobrachia pileus,* and *Mnemiopsis leidyi* (Nelson 1925). *Mnemiopsis* appears in the late spring and early summer and flourishes until late autumn or winter. *Beroe* and *Pleurobrachia* are found here only after the heat of the summer has passed.

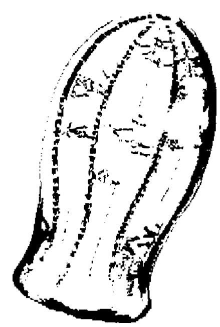
The following is a brief discussion on the life cycles, feeding habits, and important aspects of these three ctenophores.

Mnemiopsis leidyi (sea walnut)



Mnemiopsis leidyi is a large ctenophore on our east coast, common from Vineyard Sound to the Carolinas and is commonly known as a "sea walnut". They often occur in large swarms and are famous for their luminescence. Mnemiopsis leidyi are known to eat mollusk larvae and copepods. Nelson (1925) believed them capable of consuming a large number of bivalve larvae. Larvae of the sea anemone, Edwardsia leidyi, resembling pinkish tentacled worms, are often found attached to and feeding on this ctenophore. Populations of this species may be controlled by the occurrence of true jellyfish, Chrysaora (Feigenbaum and Kelly, unpubl. ms.), and may greatly influence the secondary production of zooplankton and primary production in areas where they occur.

Beroe ovata (thimble jellyfish)



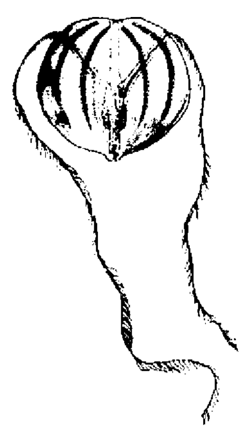
Beroe have conical bodies with large mouths and are much compressed, pink in color in northern regions, milky white in southern regions. They are abundant as far north as Chesapeake Bay, occurring regularly in Delaware Bay and are occasionally found in swarms off Sandy Hook, but their occurrence there and north of Cape Cod is more erratic, mainly summer through fall.

Beroe ovata remains motionless in open water, or swims in circles changing direction and pattern of swimming frequently by a bending movement described by DeCeccatty and Hernandez (1965). Swimming in circles permits *B. ovata* to search through a greater area of water for prey than if it swam in a random, linear direction.

Nelson (1925) reported that *B. ovata* feeds only on another ctenophore, *Mnemiopsis*; however, they will feed on most other ctenophores (Swansberg 1974). The body of *Beroe* is less voluminous and more flexible than other New York Bight species and contains numerous muscle fibers (Horridge 1974). This body structure represents an adaptation to its feeding habits since *Beroe* swallows prey like *Pleurobrachia* whole and encloses it completely in its sac-like body. Greve (1970) described ingestion as an opening of the mouth, a sudden bending of the body, and rapid sucking of the prey into the pharynx. Ingestion occurs only after the lips of *B. ovata* come into contact with its prey. Beroid ctenophores prey on other ctenophores thus acting as regulators of their abundance (Greve 1971). They may pass through cycles of relative abundance of predator and prey and the decline of the latter with depletion of food.

Pleurobrachia pileus (sea-gooseberry)

Pleurobrachia pileus, or the sea-gooseberry, is spherical or ovoid in shape, wide, and transparent, and has two long, branched tentacles retractile into pouch-like sheaths located between comb rows on opposite sides of the body. Various structures, such as the tentacles and comb rows, may be slightly colored with white, orange, or purple.



Pleurobrachia occurs in colder waters of both the Atlantic and Pacific oceans. Pleurobrachia pileus are found north of Cape Cod in summer and are driven southward only in the winter but have been reported offshore in summer-fall.

Pleurobrachia is a passive drifter when searching for prey. The food is caught on the colloblasts of the extended tentacles and then wiped into the mouth. Ctenophores feed on small copepods and their nauplii and are damaged by large copepods (Greve and Parsons 1977); large copepods predate upon young stages of Pleurobrachia and often tear their tentacles. Nauplii of large copepods provide no food to the very young ctenophores, thereby preventing population increase (Greve 1970, 1971). Larger P. pileus feed on a variety of actively swimming organisms and prey consumption is limited by the catch apparatus of the ctenophore.

