THE SOUTH PACIFIC ISLANDS FISHERIES NEWSLETTER

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C O N T E N T S

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SOUTH PACIFIC ISLANDS FISHERIES DEVELOPMENT AGENCY

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EDITORIAL

The three SPIFDA projects earmarked for support with the existing funds available to the Project by the Consultative Committee meeting in 1972 have now been reduced to two. Discussions between UNDP, New York, and the American Government still not proving conclusive, instructions were issued by UNDP that no further SPIFDA funds were to be disbursed in the Trust Territory of the Pacific Islands on the mariculture demonstration centre at Koror, Palau. The centre continues its programme of experimentation but can therefore no longer look to SPIFDA for financial support. However, SPIFDA continues to remain in close touch with the work being accomplished there as with every other fisheries interest in the Pacific and, in fact, Mr Baird, the SPIFDA Project Co-Manager, in his capacity of Fisheries Officer, South Pacific Commission, paid a brief visit to the centre during the month of February.

The funds which had been allocated to the services of an FAO consultant for the centre are now to be diverted to the other two aquaculture projects in New Caledonia and in Fiji.

Of the two experts now to be appointed by the FAO to SPIFDA, recruitment of an oyster culturist (to be based in Fiji) is under way by FAO and we hope to have definite news soon of his appointment and arrival in the Pacific. The aquaculturist - to be based in New Caledonia - has now been appointed and arrived in Noumea on 16 March. He is Mr Dan Popper from Tel-Aviv University, Israel, where he has been undertaking laboratory and field research and study into rearing and reproduction of fish and more particularly of rabbitfish. Mr Popper is an experienced diver and has been in charge of diving activities of the Department of Zoology at the University. His arrival has been awaited with impatience and the mariculture centre at the Baie de Saint-Vincent will now be able to embark on the next phase of its experimental programme, the centre also now benefitting from the services of a young volunteer from New Zealand, Wayne Osten, recruited by SPC as part of their counterpart contribution to SPIFDA.

After an initial period of orientation and assessment in New Caledonia, Mr Popper will visit Fiji to familiarise himself with the status of aquaculture there and to study how the two centres may best work together. He will, of course, be available to visit other areas of the Pacific during his one-year term. Since the last issue of the SPIFDA Newsletter both the Project Manager and Project Co-Manager have visited several of the territories within the sphere of SPIFDA interests.

This issue of the Newsletter is largely devoted to culture of prawns and it is hoped that the information will be of some value to territories who wish to interest themselves in this branch of aquaculture. However, it should be pointed out that SPIFDA does not necessarily endorse the opinions or conclusions expressed.

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AQUACULTURE IN EQUATORIAL AND TROPICAL PACIFIC ISLANDS: PRESENT STATUS AND PROSPECTS OF FUTURE DEVELOPMENT

by

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INTRODUCTION

Tropical and equatorial Pacific islands generally have only a small emerged land area. But a particular structure has evolved through geologic evolution and coastal coral reef morphology which provides a very wide surface of controlled water. In the global search for new sites capable of supporting squaculture, development of such islands emerges as the most promising.

NATURAL BACKGROUND

Best aquatural sites

(1) Completely or partially enclosed atoll lagoons.

Fully enclosed lagoons retain all the fertilization produced by washing and leaching of the coral barrier. By dividing off sections into ponds such lagoons offer the easiest management possibilities. It is also possible to use their potential as a whole by introducing new species which cannot then escape. Where a narrow and shallow passage breaks the coral ring it is possible, easily and inexpensively, to organize an effective exchange of water masses.

About one hundred atolls in the tropical and equatorial Pacific have completely or partially enclosed lagoons, mainly in the Tuamotu Islands, the outer islands of the Society archipelago, Line Islands, Phoenix, Gilbert and Ellice and Marshalls.

(2) Karstic-dissolved pools in old coral reef structures.

Many emerged reefs have small karstic-dissolved pools where the sea water enters by filtration. Usually the surface of such a basin is no more than one or two hectares and the depth one metre. But some raised reef islands have pools of different sizes from one to one hundred hectares with a greater depth of up to ten metres or more. Such sites offer the best conditions for marine farming as fences may be built easily and at a low cost and a system devised for circulation of water from pool to pool. Christmas Island has more than 5,000 hectares of such structures and others are well developed in Palau (Western Caroline Islands) and in Vavua (Tonga).

(3) Inland bays with deltas and mangroves.

Some continental or volcanic islands have large delta areas with mangroves. Many enclosed brackish-water ponds and deep channels prowde good sites for aquaculture. But the best places are the salt flats which lie between the mangrove fringe and the land. The main deltas are in New Caledonia (St. Vincent Bay 20,000 hectares, Diahot 10,000 hectares, Dumbea), in Fiji (Rewa 30,000 hectares, Ba 30,000 hectares, Daku 12,000 hectares, Lombasa 10,000) and in the Solomon Islands - but such sites also exist in other places such as Palau or Ponape in Micronesia.

Natural stocks

Often the best sites for aquaculture have existing natural stocks which can be used for initial experiments in development.

(1) Molluscs.

Enclosed lagoons often have extensive beds of mother-of-pearl oyster shell (Pinctada margaritifera), the best grounds occurring in the Tuamotu Islands and northern Cook Islands. Edible mangrove oyster, Crassostrea glomerata, extends over many areas with heavy concentrations in New Caledonia, Fiji and Society Islands. Rock oyster, Crassostrea echinata, which is larger in size and is of a stronger flavour, covers rocky areas of New Caledonia, New Hebrides and also Palau. Many other edible shells occur on sandy beaches such as arkshell claim, Anadara, and venerid shell, Gafrarium.

(2) Crustaceans.

Surveys have recently recorded several high-density stocks of Penaeides shrimps in deltas, muddy flats and mangrove channels: in New Caledonia Penaeus monodon, P. merguiensis and P. semisulcatus and in Fiji P. monodon and P. semisulcatus. Penaeides shrimps can adapt their biological cycles to a pure atoll environment (two species were recently discovered on Tarawa Atoll, Gilbert Island). Macrobrachium (giant fresh-water shrimp) occurs in heavy density in every river of continental and volcanic islands.

(3) Fish.

All over the tropical and equatorial Pacific it is relatively easy to catch from natural stock fish-fry of grey mullet (Mugil cephasus), blue tail mullet (Mugil scheli) and milkfish (Chanos chanos). Rabbitfish (Siganus sp.) are also quite common, their fry reaching the coral reefs in April/May in Micronesia and December/January in Melanesia.

(4) Turtles.

Green turtles (Chelonia mydas) and Hawksbill turtles (Eretmochelys imbricata) nest in breeding grounds of some of the remote islands affording easy collection of eggs for hatchling cultivation.

Open spaces for new species

Isolation increases from west to east in the wide tropical Pacific area and many potential but specific habitats remain unoccupied. It should be possible to successfully introduce useful species without damaging the existing equilibrium. Good examples are the transplant of a Trochus niloticus population in Micronesia between 1935 and 1940 and the same operation in 1957 from New Caledonia to Tahiti. Many areas appear to offer good potential for the Japanese oyster, Crassostrea gigas, and also for other edible tropical or subtropical molluscs such as the green mussel (Mytilus smaragdinus) from the Philippines and Perna canaliculus from New Zealand. Possibilities of introduction of brine shrimp (Artemia salina) appear good in salt marshes and lagoons of the drier islands.

TRENDS IN AQUACULTURE

Policy of development

In some islands (Gilberts, Tuamotus, Society, Tonga Tapu) people traditionally collect milkfish and mullet fry, placing it in natural ponds or fencing it off in closed lagoon areas so that there is always a ready and safe supply of fish. But, apart from the Mikimoto pearling venture on Palau Island between 1932 and 1942, no commercial aquaculture was attempted in the tropical and equatorial Pacific islands until 1959 when the Fisheries Division of French Polynesia started a programme for farming edible oysters in Tahiti and producing pearls in the Tuamotu Islands.

Since 1965 every territory in the area has launched an aquaculture enterprise in order to make best possible use of their natural resources. As such new fields of activity require the assistance of many specialists in various branches of scientific research and technology, widely-ranged international cooperation was promoted through the South Pacific Islands Fisheries Development Agency (SPIFDA) financed by UNDP, managed by FAO and with counterpart assistance from the South Pacific Commission. This Agency started its Plan of Operation during the year 1970 by undertaking surveys in the area to assess potential for fish and mollusc farming and also to assess turtle, lobster and beche-de-mer resources. Following on the recommendations of the consultants, the SPIFDA Consultative Committee took the decision in October 1971 to develop aquaculture demonstration centres in Palau, New Caledonia and Fiji; SPIFDA and other FAO experts were also to give support to research programmes in the Gilbert and Ellice Islands and in French Polynesia. National organizations were following other programmes: Hawaii University has a project in the Christmas Islands, the Oceanic Institute (Hawaii) in the Cook Islands and in Tetiaroa (French Polynesia) and French CNEXO in Tahiti.

