MMDC-HIMB COOPERATIVE AQUACULTURE PROGRAM:

FINAL REPORT

James P. McVey

WORKING PAPER NO. 29

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SEA GRANT COLLEGE PROGRAM

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INTRODUCTION:

Sea Grant has played an instrumental part in the development of Sea Farming in Micronesia through its support to the Micronesian Mariculture Demonstration Center (MMDC). The initial Sea Grant program was begun in 1972 with a special training program for Micronesians to learn the principles of raising fish, oysters and shrimps under controlled conditions. Since that time Sea Grant has provided a total of $258,500 matched by $1,118,500 of Trust Territory funds for a comprehensive program of research that has had far reaching effects for Micronesia in terms of potentials for economic development. A new physical plant valued at close to $1,000,000 has been constructed which is capable of supporting hatchery programs in freshwater shrimp, saltwater shrimp, and marine fish as well as applied research. Laboratory and dormitory space is now available for visiting scientists so that a good exchange of information between Micronesian researchers and other scientists is now possible. An educational program provides slide shows and tours to student groups and the general public. The MMDC also maintains 3.2 acres of production ponds for freshwater shrimp capable of producing 15,000 lbs of shrimp/year which is operated as a demonstration pond complex. Eleven acres of privately owned brackishwater ponds are now producing milkfish, rabbitfish, and saltwater shrimps. A small oyster industry now exists to supply local demands in the Palau Dis-

trict. The MMDC also has a nucleus of trained Micronesians capable of operating the hatchery systems and production systems so that the technology developed during the Sea Grant funding period will be maintained without substantial imput from outside consultants.

All of the above could not have been accomplished without Sea Grant support in the form of equipment, materials, and consultants. The flexibility provided by Sea Grant contributions to the overall program helped to create a dynamic program in the bureaucratic environment of the Trust Territory.

Although the MMDC has been involved in several maricultural projects in the past five years this terminal report will primarily cover the work done on the four projects that have received the major portion of their support from Sea Grant Funds: The oyster project, rabbitfish project, freshwater shrimp project and tuna baitfish project. A complete program summary is offered topically below.

Oyster Project:

Four species of oysters occur naturally in Palau; Crassostrea echinata, Crassostrea mordax, Crassostrea glomerata and Ostrea nomades. Only C. echinata are found in commercial quantities and there was some doubt that it would be suitable as a product for the raw oyster market which is superior to the shucked oyster market. In 1974, Mr. Dennis Tufts, was contracted as part of the Sea Grant program to evaluate the possibility of raising imported Crassostrea gigas under tropical conditions and also to determine if the native oyster, C. echinata, was available in significant quantities for commercial exploitation and if it was an acceptable market product.

The technical reports appended to this summary provide the data obtained during the oyster study. The difficulty in maintaining field stations for sampling spatfall resulted in data that was inconsistant but the trends can be seen. It was found that the native oyster C. echinata was available in adequate numbers to support a samll local oyster operation. Oysters were found along the entire western coastline of the big island of Babelthaop with the main commercial stocks found between the villages of Aimeliik and Ngeremlengui. During preliminary harvesting operations it was found that shell cultch placed back on the beds provided the best attachment for juvenile oysters and that the best spatfall was from November through February. Approximately 18 months were required for oysters to reach commercial size of 50 mm after settling on the cultch.

The introduction of the Japanese oyster Crassostrea gigas was unsuccessful. The main difficulties were the inconsistent growth rate, expense of culture systems, loss of oyster strings due to corrosion of the galvanized wire used to suspend them, loss of experimental data due to vandalism and storm damage. Imported C. gigas were placed in Nestier trays and a variety of cultch was placed on galvanized wire suspended from rafts and racks. The best growth was observed on oyster shells strung on wire but after an initial rapid growth period of approximately five months the oysters ceased to grow. Subsequently, there was a steady attrition of oysters until the possible monetary yield fell far below the cost of importation. Eventually all oysters were lost during a typhoon so that terminal data was not available. The final conclusion was that a Palau oyster industry should be based on the endemic species of oysters and if a half-shell oyster is desired then systems to utilize the oyster Crassostrea mordax or C. glomerata should

be developed. This would require the establishment of a oyster hatchery at the MMDC which is not possible given the present funding levels and program priorities.

Rabbitfish Project:

This project was initiated in 1973, in response to the requests of local fishermen to help restore the natural populations of the rabbitfish, Siganus canaliculatus and S. lineatus. The purpose of the project was to develop hatchery techniques for the two species so that juveniles could be released onto the natural grass beds where these species occur. A secondary aspect of the project was to develop techniques for the commercial production of these two species in ponds or floating cages.

