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ICLARM REPORT

1983

Edited by

Jay L. Maclean

and

Leticia B. Dizon

1984

ICLARM

**INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
MANILA, PHILIPPINES**

ICLARM REPORT 1983

**Edited by JAY L. MACLEAN
and LETICIA B. DIZON**

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**Cover: Shucking green mussels in Bangkok, Thailand.
ICLARM and the Thai Department of Fisheries are
carrying out a program of applied research to
improve production and marketing of molluscs.
Photo by Ronald Ventilla.**

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INTRODUCTION

As ICLARM passed its sixth birthday as an international non-profit institution this year, staff and the many individuals who provide assistance of various kinds were able to view with pride the research accomplishments of the past six years. The Center is functioning as an international research center should, and it has established a track record of sound, applicable research. It has taken international leadership roles in socioeconomic research on small-scale fisheries, on tropical stock assessment, on stock improvement and integrated farming, and in information services; the level of interaction on these topics with other international and national institutions is very encouraging. We are pleased to note the need for ICLARM has been clearly established and its role among development organizations appears to be appropriately focused.

In spite of these successes ICLARM has been made keenly aware this year of the worldwide recession and its impact on research funding. Donors are faced with increasingly difficult decisions as inflation erodes the impact of static or even decreasing financial resources, and decisions must be made concerning the relative value of research in different sectors and on topics within each sector. The questions asked by donors faced with these hard decisions are questions that are relevant to all fisheries research institutions in developing countries. A general discussion of the questions including a brief summary of our answers should be of interest. The questions fall into three general categories dealing with (1) The Fisheries Sector, (2) ICLARM Program Impact and (3) Communication of Results.

The Fisheries Sector

Questions regarding the broad fisheries sector and its importance are typically: (1) Why work on fisheries? (2) How important is fish in the developing world? and (3) Isn't fish a luxury food, too expensive for the poor?

The 75 million tonne total harvest of fishery products is relatively small compared to other food commodities but

its size belies its importance as a contribution to human protein needs. Fish contribute 6% of the world's protein or 24% of the world's animal protein. Because the animal proteins contain essential amino acids lacking in cereal grains the nutritional impact of fish in diets of the poor is often far more significant than it would appear at first glance. In several Asian and African countries 50% or more of total animal protein consumption is in the form of fish. Further, much of it is inexpensive dried or salted fish within economic reach of poorer consumers. Because of this, poorer consumers are often more dependent on fish for their animal protein than their richer neighbors who eat more meat, poultry, eggs and milk products. In short, the fragments of dried fish added to many inexpensive foods in the developing world are an extremely important part of the diet from a nutritional standpoint for a great many people.

To complicate this picture the rapid increases in the harvest of fish observed during the 1950s and 60s (20 million tonnes to 70 million tonnes between 1950 and 1970) have slowed to a crawl since 1970. Preliminary estimates from FAO are that 75 million tonnes were landed in 1982. Predictions of total production for the year 2000 are diminishing rapidly (130 to 104 to 92 million tonnes since 1976) and the present rate of increase, about 1.2% per year, coupled with problems of overexploitation and increasing fuel costs make even the 92 million tonne estimate questionable.

When we shift from consideration of the world situation to the situation in developing countries where population growth averages 2.4% per year and where some countries are already overexploiting existing resources, the seriousness of the problem begins to come into focus. Some countries that are heavily dependent upon fish have decreasing harvests (e.g., Thailand and Pakistan) or catches that are not increasing significantly (Bangladesh and India). In the Philippines per capita fish consumption decreased 47% from 1970 to 1980. The gap between supply and demand is generally widening and prices seem to be moving upward in a predictable but rather striking fashion. Many believe a nutritional crisis of serious proportions is emerging.

ICLARM Program Impact

Donors often ask, if capture fishing is facing all these obstacles to increased production (e.g., poor management, increasing costs, environmental degradation), and

catches are therefore increasing only slowly, why worry about research? What benefits can be expected? And with reference to the poor small-scale fishermen caught in an almost insoluble tangle of problems, what can be done to help them? Further what is the potential of aquaculture; would we be better off placing emphasis on production of chickens, for example?