Some species of Pleurobrachia have high growth rates (Reeve and Walter 1976). Swarms of these ctenophores may sweep the water clean; they are so voracious that few smaller creatures can coexist with them. They are eaten by mackerel, spiny dogfish, and other species, including true jellyfish.

DISCUSSION

There are several questions that are perennially asked about jellyfish. Below we have attempted to answer some of them:

1. Why do jellyfish swarm near the beach in summer? Because they are weak swimmers, jellyfish are at the mercy of currents and thus aggregates of jellyfish commonly occur where currents leave them. They are frequently found in swarms at "tide lines" where two currents meet or where up- or downwellings occur along the beach (Arai 1973). Thus, either offshore or onshore breezes can bring them into the surf zone. The occurrence and distribution of ctenophores in New Jersey inland coastal waters are considered to be affected by environmental factors. Weather and wind have a great deal to do with

movements and migrations of jellyfish. If there is an onshore wind, comb jellies move into estuaries and can be easily seen. Northerly winds that push the water offshore move the marine life out into deeper water. When the winds blow from the sea, the water warms and ctenophores come back in.

2. How dangerous are jellyfish and what should one do if stung? True jellyfish possess clusters of stinging cells, especially along their tentacles, that can trail many feet behind. The sea nettle and lion's mane are usually the only two commonly occurring species that are a problem to bathers and fishermen in the New York area. The stinging cells of the moon jelly are seldom felt by humans. The "sting" of the jellyfish usually causes a mild, local reaction including red, swollen, irritated, or itchy welts occasionally accompanied, in more severe cases, by a burning, flashing pain. Tentacles broken off the bell during storms can still sting, even if found lying on the beach after several days. Rare, especially sensitive, allergic people can exhibit additional generalized symptons such as fever and/or chills, headaches, abdominal pains, nausea, and/or diarrhea that may last for several days. Jellyfish welts may persist for several weeks and repeated exposure may lead to allergic sensitization, possibly resulting in anaphylactic shock, a severe syndrome.

A common remedy if stung includes sprinkling the area with vinegar, baking soda, or meat tenderizer as soon as possible. The tenderizer has an enzyme that is thought to break down the protein toxin (Cargo and Schultz 1967). Rubbing the area with wet sand is not good, since many untriggered stinging cells may adhere to the skin and be released by further touch. Medical attention should be sought if irritation persists for more than an hour or so. There are species that are rare in our waters, e.g., the Portuguese man-o-war and the sea wasp, that are always very dangerous. Thus, a very severe sting should be brought to a doctor's attention immediately.

3. Is pollution causing an increase in the abundance of jellyfish? There is a hypothesis which suggests that an increase in the population of ctenophores or medusae may be the result of a pollution related change in the marine food web, i.e., nutrient pollution can cause a dominance of small flagellates or nanoplankton that are fed on by small zooplankton, which are more usable as food by jellyfish and ctenophores than by fish (Greve and Parsons 1977). This interesting hypothesis needs to be examined further before it can be accepted. However, Nelson (1925) reported "great rafts" of Mnemiopsis occurred off the New Jersey coast in the first two decades of this century, apparently before coastal pollution was much of a problem; but occurrence was highly variable, being completely absent in some areas during some years. Similar observations are known for the Cape Cod region for the turn of the century. Jellyfish are particularly sensitive, for their size, to toxic chemical pollutants, e.g., heavy metals (Reeve and Walter 1977; Gibson and Grice 1977).

4. Can jellyfish cause any other problems? Sometimes. Because of the presence of large numbers of jellyfish in estuarine, bay, or local waters, small copepods that ordinarily graze on phytoplankton blooms in these areas are often drastically reduced by predation by jellyfish. The lack of grazing copepods permits the plankton bloom to develop to a point where the bloom crashes (many phytoplankton cells die and sink to the bottom) and they and dying jellyfish can contribute to the development of local anoxic conditions (Cargo 1981; Lindahl and Hernroth 1983). Jellyfish, as mentioned previously, can also feed on shellfish and fish larvae and thus can be an important limiting factor in the food web. Other than their nuisance value, jellyfish do feed on ctenophores which help keep them under control.

ACKNOWLEDGMENTS

We wish to thank Dr. Carl Sindermann and Dr. John Pearce for their comments and review of the manuscript. Appreciation is also given to Janice Caracciolo-Ward for consultation and review. We also give special thanks to Michele Cox for preparing original illustrations and Maureen Montone and Alicia Gruber for typing the manuscript.