With the more promising prospect of profitable undertakings, some private business entered the field of aquaculture on their own account (oyster farming in New Caledonia, New Hebrides and French Polynesia, giant fresh-water shrimp farming in Tahiti, pearl products in Tuamotu).

Status and results as at January 1973

(1) New Caledonia.

Three private oyster farms are undertaking small-scale farming with native rock and mangrove oysters. Catching spat is relatively easy but achieving a marketable size product takes three years. Sydney oysters, Crassostrea commercialis, are imported and grow well but they give little spat for collectors. The experimental introduction of the Japanese oyster, Crassostrea gigas, has given excellent results both from natural spat from Japan collected on oyster shells and from artificial 'free' spat bred in California.

Commercial growth of Crassostrea gigas 'free' spat is being tried on the west coast; in the south (Prony), the centre (St. Vincent Bay) and in the north (Poya).

The Fisheries Division of New Caledonia is starting experiments in farming European flat oysters. One private farmer is experimenting with Ostrea edulis artificial spat from California.

The SPIFDA St. Vincent Bay aquaculture demonstration centre, supported by the New Caledonian administration, was completed in August 1972 with an experimental pond 12,000 square metres in surface and 20,000 cubic metres in volume. Water is changed by pumping at the rate of 1,200 cubic metres per hour. The present programme includes experiments in farming natural fry of mullet, rabbitfish and Penaeides shrimps and further research will include induced artificial breeding of such species; an Israeli FAO expert in rabbitfish breeding research is already appointed for a full year term. First results show evidence of the possibility of farming banana prawns, Penaeus merguiensis, from post larval to adult stage (12 g. males, 35-40 g. females) in less than four months.

(2) New Hebrides.

A private oyster farm in Espiritu Santo is based on collection of spat and farming of the native rock oyster, Crassostrea echinata. Cultivation of imported artificial Japanese oyster 'free' spat from California was started during October 1972 and results appear good.

(3) Fiji.

In 1971 the Fisheries Division of Fiji started to develop an oyster farming scheme near Suva. Japanese artificial 'free' spat was imported from California and was put in raft cultivation after glueing on masonite sheets. Large scale operations in 1972 were successful, giving commercial-size Japanese oysters after only 9-10 months farming. The SPIFDA project includes plans to enlarge the scale of experimentation and to survey other areas where native stock is abundant but undersize. A prawn survey is to be initiated to investigate the possibility of using the local species for farming. Fish-ponds are already made for small-scale mullet and rabbitfish farming in connection with the mangrove reclamation scheme in the Ba area organized by the Agricultural Division; this fisheries project is to be run in conjunction with the SPIFDA St. Vincent Bay project in New Caledonia. An FAO oyster culturist is appointed for a one-year programme from March 1973.

(4) Western Samoa.

An experimental green turtle farm is being built by the Fisheries Division.

(5) Cook Islands.

An integrated aquaculture project, mainly for mullet, was started on the recommendation and responsibility of the Oceanic Institute of Hawaii which appears to be suffering difficulties of logistics and lack of support.

(6) French Polynesia.

The Fisheries Division is developing oyster farming on Tahaa Island in the Society Islands for the Tahiti market using the local <u>Crassostrea glomerata</u>. Fifty-two local farmers are forming a co-operative organization to market their products.

The main work of the Fisheries Service is concerned with pearl production. Increasing the production of natural beds by stocking them with 200,000 spat of mother-of-pearl shell was tried in Takapoto Island (Tuamotu). The fast growth of these shells warranted extension of such experiments by the co-operative societies of five other Tuamotu islands.

166 Polynesian islanders were trained in producing half pearls and blisters by co-operative socieites in Hikueru and Takapoto (Tuamotu) and in Gambier Islands. Many thousands of first grade round pearls are also being produced by a private French company on Maniki Island and by a Japanese company on Takapoto Island.

Movie actor Marlon Brando, owner of Tetiaroa Atoll north of Tahiti, is apparently co-operating with the Hawaii Oceanic Institute in another project of integrated aquaculture.

Giant fresh-water shrimp farming, started in 1970, has suffered major set-backs but will be on a new footing after the return of a local marine biologist trained in Hawaii. The national French CNEXO is just starting a shrimp farming operation with a five-year programme of integrated experiments including South Pacific and exotic species of Penaeides. Penaeus merguiensis breeding stock was transferred from New Caledonia in December 1972 and in January 1973. Central American Penaeides and Japanese Kuruma Ebi will be the subject of applied study in regard to artificial breeding and cheap feeding formulas to be undertaken in 1973.

(7) Gilbert and Ellice Islands.

A general survey of aquaculture possibilities is being undertaken by the Fisheries Division in collaboration with SPIFDA. A FAO aquaculture expert from Taiwan is working for a two-year term in the territory. The main project is a scheme proposed by experts from the University of Hawaii for mass production of brine shrimp (Artemia salina) eggs on Christmas Island; if the local government gives support to this enterprise it would be the first aquaculture business on a world-wide scale to be established in the Pacific Islands.

(8) Trust Territory of the Pacific Islands.

While there are doubtless many sites affording excellent potential for aquaculture throughout the islands of Micronesia, Palau has been chosen as the focus of a wide programme of applied research and experimentation. Palau mariculture demonstration centre started as a SPIFDA project and is now supported only by American Sea Grant and the local Administration. Small-scale operations started in 1971 with a first attempt at collecting native oyster spat and raising young Hawksbill turtles. The programme for 1972 was enlarged to include commercial-scale edible oyster production and initial experiments in rabbitfish farming. Major development should be possible in 1973 with the appointment of a full-time American oyster expert using imported species. A project of rabbitfish and milkfish farming in Pelelui Island (southern Palau) is to be undertaken, using a natural 3-4 hectare lagoon.

PROBLEMS OF FUTURE DEVELOPMENT

Selection of site

Until the present time the choice of a coastal or lagoon site to develop aquaculture in tropical or equatorial Pacific islands has been made with only scant knowledge of natural environment and possible productivity.

Physical, chemical and biological data on a lagoon water mass has been compiled only from observation of a limited number of areas over short periods. No series of simultaneous observations can be drawn on to build up a comprehensive classification of the best grounds for aquacultural development. Nor is a great deal known about movement of water through the lagoon passage and phenomena of water exchanges between lagoon and open sea.

In view of the widely dispersed islands and the vastness of the area, one must find new techniques affording means of simultaneously assessing different factors, such as temperature and spectral components, over the largest possible surface. Remote sensing and scanning by micrometer may be achieved from aeroplanes thus providing quick and extensive coverage of coastal and lagoon area. Selection of a site should be based on a compilation of comprehensive scientific data of archipeligos having islands scattered along a length of over 2,000 kilometres as the Marshalls, Gilberts and Tuamotus. Observations by satellite would afford the only real possibility of collating chrono-sequential figures.

Hydrobiological control

As in all warm countries the water masses of the tropical and equatorial Pacific islands suffer quick stratification as happens in enclosed ponds. Dry season trade winds are less harmful than the relatively calm and wet rainy seasons. It is, in any case, absolutely essential to either use a system of mixing water or constantly adjust the water level through gates to correspond with the rise and fall of the tide or ensure an artificial flow by pumping. Subsurface water aerators can be used for mixing, as in Japan, fof ponds ranging in surface from one to two hectares. Increase in oxygen will induce a higher productivity giving a good return for the expenditure incurred in installing an appropriate system. One of the major problems to be solved is the control of the fertilized enclosed lagoon or pond water without eutrophization by constant action of the physio-chemical factors. It is not necessary to have a very expensive or sophisticated pumping system introducing the deep outer-reef water thus increasing the productivity of the enclosed surface water by a higher mineral-dissolved content. This is necessary only for development of a long-term project involving considerable capital in keeping with a major world scheme. Setting aside such technology for the future, it appears that the main areas able to supply aquacultural development offer a fairly high level of productivity culminating in peaks of eutrophization as in some Tuamotu atolls.

Natural zooplankton, including copepods, frequently occurs with a sufficiently high density to support a high level of predation. For phytoplankton one solution would be to develop assocated cultures of heavy feeders like Artemia salina able to quickly clear a dangerous over-density and provide food supply for the carnivorous feeders.

Development of breeding and feeding for large-scale production.

