

# SEA GRANT COLLEGE PROGRAM UNIVERSITY OF HAWAII

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# RESEARCH

## Hawaiian Prawn Aquaculture Program

The Hawaiian Prawn Aquaculture program consists of six subprojects: pond productivity determinants; aquacultural engineering and systems analysis; post-harvest handling and processing; behavioral biology; genetic improvement; and economic analysis and information systems. For the biennium Years 10 and 11, the aquaculture research efforts will be directed to one species, *Macrobrachium rosenbergii*.

Pond productivity requirements. A scientifically accurate determination will be made of pond and tank water quality to monitor levels of nutrients over the next 2 years. Experiments will be conducted to determine growth rates under natural and added-feed regimens and to assess the actual amount of feed utilization by the prawn. The information to be obtained from this study on the influence of mixing rate of bottom and surface waters and biotic and abiotic factors on production levels will be used to improve pond management strategies.

Aquacultural engineering and systems analysis. Existing practices for hatchery, grow out, and harvesting will be analyzed to determine where production can be improved and costs reduced. An intermediate nursery system will be tested for economic viability in reducing grow-out time of the prawns. Alternative pond designs with different bank-to-bottom ratio will be studied to develop more efficient biomass carrying capacity. A mathematical model will be developed for broad analysis of production current and proposed systems.

Post-harvest handling and processing. Storage quality of prawns will be tested using various packaging techniques such as tray and film, waxed carton and paper wrap, laminated bags, and ready-to-boil pouches with vacuum seal. Three methods of freezing will be utilized to test for product quality: sharp, brine, and liquid nitrogen. Frozen prawns will be tested at regular intervals over a six-month period. The effects of re-freezing, post-harvest handling, blanching, and large-scale storage will also be tested.

Behavioral biology. To enable researchers to determine the relationship between density and food distribution and the interactions related to movement, mortality, and growth, the plankton blooms usually allowed in ponds will be eliminated so that direct observations are possible. The behavioral differences in different genetic stocks will be assessed by stocking ponds at different densities, sizes, and sex ratios.

Genetic improvement. This two-pronged effort will study species of prawn obtained from Southeast Asia, Australia, India, and the South China Seas and will attempt to accentuate genetically those qualities that are economically significant through selective breeding. By mating a number of females with a single male, utilizing the ANOVA methods, it will be possible to calculate heritability values from data collected during the larval and juvenile stages of growth.



The bull-runt phenomenon, a recurring growth pattern shown above, is being studied so that it can be utilized to maximize production.

The Anuenue-stock parents with large and small phenotypic values will be crossed in a number of generations to assess genetic gain. During the period of the proposed study, 7 to 10 generations of selection can be accomplished. A computer simulation and analysis will be done to project long-term breeding program results based on known empirical data of the prawn's life cycle and the degree of genetic control over economically important traits.

Economic analysis and information systems. The hope for eventuality in the management of production ponds is that control limits will be set at optimal cost-effective levels. Besides the usual investments of land, labor, and capital, such parameters as feeding rates, stocking size and density, and water quality also need to be controlled or, at the very least, their quantitative relationships need to be determined. This project will develop an econometric model of pond prawn production and evaluate it as a tool.

## Ocean Engineering Program

The two proposed ocean engineering research proposals will study two ways of utilizing the marine environment: one will study the ever-present biofouling of engineered systems that are emplaced in the ocean, more specifically, the problem encountered in a heat exchanger system and the second will prove the applicability of novel design for an aquarium that places the viewer in the ocean environment.

High visibility undersea observation structure. It is strange that the two most valuable resources of Hawaii, good climate and clear waters, have not been utilized to promote educational and recreational activities. This proposal presents a structure which has potential for a unique offshore observatory which will put the viewer into the ocean. A prototype of a full-scale aquarium which will be land-based is being proposed with additional funding from the state.

### OTEC heat exchanger biofouling experiment.

Researchers will study the rates of biofouling, the characteristics and population of the organisms, and the effect of tube arrangement and daylight and darkness on biofouling. The loss of heat transfer caused by the biofouling on the heat exchangers will also be measured.

## Ocean Water Quality Program

The immediate impact of uncontrolled human activity in the littoral zone is a negative one. Careless development of land and dumping of waste into the ocean without regard for circulation can degrade the water quality along Hawaii's coastline and adversely affect the tourist industry; hence, the gross state product. Resident enjoyment of recreational use of beaches will also suffer. This program has two basic goals: the continuing study of virus-inactivating agent(s) present in Mamala Bay and Pearl Harbor and developing technologies that may minimize degradation of coastal waters. Three activities are proposed for the biennium Years 10 and 11.

Pathogenic human enteric viruses in Hawaiian ocean waters: role and effects of antiviral agent(s). Two major thrusts of this proposed project are to monitor viral presence and survival in sewage disposal sites under field conditions and to continue the work of characterization of the properties of the virus-inactivating microbes present in seawater. A curious phenomenon observed by researchers is the presence of antiviral microbes in Mamala Bay and Pearl Harbor, which apparently are not present in easily detectable quantities in all coastal waters. For some as yet unexplainable reason, they abound at those two sites. The solving of this mystery is one of the prime tasks of this project.