The MMDC, through the help of Sea Grant consultants, has succeeded in perfecting the hatchery techniques for both species of rabbitfish. Hatchery yields have increased from less than 1% to 19% survival. We have been able to close the life cycle of Siganus canaliculatus so that we now have our F_3 generation and are expecting our F_4 generation this spring. We have our F_1 generation of S. lineatus and we expect to produce an F_2 generation in the summer of 1977. A selective breeding program has been initiated and all brood stock is selected on the basis of size, growth rate and ability to survive under culture conditions.

A tagging program to determine whether hatchery produced rabbitfish can help the commercial fisheries has recently been initiated; thusfar, 550 fish have been tagged and we are awaiting recaptures to determine the effectiveness of a wild release program. One tag has already (10 days after release) been returned from a point 10 miles away from the point of release.

Field trials to determine the feasibility of culturing rabbitfish in

ponds and cages have shown mixed results. The most difficult problem is one of economics because of the low market price of rabbitfish in Palau and the difficulty in establishing markets and transportation systems to Guam where the price is higher. Three types of culture systems have been tried: Mangrove ponds, floating net cages and rock enclosed natural bays with sand and rock bottoms.

Siganus canaliculatus can not survive well in mangrove ponds. Three different culture attempts in mangrove ponds yielded only 0%, 1.5% and 11% survival. In contrast, the first field trial using Siganus lineatus showed 92% survival in one of the same experimental ponds. Future work in mangrove ponds will be done with S. lineatus.

Both S. canaliculatus and S. lineatus survive well in floating cages or natural bays that have been walled off. The difficulty with these systems is also economics as high density culture, which is necessary because of the cost of materials, also necessitates supplemental feeding. Imported feeds cost a minimum of 40¢/lb and pellets produced from local protein sources such as copra meal and fish meal cost about 15¢/lb.

At a conversion rate of 3:1 the minimum food costs per pound of fish produced would be 45¢ to $1.20. Add to this the cost of netting, floats or labor for feeding and maintaining the systems and you have a fairly high cost commodity. We calculated that we would have to obtain a minimum of $2.00/lb to break even in the culture of rabbitfish.

In addition to a wild release program and the mariculture program for rabbitfish a recent effort has been made to market S. lineatus as an aquarium fish. Although not spectacular in color, S. lineatus is an attractive fish with gold varigations and a bright yellow spot at the base of the dorsal fin. We are awaiting the response of tropical fish wholesalers so

that we can determine the receptiveness of the market to this species. The present experimental hatchery is capable of producing 100,000 juvenile rabbitfish, and if some of the production was sold as an aquarium fish it would be possible to offset our production costs.

The future programing for rabbitfish at the MMDC should include a selective breeding program for both species of rabbitfish, additional tagging of hatchery-produced individuals to determine the contribution of the hatchery to the wild populations of rabbitfish, further experiments on intensive culture of S. lineatus in mangrove ponds as well as testing cages and rock enclosures for both species to determine optimum culture methods. Increased emphasis should be placed on developing supplemental foods at the MMDC food processing laboratory. Thusfar, a meal composed of 60% copra meal, 20% fish meal and 20% flour mixed with a Syntex vitamin mix has proven the most productive but additional tests need to be run.

Freshwater Shrimp (Macrobrachium rosenbergii) Project:

The freshwater shrimp project was first initiated after the discovery of Macrobrachium rosenbergii, the freshwater shrimp presently utilized in commercial culture in Hawaii, in the streams of Palau. A consultant was obtained in 1974 to develop a small experimental hatchery for the production of juvenile shrimp which in turn would be placed in experimental ponds at various locations in Palau. Local brood stock was obtained and 10,000 juveniles produced and placed in growout ponds. The growth rate of this first group demonstrated that freshwater shrimp could be grown to market maturity in 6-8 months. On the basis of this information a larger mass hatchery capable of producing 6,000,000 post larvae per year was constructed and a 3.2 acre (14 pond complex) production pond facility completed on the big

island of Babelthaop. Additional village ponds at Ngiwal and Melekeok were built to try the concept of backyard production of shrimp in small ponds using local protein sources as supplemental food. We are still awaiting the maturation of the first crop of shrimp from our pilot farm in order to determine the overall feasibility of shrimp culture in Micronesia.

Scientifically the shrimp project at the MMDC is significant in that we have domesticated the Palauan strain of M. rosenbergii which is morphologically distinct from the Hawaiian strain. The Hawaiian strain is the basis for most other commercial culture operations and we are interested to see what differences there are between the two strains and if a hybrid vigor could be realized. We will compare the growth rate of Hawaiian stock to Palauan stock at our pilot farm.