Producing an adequate supply of spat and larvae is a basic requirement of any large-scale operation. It would not be safe to rely exclusively on natural stock except where it is quite impossibleeto obtain self-breeding, as in particular species such as milkfish (Chanos chanos). For development of oyster and shrimp farming, breeding centres are necessary having supporting field laboratories and the means of selecting breeding stock and despatching spat and post larvae all over the area. Hybrid species selected should be capable of making maximum use of the natural environment.

But the main problem to face in large-scale projects for shrimps and also turtles, and even fish, is concerned with formulas of cheap feed. As all the islands suffer a total lack of second-class fish and shellfish to be used large-scale as natural feed, it would appear necessary to restrict farming to the herbivorous species or to import large amounts of dry pellets from USA or Japan. However, the associated development of Artemia salina farming should provide the necessary support for integrated shrimp farming and the present search for new bonito and tuna fisheries may furnish the opportunity to use side-products from freezing plants in some places in Micronesia, the Gilbert and Ellice Islands and Fiji. In the same way aquaculture opens a new means of using side-products of some local industries such as coprah mills and beer factories.

Logistics

The main problem in the tropical and equatorial Pacific is not to select convenient places for aquaculture - there are plenty and perhaps too many - but to have sound logistic support of transport and maintenance in such an area. Many islands are too isolated for the development of any new enterprise. It would seem absolutely essential to locate new aquaculture ventures near established and developed centres which can provide the necessary facilities: energy, machinery, feed, storage, laboratory control, etc. In the present economic position of the area, the only way to success is to promote projects in the simplest form in the vicinity of the main centres. Exceptions should only be made when a considerable investment is being or has already been made in a remote area for some other objective such as a military project or atom testing plant. The scheme for large brine shrimp egg production on Christmas Island is acceptable and promising because of the abundant facilities and equipment built up ten years ago for the Anglo-Australian-American atomic tests. The same may be said of some Tuamotu islands when the present French experiments are terminated.

But, apart from such specific instances, there is little chance of success in developing aquacultural centres without the support of air transport, electricity, engineering services, laboratory analyses, etc. This severely restricts the choice in selecting a good site.

Marketing

On the basis of present population distribution and economic development the area of the tropical and equatorial Pacific has a somewhat limited local market. It must always be remembered that the total population as of 1973 is only 1,300,000.

(1) Family level consumption.

When heavy over-fishing endangers the reef and lagoon complex a good solution of island-level problems would be to build up small-scale traditional fish farming for mullet and milkfish. But as the population pressure is quickly decreasing in the outer islands through islanders migrating to the main islands with urban centres, such development is fairly limited in the future. The one big exception is turtle farming which, when successful in selection of feeding formulas, can provide a very popular and successful family occupation.

(2) Marketing at local and regional level.

Islanders now do not need food so much as money; aquaculture is accepted and regarded by local people only as an efficient cash-crop bringing a return of money. Some island markets are importing more and more sea products under pressure of the process of urbanization and the progress of tourism.

Having from 60,000 to 90,000 consumers enjoying a high level of living and having many tourists and expatriates, Guam Island, Tahiti Island and Greater Noumea City are each able to count on a yearly market of about one million dollars in sea food, mainly shrimps, fresh oysters and high quality fresh fish - and they can easily expand this market to more specialized products like half-pearl and blisters and small stuffed Hawksbill turtles to the extent of at least another half million dollars each. With the booming tourist industry and increase in local standard of living, Greater-Suva (Fiji) is rising to reach the same potential levels.

Prospects for regional markets as a whole are encouraging and, based on the general progress of the many urban centres serving as capitals for the different territories, have a potential yearly growth rate of more than fifteen percent.

(3) Supply of live baitfish.

Inasmuch as many recent successful surveys have located bonito and small yellowfin tuna schools throughout the year in many island groups, there is clearly a strong need of baitfish to supply local fishing fleets. Samoa, Fiji, Gilbert and Ellice and the Marshalls are alreaey concerned by the need of such a supply. Producing baitfish is a fairly recent aquacultural objective but it is already a promising one as prices can reach one dollar a kilo for an appropriate selection of small fishes easy to keep alive. The success of this new field of aquaculture depends mainly on ability to select appropriate species to fulfil the requirements of tuna fishermen. As the estimated increase of livebait bonito fishing for the area is a minimum of 60,000 tons, there are marketing possibilities open for many hundreds of tons of cultivated livebait.

(4) World market.

Potential for aquacultural development is so high that it should easily be possible to supply regional requirements by using no more than one ten-thousandth of the available natural resources. For the furtherance of island development the real problem is to challenge the world market. But, as transport in the area is particularly hazardous and expensive, it is necessary to select for the purpose specialized products of sufficiently high value to absorb in their selling price the cost incurred in shipment. As the economics of feeding remains unsolved, the first species to be selected must be those requiring for their productivity only a natural environment.

Seen in this perspective the first choice must lie in pearl and jewellery products and brine shrimp eggs. Both provide a product of value, easy to store and to transport, and for which there is a wide-open world market for production of high waulity. Exploitation of both requires only improvement to their natural environment and the minimum of essential imported facilities. Both must compete with strong competition (Japan for pearls, America and Canada for brine shrimp eggs) but, as the world market needs a so much greater supply of top quality products, the Pacific islands can offer their large, unspoined, warm waters, having easily exploitable facilities, as a substitute for the polluted coastal areas of Japan and California. Such scope can attract large companies to enter Pacific islands aquaculture as a business investment. In the category of produce able to absorb the expense of export transport are live prawns for the fresh market or frozen pink shrimp tails, of which the first production would be easily taken up by regional requirements.

CONCLUSION

Through a combination of scientific research, private investment, economic development planning by the territories and international co-operation (UNDP, FAO and SPC) applied aquacultural projects have already been launched in the waters of the tropical and equatorial Pacific islands. Limiting factors such as lack of adequate knowledge of a large part of the area, difficulties of supply of stock for farming and of cheap feed, lack of logistics and hazardous marketing cannot impede the present movement towards better valorization of the most extensive mass of easy-to-control, unspoiled, warm water in the world.

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PACIFIC AQUACULTURE CONFERENCE

held at
The Institute of Marine Biology, University of Hawaii

6 - 8 February 1973

This Conference was held under the auspices of the United States Sea Grant Programme, the purpose being to try to ascertain how each organization concerned with aquaculture could best contribute to its furtherance and how best use might be made of existing means of coordination. It was therefore of some importance to aquaculture activities in the whole of the Pacific area.

SPIFDA Project Manager, Professor François Doumenge, was invited to attend. Other participants present represented -

Sea Grant
National Oceanic and Atmospheric Administration (Hawaii and Seattle)
Institute of Marine Biology, University of Hawaii
Oceanic Institute, Hawaii
Marine Laboratory, Guam University
Fish and Wildlife Division, Guam
Marine Resources Division, Trust Territory
East-West Center, Hawaii

Several participants addressed the Conference on the status in the Pacific of various fields of aquaculture and the meeting afterwards split up into working groups to discuss in more detail the potential of individual species.

The main species of value to aquaculture were given an order of priority for Sea Grant funding in the Pacific area; this was as follows:

Vertebrates:	Sea turtles	(Chelonia)
	Rabbitfish	(Siganids)
	Mullet	(Mugil sp.)
	Milkfish	(Chanos chanos)
	Baitfish for skipjack fishing	
Invertebrates:	Giant freshwater shrimp	(Macrobrachium rosenbergii)
	Brine shrimp	(Artemia salina)
	Shrimps	(Penaeid sp.)
	Lobster	(Homarus sp.)
	Oyster	(Ostrea sp.)
	Coconut crab	(Birgus latro)
	Mangrove crab	(Scylla serrata)

Other species reviewed were -

Fish:	Jack	(Carangidae sp.)
	Dolphin-fish (Mahimahi)	(Coryphaena hippurus)
Molluscs:	Giant clam	(Tridacmea and Hippopus)
	Octopus	(Octopus sp.)
	Mussels	(Mytilus sp.)
Crustaceans:	Crayfish/spiny lobster	(Panulirus sp.)

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Report on the SIGANID MARICULTURE IMPLEMENTATION CONFERENCE

held at the Hawaii Institute of Marine Biology
1 - 5 November 1972

by
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Introductory comments

1. Fishes belonging to the family Siganidae are widely distributed in the Indo-Pacific region and are now the subject of considerable interest because of their potential for mariculture. The attention of mariculturists has been drawn to these fishes for several reasons. Siganids are highly esteemed as food by indigenous peoples in many parts of the Indo-Pacific and the existing demand and market potential are high. Secondly, siganids have biological characteristics which make them attractive as mariculture animals: they are primarily herbivores, adapt well to captivity and can be fed either natural foods or artificial rations. Siganids have been induced to spawn in captivity in Singapore and Israel and siganids have spawned spontaneously in captivity in Palau. One species has been taken through its entire life cycle in Japan.