The Aquella, a virus concentrator used to recover viruses from samples of ocean water, is shown in operation off Ala Moana Beach Park. The Aquella is capable of processing 50 to 60 gallons of water per hour, concentrating the virus from the water sample through a series of selective filters. Photo by Henry Gee.

Microbial indicator for ascertaining fecal contamination of marine recreational waters. Researchers will evaluate the feasibility of using fecal streptococci as the indicator microbe for fecal contamination of Hawaiian marine environments and as a possible substitute for the currently used fecal coliform bacteria. An interpretation of the significance of the FC:FS ratio will be made for marine waters. Other viruses which infect bacteria associated with respiratory and dermal infection of swimmers will be considered if the evaluation of fecal streptococci produces negative results.

Marine mollusks as indicator organisms in benthic communities. Because they are ubiquitous and also sensitive to environmental stress, benthic marine mollusks can rapidly and inexpensively provide information on benthic marine communities. Water quality conditions of both stressed and unstressed areas will be related to mollusks as indicator organisms. A manual will be prepared on counting and analytical techniques and the dominant species found in selected sites. Mollusks will also be studied to determine whether they are possible carriers of pathogens.

## MARINE EDUCATION AND TRAINING

"Marine education" is a category which spans pre-college to graduate programs under the University of Hawaii Sea Grant College Program. The pre-college projects, in general, attempt to develop an informed marine constituency among the state's youth. At the undergraduate-level, the program is one of enrichment; at the graduate-level, three multidisciplinary courses in aquaculture which will be offered as part of formal departmental courses.

### Pre-college education

Makahiki Kai--festival of the sea. A multidisciplinary educational experience for upper elementary children, Makahiki Kai '78 will be a mini-expo during the Hawaiian bicentennial. It is a complete module, including a teacher guideline of preparatory activities for students, a student workbook, and teacher-guides at the exhibit site. The theme of Makahiki Kai '78, targeted toward upper elementary grade levels, will be "Hawaii during the whaling era."

### Curriculum design for secondary schools--grades 10-12.

A marine science curriculum for pre-college students begun during Year 07 will be completed during Year 10. The materials developed, which include a teacher's manual, a student manual, reference materials, and tests, will be field-tested during Year 10. Revisions will be made as needed in preparation for publishing materials with state and/or other funds as projected for fiscal year 1978-79.

### Undergraduate college education

Marine option program. Undergraduates in any discipline are given the opportunity to obtain a marine skill and to apply the skill in some way. MOP, although not a part of the formal university program, offers student participants a certificate after completion of a prescribed list of activities which include course work as well as hands-on skills application.

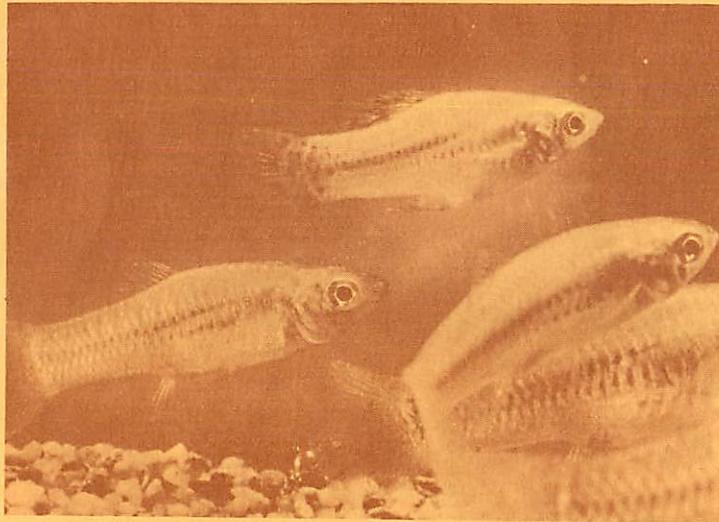
### Graduate education

Development of three new courses in aquaculture. One of the benefits which will result from the adoption of the three proposed courses is the legitimizing of studies in aquaculture as formal courses to be offered by the University through several departments. The proposed courses are: Genetics 625: "Aquaculture genetics: quantitative genetics and breeding methods in aquaculture species"; Zoology 716: "Biotechnological basis for fish culture management"; and IS 498B: "Aquaculture: the biology technology and economics of the commercial production of aquatic organisms."

## Marine Resources Development Program

Marine resources development and management are two sides of the same coin—that of exploitation of marine resources. Sea Grant-funded research provides data bases which are needed to develop rational guidelines. Hence, under this particular banner, research specimens range from living to non-living. Implicit in each project is the element of conservation and wise use.