Since its completion the mass production hatchery has undergone considerable alteration. We are turning more to recirculating systems because of the greater control we can effect over the larval rearing process. There is also a shortage of good quality fresh water at the MMDC and a recirculating system allows us to make better use of our limited water.

The economics of shrimp farming has been investigated during this study and it was determined that a family-operated 8 ha farm would probably have the greatest efficiency for a shrimp farm with an estimated break even point of about $1.72/lb. Smaller farms would be less efficient but it is probable that a $2.00/lb break even price would be possible for most Palau shrimp farms.

During the three years that the shrimp project has been in operation the majority of work has been involved with creating the infrastructure of the laboratory and production ponds as well as developing the techniques for hatchery culture of the Palauan strain. We are now prepared to produce

juvenile M. rosenbergii for distribution throughout Micronesia and we have a staff of trained Micronesians capable of continuing the project indefinitely.

Tuna Baitfish Project:

The supply of live tuna bait is at present the limiting factor in the expansion of the pole-and-line tuna fishery in Palau and throughout Micronesia. Muller (1976) estimated that the natural baitfish population in Palau, primarily Stolepherous purpureus, could support a maximum of 15 Okinawa style fishing boats at any one time.

In order to alleviate this problem the MMDC is working in cooperation with the University of Hawaii Sea Grant Program to develop the controlled culture of the topminnow, Poecilia vittata, so that there can be a supplemental bait source for the expanding tuna industry.

Thusfar, this program has been managed by a Peace Corps Volunteer who utilized Sea Grant funds to construct two baitfish hatchery tanks. The Van Camp Tuna Company has provided one baitfish growout pond and a tuna boat complete with crew for testing the bait, and the T.T. government has constructed three additional growout ponds and one baitfish hatchery tank.

The three hatchery tanks which are supplied with full strength sea

water, are producing 2000-4000 juvenile baitfish daily, which is equivalent to one to two buckets of bait after the fish have reached maturity. The fish are then transferred to the growout ponds where they are fed with pelleted food. We have found that it takes 3 to 4 months to reach a size suitable for using the topminnows as tuna bait. We fertilize the growout ponds with chicken manure and allow them to age so that a good supply of natural food such as mosquito larvae and chironomid larvae are available. The growth rate on these natural foods is at least equal to that on the pelleted foods.

Our first field test using the topminnows was held in March, 1977. The results were encouraging but not conclusive.
Our catch rate of .89 fish per hook minute is an improvement over the American Samoan tests which obtained .58 fish per hook minute.

We are now planning a second field trial for the end of the summer 1977. We intend to modify our fishing techniques and the way the topminnows are handled before being fished. The topminnows exhibited strong evasive action on one of the tests that we feel should be modified in order to improve fishing success. Therefore, we will be altering their behavior through chemical and/or mechanical means to reduce their mobility. The results of these tests will then be used to determine the future direction of this project. As of this writing it appears as if the mollies would prove superior to natural bait when rough weather prevents the boats from using the natural bait because of high bait mortalities which occur when the live wells are subjected to excessive agitation; when tuna are found in concentrations 50 or more miles from shore, and of course when there is insufficient natural bait available.

Miscellaneous Projects:

Although studies of saltwater shrimp and giant clams were not a significant part of the Sea Grant Program they should be mentioned because of their potential for future development. Peace Corps Volunteers studied the species distribution of giant clams and saltwater shrimp as well as the feasibility of establishing hatcheries for these valuable species. Approximately five species of commercially valuable saltwater shrimp were found in the Palau area: Penaeus monodon, P. semisculcatus, P. japonicus, Metapenaeus ensis. These shrimp were most abundant in the estuary systems associated with Ngatpang Bay, Taiyo River, Ngardoch river, Ngardmau river and Airai river, in that order of relative abundance. Although several hundred shrimp could be seen at any one of the above locations it was difficult to obtain sufficient numbers for stocking growout ponds with the inefficient means utilized in sampling, ie., dipnets and lantern technique. We are presently utilizing Filipino consultants to develop improved capture techniques for juvenile shrimps. If sufficient numbers can be obtained in future collections, then they should be placed in the milkfish ponds now in operation.