/Editor's comment: This is not to say that at present siganid breeding is an attractive proposition - refer (2) and (3) below./

The purpose of the meeting was to review knowledge of siganids and progress in their mariculture to date and to formulate plans which would implement the farming of siganids on a commercial scale as rapidly as possible. It was also felt that the meeting would help to avoid duplication of effort in siganid research and would promote communication and cooperation between interested parties.

Participants

Participants came from Guam, Singapore, the Trust Territory and three institutions in Hawaii (the Oceanic Institute, the Hawaii Institute of Marine Biology and the Bishop Museum).

Proceedings

Participants discussed the biology of siganids, reviewed preliminary mariculture efforts and formed an informal Siganid Mariculture Group which drafted a proposal for a siganid fish farming programme, the overall objective being:

"to enhance the yield of siganid species suitable for human consumption by a variety of means ranging from management techniques in natural environment to intensive culture".

The following activities were identified as essential to the implementation of this objective.

1. Species survey. An effort be made to establish a generally-accepted nomenclature and to identify siganid species in each region by use of photographs, scientific and common names. Revision of the family Siganidae presently being carried out by Dr David Woodland (University of New England, NSW, Australia) should materially aid this effort. Factors affecting the local market value of various species - palatability, abundance, etc. - should be identified in order to provide a rational basis for selection of species to be cultured.

2. Juvenile-Adult farming. In certain areas large numbers of juvenile siganids seasonally invade reefs. Collection of these juveniles and their rearing to market size represents the best immediate prospect for the initiation of commercial siganid farming, analogous to the Japanese method of culturing Yellowtail (*Seriola quinqueradiata* - Temminck & Schlegel).

/Editor's comment: In some areas farming in cages may produce reasonable results./

3. Fry production. Research on spawning in captivity, induced gonadal maturation and larval rearing are necessary to place siganid farming on a sound basis in the long term.

4. Production economics. An analysis of all economic aspects of siganid farming should be carried out to establish whether the venture will be commercially successful in a given set of circumstances.

5. Spine irritation and ciguatera. The irritant properties of siganid spines, while not a significant obstacle to farming operations, should be studied more thoroughly, and siganids from various localities should be screened for ciguatoxin (confirmation of ciguatoxin in siganids is as yet lacking).

The Siganid Mariculture Group agreed on a tentative plan of organization, dividing tasks among participating institutions. A report, "Plans for a siganid fish farming program", was produced, outlining the programme and presenting the organizational plan. Dr T.J. Lam (Department of Zoology, University of Singapore) was chosen as interim coordinator for the programme and persons having information relevant to the programme should communicate with Dr. Lam.

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A FEED PREPARATION SYSTEM FOR CRUSTACEAN DIETS

by

George H. Balazs, Ernest Ross and Coy C. Brooks
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INTRODUCTION

The development of experimental rations for crustaceans under consideration for aquaculture has been hampered by the lack of a simplified and inexpensive method of binding feed ingredients into a water-stable form. This is especially true if conventional feedstuffs are to be utilized. Standard pellets and "crumbles" manufactured for domestic animal production disintegrate rapidly when placed in fresh or sea water, thus fouling the medium and rendering nutrients less available for consumption. For juvenile and adult shrimps and crabs feed particles need to be bound tightly enough to prevent undue wastage during the slow mastication process thus ensuring that ingestion of a ration can continue for at least several hours after introduction. In addition, it is highly desirable to be able to store an animal ration without refrigeration.

Ingredients which have been tested for their binding ability include agar, alginates, carageenan, guar and locust bean gums, gelatins, celluloses and various other combinations of agents manufactured under brand names. Some success can be obtained with each of these additives when incorporated at the proper level into a diet. Experimentation in our laboratory has indicated that for any one of these binders, dissolution of feed is affected by feed ingredient combinations used, type of medium (sea or fresh water) and flow rate and temperature of the medium. In addition, method of preparation is critical for some systems, thus close attention must be given to quality control if adequate binding is to be achieved. Although suitable for small batches, the large scale production of experimental rations bound with any of the above-mentioned additives is limited by 1) cost, 2) availability and 3) machinery which can be readily utilized in the manufacturing process.

FEED PREPARATION

Feed ingredients used in animal diets include soybean meal, fish meal, shrimp meal, brewer's yeast and ground corn, to name a few. Representative experimental crustacean diets of differing protein level and source are listed in Table 1. The ingredients were first weighed out according to formula and thoroughly blended in a dry feed mixer. All formulas contain 20% high gluten durum wheat (*Triticum durum*) flour. Hot water is added to the dry mixture at a rate of from 35% to 45% by weight. The exact quantity is dependent upon the particular combination of ingredients in the formula. Ration 1 used 45% and ration 4, 35%. The mass is thoroughly kneaded to wet all particles and to form a tough dough. Kneading is readily accomplished by passing the material three or more times through a heavy-duty meat chopper fitted with a large bore (10 mm) die. The machine used in this study is a Toledo Hi-Speed Chopper (Model 5521) fitted with a 5 hp motor and reduction gear drive.

The resultant dough is shaped into final form by extruding with the same machine through a small die. Rations in this study were prepared using a 3 mm die, although larger sizes may also be suitable. As the spaghetti-like strands were formed, they could easily be spread out on flat trays. When correct water additions are made, extruded material may be stacked as deep as 3 cm without sticking together. Extruded material is subsequently dried at 80°C for 10 hours in a forced air oven and sealed in air-tight heavy-duty plastic bags.

Table 1. Percent composition of prepared experimental crustacean diets.

Ingredient	DIET 1	2	3	4
Soybean meal	30.5	8.0	8.0	8.0
Hawaiian fish meal	–	4.0	6.5	11.5
Shrimp meal	–	15.0	24.0	42.0
Brewer's yeast	5.0	5.0	5.0	5.0
Corn, ground	40.5	47.0	35.5	12.5
Wheat flour, high gluten	20.0	20.0	20.0	20.0
Tricalcium phosphate	3.0	–	–	–
Vitamin-trace mineral premix	1.0	1.0	1.0	1.0
Total protein, calculated	25.0	25.0	30.0	40.0

RESULTS

Results of water stability tests conducted on diets prepared by this method are presented in Table 2. These data show that binding efficiency is affected by diet composition as would be expected. Stability in sea water was consistently better than in fresh water. Nutrient dissolution from each particle is apparently slower in sea water due to the higher ion concentration in comparison to fresh water. At the end of the five-hour tests all particles were still firm, retained original shape and could be handled without falling apart. Losses displayed in Table 2 were considered acceptable for aquatic crustacean feeding. Under intensive farming conditions it may be advantageous to feed growing shrimps every 3 to 4 hours, making a longer ration stability time unnecessary. In fact, the present cost of producing a more stable ration may well be uneconomical in terms of the benefits derived.

Rations were subsequently tested in feeding experiments to evaluate their growth promoting ability. Animals were held under controlled laboratory conditions in fibreglass aquaria which provided a 0.9 m^2 bottom area with no substrate. Results of these studies are presented in Table 3. In general these data show that all diets produced good growth with low mortality.

Under the conditions of this study it seems logical to conclude that the feed preparation method described offers a simple, rapid and relatively inexpensive technique for producing experimental crustacean rations with acceptable levels of water stability. In addition, these rations are capable of producing good growth when fed to two species of Penaeid shrimp.

Table 2. Percent dry matter weight loss of prepared crustacean diets in water(1)

Ration	1 hour		3 hours		5 hours	
	Sea	Fresh	Sea	Fresh	Sea	Fresh
1	6.7	10.7	9.8	11.6	11.3	12.4
2	6.4	11.9	8.2	11.9	8.4	12.3
3	5.9	13.1	9.5	13.2	11.4	13.4
4	5.8	14.3	9.1	16.3	10.5	16.6

(1) 26°C flowing at 6 litres per minute.

Table 3. Results of feeding studies using prepared crustacean diets.

Species	Ration	Number of animals	Experimental period (days)	Mean weight, grams Initial	Mean weight, grams Final	Weight Incr. (%)	Survival (%)
Penaeus japonicus	1	15	25	2.25	4.63	105.8	93.3
" "	2	15	25	2.27	4.70	107.0	86.7
" "	3	15	25	1.66	5.62	238.6	93.3
" "	4	15	25	1.50	6.44	329.3	100.0
Penaeus aztecus	2	155	25	0.58	1.20	107.0	95.5

*

* *

INTENSIVE CULTURE OF *PENAEUS* SHRIMP IN HAWAII

by

Robert D. Cordover
Hawaii Institute of Marine Biology

The *Penaeus* shrimp research programme at the Hawaii Institute of Marine Biology emphasizes two aspects of mariculture: feed development and intensive mass culture of juveniles to market.