REFERENCES

Arai, M. N. 1973. Behavior of the planktonic coelenterates, Sarsia tubulosa, Philidium grearium and Pleurobrachia pileus in salinity discontinuity layers. J. Fish. Res. Board Can. 30: 1105-1110.

Bowman, T. E., C. D. Meyers, and S. D. Hicks. 1963. Notes on associations between hyperiid amphipods and medusae in Chesapeake and Narragansett Bays and the Niantic River. Ches. Sci. 4(3): 141-146.

Cargo, D. G. and L. P. Schultz. 1966. Notes on the biology of the sea nettle Chrysaora quinquecirrha in the Chesapeake Bay. Ches. Sci.: 95-100.

Cargo, D. G. and L. P. Schultz. 1967. Further observations on the biology of the sea nettle and jellyfish in Chesapeake Bay. Ches. Sci. 8: 209-220.

Ceccatty, M. P. and Hernandez, M. L. 1965. Integration and symmetry in Beroe. Am. Zool. 5: 537-543.

Delap, M. J. 1907. Notes on the rearing, in an aquarium, of Aurelia aurita, and Pelagia perla (Slabber). Rept. Sea Inland Fish. Ireland 1905: 22-26.

Feigenbaum, D. and M. G. Kelly. 1984. The effect of sea nettle abundance on the lower Chesapeake Bay food chain. Dept. of Oceanogr., Old Dominion Univ., Norfolk, VA (unpubl. ms.).

Fraser, J. H. 1962. The role of ctenophores and salps in zooplankton production and standing crop. Marine Reprint 190, Dept. of Agric. and Fisheries for Scotland. Vol. 15. Extract Cons. Internat. Explor. de la Mer.

Fraser, J. H. 1969. Experimental feeding on some medusae and chaetognatha. J. Fish. Res. Board Can. 26: 1743-1762.

Gibson, V. R. and G. D. Grice. 1977. Response of macro-zooplankton population to copper controlled ecosystem pollution experiment. Bull. Mar. Sci. 27(1): 85-91.

Gosner, K. L. 1979. A Field Guide to the Atlantic Seashore. Houghton Mifflin Co., Boston. 329 p.

Greve, W. 1970. Cultivation experiments on North Sea ctenophores. Helgol. Wiss. Meeresunters. 20: 304-317.

Greve, W. 1971. Okologische untersuchengen an Pleurobrachia pileus Krelanduntersuchungen. Helgol. Wiss. Meeresunters. 20: 303-325.

Greve, W. and R. R. Parsons. 1977. Photosynthesis and fish production: Hypothetical effects of climatic change and pollution. Helgol. Wiss. Meeresunters. 30: 666-672.

Horridge, G. A. 1974. Recent studies on the Ctenophora, pp. 439-468. In: Coelenterate Biology. L. Muscatine and H. M. Lenoff (eds.). Academic Press, NY.

Lebour, M. V. 1922. The food of plankton organisms. J. mar. biol. Ass. U.K. 12: 644-677.

Lindhal, O. and L. Hernroth. 1983. Phyto-zooplankton community in coastal waters of western Sweden -- an ecosystem off balance? Mar. Ecol. Prog. Ser. 10: 119-126.

Mansueti, R. 1963. Symbiotic behavior between small fishes and jellyfishes, with new data on that between the stromateid, Peprilus alepidotus, and the scyphomedusa, Chrysaora quinquecirrha. Copeia 1: 40-80.

Miner, R. W. 1950. Field Book of Seashore Life. Van Rees Press, NY. 888 p.

Moller, H. 1984. Reduction of a larval herring population by jellyfish predator. Science 224: 621-622.

Nelson, T. C. 1925. On the occurrence and food habits of ctenophores in New Jersey inland coastal water. Biol. Bull. 48(2): 92-111.

Reeve, M. R. and M. A. Walter. 1976. A large-scale experiment on the growth and predation potential of ctenophore populations, pp. 187-199. In: Coelenterate Ecology and Behavior. G. O. Mackie (ed.). Plenum Press, NY.

Russell, F. S. 1970. The Medusae of the British Isles. II. Pelagic Scyphozoa with a Supplement to the First Volume on Hydromedusae. Cambridge Univ. Press.

Swanberg, N. 1974. The feeding behavior of Beroe ovata. Mar. Biol. 24: 69-76.