In addition to work with juvenile shrimps an attempt was made to obtain mature spawners for hatchery work. Adult Penaeus monodon, P. semisulcatus, and Metapenaeus ensis can be obtained at the locations mentioned above. Some gonad development was observed in captive individuals but no spawning was observed. As spawning of captive Penaeid shrimps has been achieved in Tahiti and the Philippines, an attempt was made to develop a system for

maturing shrimp at the MMDC. A tank system similar to the successful prototype in Tahiti was assembled and we have ablated eyestalks of adult P. monodon in an attempt to duplicate the induced spawning techniques established in the other countries; however, there has been no success to date.

Unless the difficulty in catching enough juvenile shrimps from the wild is resolved, the future work at the MMDC should concentrate on obtaining sexually mature individuals in captivity and then establishing a small hatchery to supply the brackish water ponds now in operation.

The giant clams, Tridacnidae, are represented by six species in Palau: Tridacna gigas, T. maxima, T. derasa, T. crocea, T. squamosa, and Hippopus hippopus. All of the clams are declining in number because of the demand for their shell and meat. The MMDC has been able to obtain spawning in captivity with two species, Tridacna maxima and Hippopus hippopus. The object of the work was to establish hatchery techniques for giant clams so that juveniles would be available to reseed the reefs which are seriously depleted of clams. Our work has shown that giant clams can be produced in hatcheries, and now we should concentrate on improving hatchery survival and developing systems for placing the young clams back on the reef.

PROGRAM SUMMARY

Technologically the applied research programs conducted with the support of Sea Grant have produced excellent results. It remains to be seen just how much economic impact these programs will have under the constraints of the social and political systems now in effect in the Trust Territory of the Pacific (Micronesia). We have tried to apply the systems that work effectively in other parts of the world, primarily the Philippines and

Indonesia, to the Micronesian situation. However, the economy of Micronesia is inflated and artificial because of financial support from the U.S. This has led to a higher standard of living and higher wages than would normally be possible with the present gross national product. Very few people are actually involved in primary production industries and a government job is considered the ideal. This makes establishment of a primary industry, such as aquaculture, very difficult. There is no motivation to do the hard manual labor that is necessary in constructing ponds and enclosures. The end of the United Nations Trusteeship Agreement in 1981 should bring about a situation that will be more favorable to economic development.

With the withdrawal of U. S. funding there will be considerable economic pressure to develop the primary production industries. The knowledge gained in our work on aquaculture at the MMDC should then prove invaluable in helping to create new industries for Micronesia. Sea Grant funding has enabled us to explore developmental possibilities that otherwise would be impossible to us on the limited budget provided by the Trust Territory. Our work with rabbitfish has provided the techniques for the mass rearing of a commercially valuable marine fish. The fact that at least two species, Siganus lineatus and Siganus canaliculatus, can be cultured, that they are herbivorous and easily domesticated, that they grow well on a wide variety of prepared diets, and that selective breeding is now possible because of the closed life cycle, all indicate that this group of fish can be used in a wide variety of monoculture and polyculture systems. Because of the accomplishments of the MMDC in establishing these facts about rabbitfish we are now one of the world leaders in the area of marine fish culture. Continuing efforts in this area will provide valuable information to Micronesia and the rest of the world interested in management of marine fisheries.

Our work with freshwater prawn culture has brought the technology developed in other areas to Micronesia and established an infrastructure for support of large scale production of this commercially valuable species. Recognition of a Palauan strain of Macrobrachium rosenbergii will enable genetical experiments to determine the commercial qualities of this strain alone or in mixture with the Hawaiian strain. Economically, prawn culture offers the best potential for Micronesia, and therefore, should be considered a top priority project.

The tuna baitfish project has attempted to resolve the problem of the availability of bait as a limiting factor to the tuna industry. As of this writing the mollie, Poecilia vittata, shows the best potential because of its fast reproductive and growth rates and because of its hardiness both in ponds and in the baitwells. If the additional field trials prove the feasibility of mollie culture for tuna bait, this will enable an expansion of the present tuna fleet which will improve the economic situation in Micronesia.

Even though oysters have a limited market in the Trust Territory and Guam, our work has shown the degree to which this resource can be developed. The small local oyster fishery is capable of supporting one or two families and as the market expands additional people can join the industry.

Saltwater shrimp should be the next project developed with the goal being the establishment of a pilot hatchery for the species found in Palau. This simply requires the adaptation of the techniques developed in the Philippines and Tahiti. Shrimp produced in the hatchery would then be used in existing brackish water ponds to improve the yield and economic return.

Giant clams (Tridacnidae) are rapidly declining in number. Our work has shown that a hatchery for these unique animals may be a possible tool

for reseeding the natural populations and that it may even be possible to have enough seed to attempt a giant clam "farm" on tropical coral reefs. This would enable people living on isolated coral atolls to have a cash crop growing on their surrounding reefs.