Our mass holding techniques were developed to overcome problems specific to Hawaii: shortage of land adequate for mariculture and very expensive land and labour. In many islands in the South Pacific that otherwise have optimum conditions for shrimp culture, the lack of sufficient land adequate to produce a commercially profitable shrimp crop is a problem.

Farming of any organism implies control; control over environmental variables, predation, competition, health, reproduction, feed conversion and harvesting. Control over these factors allows us to manipulate the cultured animal to maximize yields to the farmer. In more advanced animal husbandry the genetic component of the animal is also manipulated to produce larger, faster-growing or better feed-converting animals.

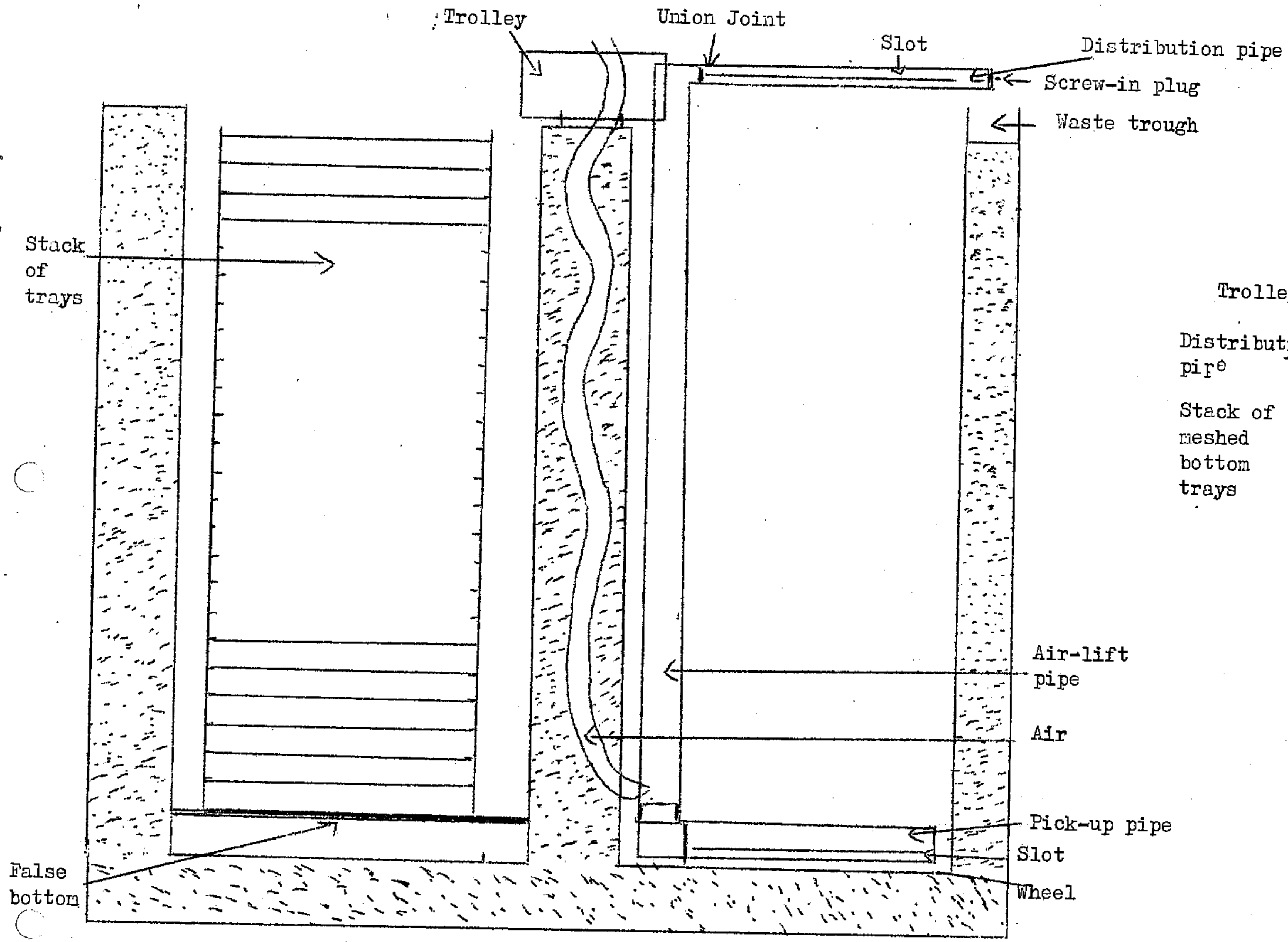
Usually *Penaeus* are raised from postlarvae in ponds where there is very little control over even the most grossly limiting variables. Consequently, yields per square metre are uneven and generally low. Whereas the average pond yield is 0.1 – 0.3 k/m^2 in the best managed ponds, and is 2.5 k/m^2 in the newest Japanese-designed tanks (K. Shigueno, Kagoshima Prefecture, Japan), we expect to harvest ten to twenty times that by raising *Penaeus* in plastic mesh trays stacked up through the water column.

Our current trials using this method are very promising. Growth has been roughly equal to control shrimp raised in the conventional manner in a sand bottom tank. On our first trial, mortality was 10% per month after we modified our tanks to keep the direct rays of the sun off the trays. Our present tank design is hardly finalized but the concept is quite encouraging and we are presently preparing to build an improved model.

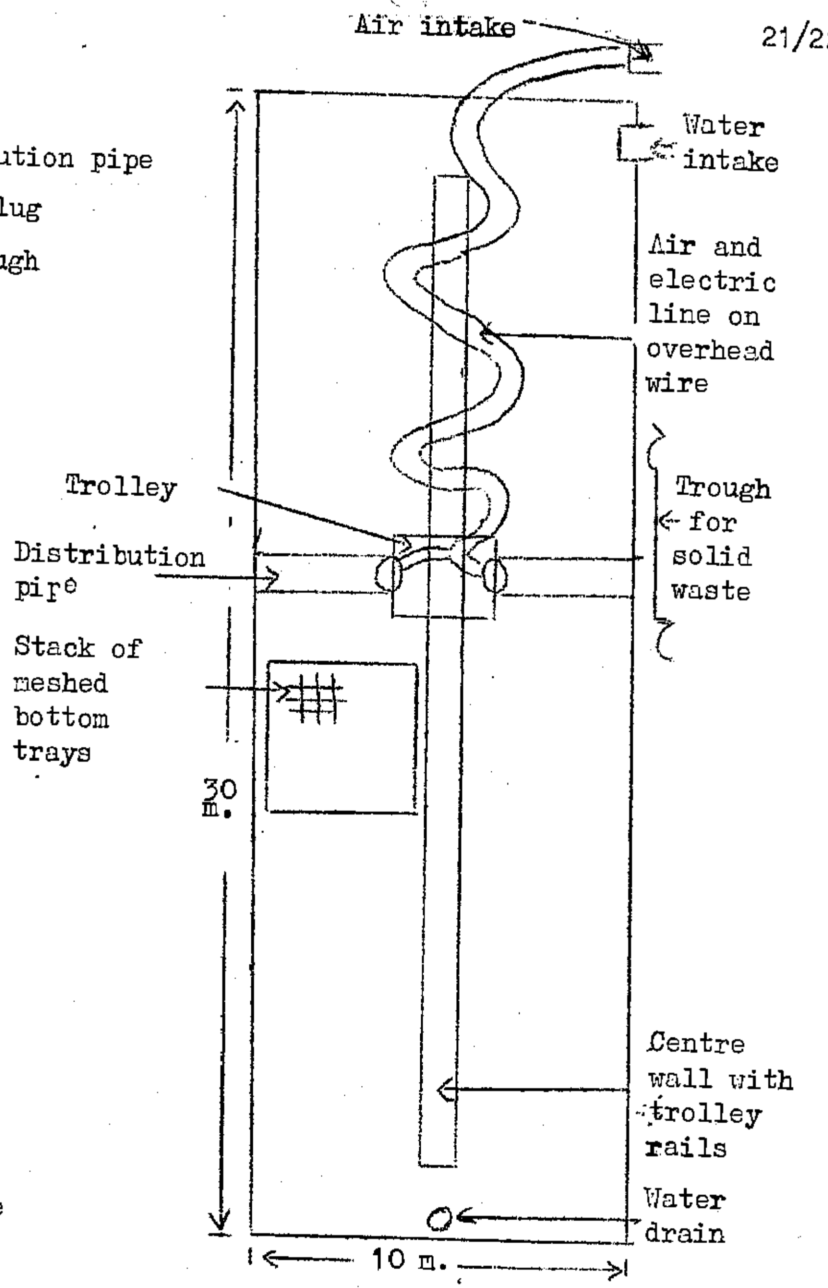
The prototype in which the present trials are being conducted works as follows: We have constructed a 10m x30m tank, 1.2m deep. Running down the length of the tank, bisecting it, is a block wall on which a trolley rides at about 0.1 m/sec. Attached to the trolley, and extending into the water on both sides of the centre wall, is an air lift pump. This device is simply a vertical length of pipe stuck into the water with air injected into the bottom. The air forms bubbles and rises, carrying water up the pipe. At the bottom of the pipe we have attached a horizontal extension pipe spanning the width of the tank. This pipe has a slot allalong its length which picks up water from the entire width of the tank. As the trolley carries the air lift pump along the length of the tank, particles of food that have filtered down through the stack of mesh trays are sucked up, pumped up the vertical pipe and redistributed across the top of the stack of trays. The distribution pipe can be adjusted to send waste particles to a drain along the side of the tank by turning the slit to the top of the pipe.