Culture of baitfish. Recognizing the need for baitfish to catch the economically valuable skipjack tuna which abound in the Pacific Ocean, researchers propose a topminnow as a viable species for large-scale culture to supplement the popular but often elusive *nehu* (*Stolephorus purpureus*). Culture and sea trials have been held in Samoa where local fishermen are receptive to participating in tests. During Year 10, this continuing project will conclude the economic study on the cost-effective application of topminnow culture to skipjack tuna fishery development.



Topminnow is being cultured as an alternative baitfish for skipjack in American Samoa and Hawaii.

Survey and assessment of green sea turtle resource of the Northwestern Hawaiian Archipelago. The biology of the green sea turtle resource of the Northwestern Hawaiian Archipelago will be studied under this proposed project. The aggregations of all green sea turtles and their reproductive potential as well as the mortality factors that limit the expansion of the population will be studied. Daily movement, feeding, basking activities, and their long-distance migratory patterns will be monitored over a long term by tagging immature turtles. The biological data obtained will be the basis for recommendations for the management of this endangered species.

Ecology and resource potential of bottom fisheries in the Leeward Hawaiian Islands. In cooperation with the extensive federal-state program of data collection to determine ecological and resource potential of the Leeward Hawaiian Islands, this project will provide supplementary information and observations which will be obtained with the use of the submersible, *Star II*. The much-needed information base on the commercially valuable resources of the Leeward Islands will enable the state and federal governments to develop management plans required under the Fishery Conservation and Management Act of 1976.

Hydrometallurgical separation of metals from ferromanganese nodules and large-scale uses of residual oxides. An in-depth survey of selective leaching agents such as oxalic acid and other polycarboxylic acids for the separation of copper, nickel, and cobalt from ferromanganese nodules is proposed. An ancillary effort is a study of the absorption of sulfur dioxide by the nodule. The chemical nature of the interaction of sulfur dioxide with the manganese nodules will be studied.

Novel approaches to the uses of land plants in the sea. A number of plants useful for food and energy will be cultivated using saline water and non-arable land. Researchers hope to identify fast-growing leafy and root crops which can be cultivated with one-third strength seawater and to establish the physiological-biochemical responses to varying salinity by these plants. Plants will be cultivated in soils having high lava content and significant drainage.

## Pacific Basin Policy Studies Program

Recognizing that it is probably only a matter of time before the exploitation of manganese nodules will occur on an industrial scale, researchers are proposing an examination of the environmental impact of such processing activities. To this core of Pacific basin studies is added the activities of the Law of the Sea Institute which was transferred from the University of Rhode Island to the University of Hawaii in Year 09.

Environmental protection aspects of deep-sea mining and processing. Legal structures at the local, national, and international levels will be examined to determine their relationship to the environmental impact of deep-sea mining and processing of manganese nodules. Existing international agreements which may have bearing on the processing of manganese, either on land or ocean-based on floating platforms, will be critically examined. In addition, a preliminary compilation of US environmental laws as they apply to American mining corporations operating outside the 200-mile economic zone will be drafted.

Law of the Sea Institute. The Law of the Sea Institute was founded to provide a neutral forum for productive debate and research. Under the University of Hawaii, the Institute will continue to promote communications and research among those interested in all aspects of marine affairs. To continue the primary focus of the Institute on international aspects of law, utilization, and management of the ocean, emphasis will be given to the legal political, social, and economic consequences of the evolving uses of the sea. The eleventh annual conference which will feature workshops and papers will be convened in the fall of 1977 in Honolulu.

## Human Performance in the Sea Program

Since 1830, when an air-supplying device was invented to enable a diver to explore the wonders of the undersea world, the penalty for venturing into a foreign and hostile environment was also discovered. The diver learned the fearsome effects of decompression sickness or gas bubble disease which ranged from paralysis of the limbs, blindness, loss of balance and hearing, to a creeping destruction of the limbs and joints. Today, some 150 years later, the same fearsome penalties still plague the diver.

The University of Hawaii Sea Grant College Program has supported studies in human performance in the sea for the past 9 years to close the knowledge gaps that exist before man can live in harmony in hyperbaric environments. The ongoing studies have examined the response of the human system to the physical and chemical aspects of the marine environment and the resulting effects upon the physiological systems of the human organism and their ability to adapt satisfactorily to environmental stresses.

Exogenous gas bubble disease: physical factors in the etiology, detection, and prevention. Three basic activities proposed by the researcher are: data acquisition of physical laws that govern the generation, growth, and destruction of bubbles in water and in gelatin; the analysis and interpretation of data and the construction of nuclear models; and the computer analysis of existing decompression tables for empirical content and calculation of new decompression tables based on the refined nucleation model which will be developed.

Inert gas elimination during decompression. This project will study *in vivo* the onset and quantity of bubbles in the circulatory system with the Doppler ultrasonic probe implanted on the inferior vena cava. Other measurements will include cardiovascular performance, performance of the respiratory system, regional blood flow, respiratory gases and blood gases, effect of exercise on gas elimination, and hyperbaric exposure. Dogs and rats will be used as experimental animals.