The water in the tank is continually being aerated by the pump and thus supplying oxygen for the shrimp and oxidising dissolved metabolites. Solid wastes can be cleaned out at will, which prevents the development of bacterial decomposition and its resultant stresses. Food can be continually redistributed with almost no waste. Water exchange can be minimized in this system since water quality is maintained at a high level and oxygen is continously being added to the water. Since water exchange is minimized, temperature control can be maintained with great precision. The incoming water can be delivered free of predators, competitors and even of fouling organisms.

An important advantage of this system is that shrimp can be continually stocked and continually harvested throughout the year. The farmer can guarantee delivery to the market of a known quantity and size shrimp. Formerly, a pond had to be stocked all at one time and harvested only once or twice a year, thus risking a glutted market and lower market price for the shrimp. The development of an intensive system of <u>Penaeus</u> shrimp culture will allow us to control many aspects of the environment and result in large production of shrimp at relatively low cost on Pacific Islands where formerly no shrimp at all could be raised.



CROSS SECTION VIEW



PLAN VIEW

GIANT PRAWN CULTURE TRAINING PROGRAMME

Hawaii

15 June - 5 October 1972

The State of Hawaii Department of Fish and Game, after years of research, have discovered a viable method for rearing the Giant Malaysian Prawn (Macrobrachium rosenbergii) in captivity. Recognizing this success in Hawaii, the Mekong Committee of the Economic Commission for Asia and the Far East (ECAFE) requested, through the East-West Center Food Institute at the University of Hawaii, aid in developing a training programme in the culture of the Giant Prawn for fisheries officers in the Mekong area. This request culminated in the implementation of the Giant Prawn Culture training programme, by which ten participants (two each from Cambodia, Thailand, Mauritius and Hawaii and one each from Malaysia and Tahiti) completed an intensive four-month course.

The course was sponsored by the East-West Center Food Institute and ECAFE and cooperating institutions were the Hawaii State Fish and Game Department, Fish Farms Hawaii Inc. of Maui, the Hawaii Institute of Marine Biology, the Department of Animal Science and Oceanic Institute.

The programme included training in larval culture, pond management and in the solution of engineering problems that had been overcome at the Anuenue Research Station of the Fish and Game Department at Sand Island. The direction of the course at Sand Island was by Mr Takuji Fujimura, who originated mass-culture work with the Malaysian Prawn. The objective of this part of the programme was to develop skills requisite to planning and implementing prawn culture operations.

The Hawaii Institute of Marine Biology provided a week's instruction in shrimp nutritional problems, intensive phytoplankton culture and shrimp taxonomy. The Oceanic Institute at Makupuu was the site of an additional week's activity in which the participants learned techniques of inducing spawning in the grey mullet, learned to culture phytoplankton using sugar cane waste as a source of nutrients and, through numerous seminars, were introduced to a variety of problems that arise in aquaculture. Shrimp disease problems were covered by the Animal Science Department at the University. The participants studied field management of a prawn farming operation at Fish Farms Hawaii Inc.

The principal objective of this overall programme was to provide sufficient practical training in the culture of Macrobrachium to enable the participants to construct and operate a hatchery and to raise the juveniles through to adulthood in captivity and to give some understanding of the problems arising in related fields.

It is not planned at present to repeat the course in Hawaii. However, it might be possible that the State of Hawaii Department of Fish and Game would agree to one or two graduate student assistants working with Mr Fujimura for a period of up to one year. Such participation, it is thought, would give a thorough grounding in the techniques, both biological and engineering, required of a commercial programme of prawn rearing.

* * *

Extracts from

"ECONOMIC FEASIBILITY OF FRESH WATER PRAWN FARMING IN HAWAII"

by

Yung Cheng Shang
Assistant Economist, University of Hawaii

A 49-page mimeograph (June 1972)
published by

Economic Research Center
University of Hawaii
1110 University Avenue
Honolulu, Hawaii 96814

The Fish and Game Division of the State of Hawaii imported 36 giant freshwater prawns (Macrobrachium rosenbergii) from Malaysia in 1965.* After a thorough investigation of the physical and biological characteristics and after numerous rearing trials, a mass rearing technique was developed. The State scientists can now hatch eggs and rear them through the life cycle. To date more than 2 million prawns, comprising five generations, have been produced from the 36 originally imported prawns. The advantages of this particular species over many other crustaceans are: (1) It readily adapts to a wide range of salinity, (2) it is amenable to culture techniques, (3) it breeds throughout the year under natural conditions, (4) a large female can produce as many as 80,000 eggs, (5) the female carries and cares for eggs thus resulting in relatively high hatching success, (6) it has a relatively short larval life, (7) it is a fast-growing omnivore, feeding on both animal and plant materials and (8) taste test done by an independent laboratory in New York indicated that the frozen freshwater prawn was more delectable than frozen salt water shrimp.

Although it is technically feasible to produce prawns in Hawaii, the economic feasibility of this production has yet to be determined. The major objective of the study is to evaluate the economic feasibility of freshwater prawn production in Hawaii.

The study is divided into six sections. The method of evaluating investment worth is presented in Section II. Section III estimates the cost of juvenile prawns, while Section IV measures the economic worth of the investment in prawn farming. The prospects of the industry and a summary and conclusions are presented in Sections V and VI. (Text of the latter Section follows - Ed.)

Two major steps are involved in prawn production on a commercial scale: (1) producing juvenile prawns (eggs to stockable size) in a hatchery and (2) rearing stockable juvenile prawns in ponds to market size.

*T. Fujimura and H. Okamoto, Notes on Progress Made in Developing a Mass Culturing Technique for Macrobrachium rosenbergii in Hawaii, Division of Fish and Game, State of Hawaii, 1970.

Juvenile prawns are an important input to the industry. The costs of producing juvenile prawns are estimated and the break-even price of juvenile prawns is calculated. The calculation is done by using the present value formula under various conditions. The level of production is the only variable that makes a significant difference in the results of the calculation. The calculated break-even price of juvenile prawns ranges from $5.33 - 6.12 per thousand based on an annual production of 16 million and from $4.10 - 4.69 on an annual production of 23 million. Production could be increased by reducing the mortality rate and the length of the production cycle.

The economic worth of investment in prawn farming is also measured by the present value method. The net present value and the break-even price of prawn farming are calculated. The criteria are that (1) if the calculated net present value is positive, investment in prawn farming would be profitable and (2) if the calculated break-even price is lower than the expected farm price of prawn, investment in prawn farming would also be profitable. The calculations are done by two levels of production: 3,000 and 4,000 pounds per acre per year; four sizes of farm: 10-acre, 50-acre, 100-acre, 150-acre; five levels of discount rate: 6, 8, 10, 12, 14; and three levels of farm price (present value calculations only): $1.20, $1.60, $2.00 per pound. Except for the 10-acre farm at the price of $1.20 and $2.00 per pound and the 50 and 100-acre farms at $1.20 per pound, the calculated net present values are all positive. The calculated break-even price of prawn varies with the farm size and the discount rate used. It is in the range of $1.09 - 1.86 per pound when the annual production is 3,000 pounds per acre and in the range of $0.90 - 1.48 per pound if the annual production is 4,000 pounds per acre. As one would expect from the cost data, there are economies of scale. The large scale operation is more profitable than the small ones. The minimum price of prawns for a 150-acre farm is about 50 percent lower than those for a 10-acre farm.

The prospects of this industry depend on the market potential of prawns. It is estimated that the local market potential is less than half a million pounds at the price range of $1.60 - 2.00 per pound with heads on. It requires less than 170 or 125 acres with an annual production of 3,000 or 4,000 pounds per acre respectively. If the price of prawns is about the same as that of shrimp of comparable size, which is equivalent to about $1.20 per pound in live weight, the local consumption may be over 0.5 million pounds under an adequate market promotion program.

There is a potential market on the U.S. mainland and in Japan. However, it is unlikely that locally produced prawns can compete with shrimp of comparable size in those markets at the present unless production cost is reduced and/or the price of shrimp is still increasing there. With demand for shrimp outpacing supply, shrimp prices have been increasing rapidly during the past few years in the United States as well as in the world markets. This appears to hold some promise for prawn farming in the future.

Since there are no commercially operated prawn farms in existence here, most of the data used in this study are based on preliminary estimates. The estimates of the production costs of juvenile prawns are based largely on the actual data of the hatchery owned by the State, while the estimates of prawn farming are based on several sources. The former estimates are considered more reliable than the latter.

The value of agricultural land ranges from $4.000 to $25,000 an acre. It is assumed in this study that land is leased from the State. The rent of State agricultural land is relatively low, about $25.6 per acre per year. Such an assumption would bias the estimation on the high side (on the low side for break-even price estimates) in the case of land purchased or leased from other sources.

Freshwater prawn is a new product. Little information is available at the present concerning the price and demand for prawns. It is assumed in this study that prawns are closely competitive with shrimp of comparable size. However, these two products are not strictly comparable. The taste test indicated that frozen freshwater prawns were more delectable than frozen salt water shrimp and may command a higher price. The market potential of prawn in the local as well as outside markets should be investigated closely in the future.

The farming method described in this study is a labor intensive operation. Harvesting and feeding are all done manually. The cost of production would be reduced significantly if the farm could be mechanized and if a better and cheaper commercial feed could be developed. Since labor and feed are the most important cost items further research to cut these costs seems necessary.

Fish farming generally requires a higher level of management than conventional agriculture in the sense that the technology as yet lies mainly in the realm of art rather than science. For any individual or firm embarking on a commercial prawn rearing venture, it is essential that the operation be headed by or closely advised and supervised by a person specifically trained in the culture of prawns. At present, only a few persons have this competence within the State. Training of management personnel seems necessary before a commercial prawn industry is started.

* * *

BREEDING OF COCONUT CRABS (*Birgus latro*) IN THE NEW HEBRIDES

The news bulletin published by the French Residency in the New Hebrides (page 10 of the issue dated 23 March 1973) (Thirteenth Year, No. 12, week from 12 to 18 March) contains a note on a native coconut crab breeding project.

"At Fanáfo, a village sixteen miles from Luganville, on the island of Santo, a coconut crab (Birgus latro) breeding venture has been started.

"Between 800 and 1,000 such crabs, all of them of fair size, are parked in three enclosures. Each of these enclosures is made up of sturdy wire-netting (going deep into the ground to prevent escape by burrowing) capped with corrugated iron (to prevent the crabs from climbing out). Two further enclosures, each of them spacious, are being constructed. Within the wire-netting, the natural wooded habitat of these crabs has been preserved, so that they can nest in the tangled roots. The coconut crab is a sturdy creature and no elaborate installations are required.

"The villagers, anxious not to destroy the free-living crab population, alternate between several areas previously defined for the purpose of choosing crabs for breeding. Besides which, a good many crabs are contributed by the people of other villages, such as Port-Olry.

"The young crabs are fed on sprouted coconut and bread. After the first moulting, the growth rate increases and the crabs soon reach marketable size.

"This is a profit-earning venture since a crab sells for around 200 francs, and major investments are not required. In Santo and elsewhere, crab-breeding could well provide a useful source of income for other villages. There would be a demand, since Vila, Santo and even Noumea could absorb far more crabs than are now available. The example set by Fanafo could well be followed elsewhere".

This note is accompanied by two photographs in black and white.

* * *

A P P E A L
for information concerning
<u>Cetacea</u> washed ashore
by

Dr Paul Rancurel, ORSTOM, Noumea

ORSTOM, in Noumea, has begun to keep a record of notable marine incidents occurring in the Western Pacific. It is chiefly interested in forms of aquatic animal life (whether such animals be large or small), washed up in large numbers, and in any unusual form of such life which may be stranded on the coast.

In recent months ORSTOM has investigated reports of the stranding of Cetacea in the New Hebrides and Loyalty Islands, and of fur-seals in New Caledonia. Such reports may concern large Cetacea (such as whales and sperm whales) or small ones (such as dolphins), whether stranded in large numbers or individually; or forms of marine animal life unusual in the area (the sea-lion in New Caledonia is a case in point). They may relate to dead fish washed ashore in large numbers, or to dense shoals of small crustaceans. Such phenomena, together with any apparent changes in the colour of the sea (whether associated with the destruction of marine animal life or not) are of interest to ORSTOM.

The ORSTOM research workers in Noumea would also very much like to have reports of any attacks by sharks, against either human beings or boats.

As regards stranded Cetacea, informants are asked, as far as possible:

1. To supply photographs. These should be taken perpendicularly to the animal, so as to avoid foreshortening. Scale should be added by including some familiar object of known dimensions.

2. To indicate measurements, and the proportion of males and females.

3. To preserve, as far as possible, the bony parts (crania and jaws), which will be sent to the Taxonomic Museum, Amsterdam, Netherlands, for study by Dr. van Bree.

4. To note the state of the sea and the weather at the time of the stranding.

5. To provide information such as would assist a scientist in reaching the scene of the incident with the minimum loss of time, so as to undertake biological examinations.

The above information should be sent to:

Dr. Paul RANCUREL, or

M. René GRANDPERRIN, at:

O R S T O M,

B.P. A5,

Noumea, New Caledonia

Telephone: 610.00 Telegrams: ORSTOM NOUMEA
624.55
626.77

For those of our readers who possess no works of reference, the following brief account may assist them in making a speedy identification of any specimen of the Cetacea which may have been washed ashore.

The Cetacea fall into two sub-classes:

1. The Mysticeti, or whales properly so called, with whalebone (baleen) instead of teeth. In the South Pacific, the Megaptera (fairly big) are the ones most commonly encountered. However, specimens of small species (such as the Minke or Dwarf Whale), about which very little is known, may be met with.

2. The Odontoceti, or toothed Cetacea. These fall into four classes, according to how many teeth they have in the upper and lower jaw, counted separately.

Group I: 0/1 to 0/27 (this means that the range runs from specimens with no teeth in the upper jaw and 1 in the lower to specimens with no teeth in the upper jaw and 27 in the lower).

Monodon	0/0 - 1/0	(Narval Whale)
Hyperoodon	0/1 - 0/2	(Bottlenosed whale)
Ziphius	0/1 - 0/2	(Beaked Whale)
Mesoplodon	0/1 - 0/2	(Beaked Whale)
Berardius	0/2 - 0/2	(Beaked Whale)
Grampus	0/6 - 0/14	(Risso's Dolphin)
Kogia	0/9 - 0/14	(Pygmy Sperm Whale)
Physeter	0/20- 0/27	(Sperm Whale).

Group II: 10 to 20 in upper or lower jaw:

Globicephala	10/10	(Pilot Whale)
Pseudorca	10/10-11/11	(False Killer Whale)
Orcinus	10/10-12/12	(Killer Whale)
Feresa	11/12	
Orcoella	12/12 - 19/19	
Neophocoena	15/15 - 19/22	

Group III: 20 to 30 teeth in upper or lower jaw:

Phocoena	19/22 - 27/27	(Harbor Porpoise)
Steno	20/20 - 27/27	(Rough-Toothed Dolphin)
Tursiops	25/25	(Bottlenosed Dolphin)
Peponocephala	25/25	(Mallicolo Porpoise)
Cephalorynchus	25/25 - 32/32	(Magpie Porpoise)
Lagenorynchus	27/27 - 34/34	(Magpie Porpoise)

Group IV: More than 30 teeth in upper or lower jaw:

Delphinapterus	32/40	(Beluga)
Prodelphinus	34/34 - 52/52	(Long-Beaked Dolphin)
Lissiodelphis	43/43 - 46/46	(Long-Beaked Dolphin)
Delphinus	47/47 - 65/65	(Dolphin).

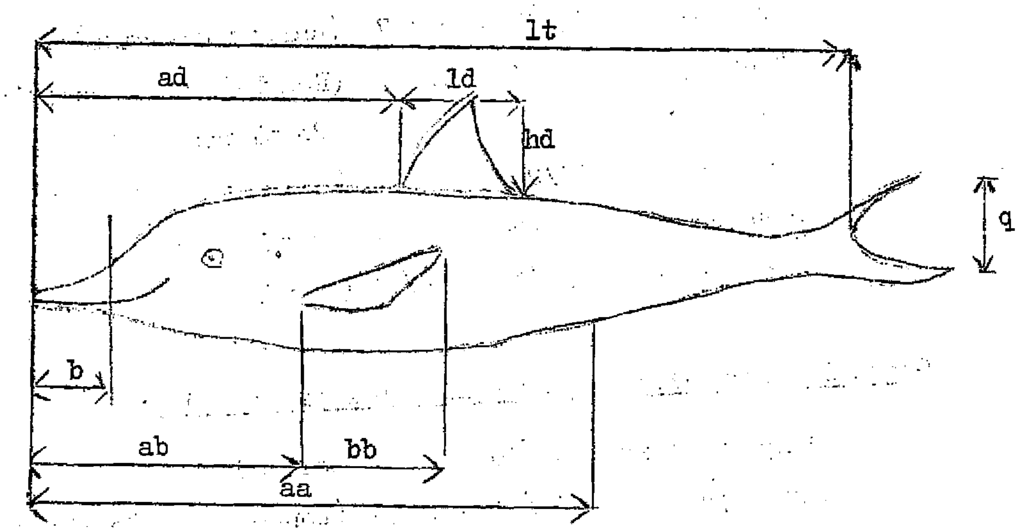
Naturally, the above is somewhat arbitrary and is merely designed to assist in distinguishing between the various kinds of Cetacea, which may externally look very much alike. Furthermore, some of the above genuses live in chilly waters. But there are always liable to be surprises in the distribution of these large migrant animals.

Measurements to be taken:

aa:	Distance in front of anus
ab:	Distance in front of fin
ad:	Distance in front of dorsal fin
b:	Length of beak
bb:	Length of fin
hd:	Height of dorsal fin
ld:	Length of dorsal fin
Lt:	Overall length
q:	Width of tail

The following should also be recorded:

No. of teeth, upper jaw and lower jaw;
Colour;
Sex.



Cetacea:

A Few Notes on Strandings in the Pacific during the Last Few Months

The Pacific is vast, its islands, atolls and reefs innumerable. Until recently, population density was relatively low and communications were often non-existent. Hence up to a few years ago information about the stranding of marine animals, as supplied to the appropriate scientific authorities, was scant indeed. Recently, however, population has notably increased, transistor radios are common, and communications by aeroplane have significantly developed, with the result that the scientists are no longer quite so badly off in this respect as they used to be. Nevertheless, there is all too frequently a considerable time-lag in reporting, and laboratories find themselves frustrated of interesting and valuable data which could have been investigated had they been alerted at once. This state of affairs is largely due to the fact that coastal island-dwellers are not aware that a stranding can be an event of major scientific interest. All too often, it is for them no more than a striking but by no means exceptional natural phenomenon. If they only knew !

We are exceedingly ill-informed about the marine mammals, large and small, which frequent these areas. Many species are represented only by a few skulls in museums and are considered to be extremely rare. Whether they are so in fact is another matter; it often happens that a species is considered rare only because information is so scanty, as we shall see. Very little is known about the movements of these animals and the ecological conditions in which they live, and only by repeated examinations on the occasion of strandings can we hope to fill the gaps in our knowledge. This is why news of a stranding should be passed with all possible despatch to the nearest science centre or scientific authority, so that accurate observations may be made by trained personnel.

Since the moment when ORSTOM, in Noumea, first took up these problems, a series of strandings have been reported. Curiously enough, most of the animals involved were rare(which would seem to show that rarity is indeed a subjective notion !).

In June-July, 1972, a Kogia breviceps (a little Cetacea believed to be rare) was washed ashore at Poum in New Caledonia. Since 1871, no more than a hundred or so specimens of this species have been captured anywhere in the world ! Accordingly, very little is known about its movements and food habits. As luck would have it, the animal was photographed and the photographs, many months later, were handed to Professor François Doumenge, who has recently passed them on to me.

In August 1972, at Yate and again on Kounie (Isle of Pines), New Caledonia, two sea-lions were washed ashore. That found at Yate was still alive and was looked after by Dr. and Mrs. Catala at the Noumea Aquarium, where it still attracts a good deal of attention. The other one was dead when washed ashore at Gadji; it was buried and I myself assembled the skeleton only last month. The animal in question was a fur seal - the first and only one to be stranded (as far as we know) in this part of the world. Both these young animals had certainly belonged to a school come all the way from south of New Zealand or south of Australia. Since the cranium examined was that of a young animal, the specialists have been unable to decide where exactly its owner came from. The skulls of members of the two species - Arctocephalus forsteri from New Zealand and Arctocephalus doriferus from south of Australia - are absolutely identical.

In November 1972, a group of Cetacea was washed ashore in the southern part of Mallicolo Island in the New Hebrides. No less than 231 animals were involved. Unhappily, ORSTOM was informed only ten days later, and by the time I could appear on the scene 22 days had elapsed. This delay was most unfortunate in that it might have been possible to find out, by biological examination, why this very large-scale stranding had occurred. Here again, the species involved was rare and little known - Peponocephala electra - and very few strandings are known to have occurred anyhere in the world. These animals were washed ashore on Malekula during the night of 15-16 November, at high tide. A first group of thirty-two animals, mostly males, was stranded while the rest of the school stayed out in the bay. Then, at the next high tide, no less than 199 animals threw themselves on to the beach at the other end of the bay. The shape of the bay is such as to suggest a reason for the stranding, but I arrived on the scene too late to be able to test my assumptions. At night, these animals navigate by means of a kind of natural echo device working on the same principle as the echo-sounder, and it has been suggested that they were led astray by layers of warm fresh water emerging into the bay from rivers and streams; it is possible that the sounds emitted by the animals were reflected by the fresh water, leading them to believe that they were suddenly in the shallows. Since they normally live in deep waters, they may have given way to panic, and when the tide ebbed they found themselves prisoners.

In all likelihood the first ashore were the leaders of the school. The remaining animals, and especially the females, would have remained in the neighbourhood listening to the leaders' cries, and at the next high tide, being gregarious and probably led astray, too, by what they imagined was the bottom, they found themselves stranded. Clearly, this assumption, if borne out by facts, would explain many a stranding. But immediate analyses of water in the bay would have been necessary, and three weeks later, by the time I had arrived, the oceanographic and meteorological conditions had entirely changed.

In December 1972, in the south of the island of Efate (New Hebrides), a female specimen of Globicephala macrorynchus was stranded on the reef and killed by a native fisherman. The animal was buried and it should be possible to re-assemble the skeleton or at least to undertake some measurements.

At the same time, on Ouvea, in the Loyalty Islands, two long-nosed dolphins were washed ashore. But the islanders were able to refloat both of them, and, contrary to what happens when large numbers are involved, both ended up by disappearing out to sea.

Mr. R.H. Baird, SPC Fisheries Officer, having appealed for information to the various fisheries departments of the Western Pacific, I was told by Mr. Gregory, of the Fisheries Department in Honiara, that a "whale" had been stranded on an islet in the Solomons. The animal, probably injured by a ship, seemed to have died of its injuries and to have been washed up on Kennedy Island, near Gizo. Unhappily there were transport difficulties, and the animal's remains were washed out to sea in bad weather, so that no further investigation was possible.

It appears from the newspapers that a 16-foot Cetaceus was washed ashore at Mahina (Tahiti) in January 1973. From the photographs, it would seem to have been a Globicéphalus and a member of the species Macrorynchus.

It is clear that once people have been made to realize the importance of these matters, reports of strandings will come in increasing numbers. However, if the maximum possible knowledge is to be obtained concerning these animals (by an examination of stomach contents, sexual state, and the make-up of schools), it is important that the scientists be advised with no loss of time, so that they may attempt to discover those additional secrets which may - who knows ? - provide a key to a better understanding of the marine mammal.

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DIARY OF FORTHCOMING MEETINGS

1973		Language
May 20 – 25	Pacific Science Association: Second Inter-Congress University of Guam	E
May 28 – June 8	SPC: Training Seminar on Conservation Education Guam	E/F
September	SPC: Thirteenth South Pacific Conference & Thirty-Sixth Session Guam	E/F
October 9 – 16	FAO: Technical Conference on Fishery Products Tokyo, Japan	E/F/S
December 7 – 16	Pacific Science Association: Marine Science Special Symposium Hong Kong	E

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