As serious study of the population dynamics of heavily exploited tropical stocks began, ICLARM scientists realized that tropical stocks are very poorly understood in comparison with temperate fish stocks. A part of the reason nations have often been unable to continue increasing total yields toward predicted levels is the inadequate knowledge of what levels of sustainable harvest the tropical stocks will support. Typically, overexploitation damages productivity of stocks and overcapitalization reduces profitability of tropical fisheries because managers do not have appropriate information regarding optimum sustained yields. Therefore, stock assessment becomes the first required step in working toward effective management and increasing sustainable harvests. ICLARM's leadership in developing simplified analytical methods applicable to tropical stocks and manageable on desk-top computers has been important here.

With respect to the benefits to be expected, the stocks of many species have been so heavily overfished that maintenance of present catch levels is a problem. The extent of competition between traditional and industrial fishermen for limited stocks is increasingly intense. Dangerous shifts in species composition are occurring on many fishing grounds as more valuable stocks diminish and fishermen shift to smaller species that are lower on the food chain. Irreversible changes may be taking place reminiscent of those occurring in the California sardine fishery or the Peruvian anchoveta fishery in which heavily fished stocks have been greatly reduced resulting in lasting ecological changes. The stock assessment research is

The fragments of dried fish added to many inexpensive foods in the developing world are an extremely important part of the diet from a nutritional standpoint for a great many people.





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In the Philippines per capita fish consumption decreased 47% from 1970 to 1980.

needed, first to enable management measures suitable for maintaining present yields, and secondly, to slowly increase sustained harvests and reduce harvesting costs as management practices are refined.

The dilemma of the millions of small-scale fishermen dividing too few fish among too many fishermen is not likely to be resolved entirely within the fisheries sector. As this dilemma is comprised of a complex set of social, economic and legal problems, the solutions will be complex involving agricultural and industrial sectors as well as fishing and aquaculture. When the situation is viewed as a socioeconomic rural development problem, it can be seen that too often efforts to correct it have been mistakenly limited to the fishery sector. The solutions are not simple and are location specific in nature, but when approached as a part of the total rural development problem solutions are possible. ICLARM's research here has been interdisciplinary with emphasis on understanding the situation from sociological, economic, legal, biological and institutional viewpoints. Approaches to potential solutions are also framed in this broad interdisciplinary context and include consideration of basic changes relating to rural development generally and fisheries/community interactions specifically. In the latter category fall access and use rights, limited entry, ownership of resources, local vs. regional management, community organization, enforcement of regulations, education and a variety of considerations pertaining to wise resource utilization.

Aquaculture should be viewed as a form of animal husbandry with potential and problems characteristic of that industry. It is perfectly valid to compare aquaculture with chicken, egg or goat production as alternative means for production of animal protein. The potential for production of fish through aquaculture is possible to evaluate only as we would another form of animal husbandry, by rigorous economic analysis including examination of required inputs, costs, demand and prices. The exciting aspect of aquaculture is that it offers opportunities for economical utilization of previously underutilized resources (e.g., freshwater, seawater, swampland, labor and organic wastes) and in some cases better opportunities for

utilization of presently utilized resources (e.g., feed grains, freshwater, labor and land). To the extent that aquaculture can utilize resources, recycle wastes, employ people and produce food more efficiently than other forms of animal husbandry it will continue to expand. According to FAO the present rate of increase in food production through aquaculture (1975-80) is 7.3% per annum worldwide. ICLARM projects have often involved economic analysis of aquaculture practices and have focused on improvement of production efficiency through stock improvement, integrated aquaculture-agriculture, and improved technology.

Fish worth millions of export dollars are swimming away at leisure in at least 166.6 million hectares of territorial marine waters

Fish to the north of us, fish south of us, fish to the right of us and fish to the left of us

The "idling" marine fishery industry is the one inexhaustible natural resource that can shore up today's wobbling pseudo-industrial oriented economy—by bringing in an endless stream of export dollars from the fish-hungry world.

Extracts from a recent column in a Philippine daily newspaper. Rapid increases in fish harvests in recent decades have created a false impression of the vastness of fish resources.

Communication of Results

As donor representatives travel they see duplication of research, poor communication and completely inadequate access to reference materials in most developing-country institutions. This leads to questions regarding how to coordinate and communicate better and how to get research results to the developing-country users.

The designers of ICLARM were well aware of the problems of communication in the developing world and therefore designed an institution to work among the international and national fisheries research and development organizations rather than separately. Cooperative research conducted in developing-country institutions is ICLARM's primary mode of operation. Further, the Center was designed to supplement the work of existing development and extension organizations by conducting complementary research to address specific needs. This requires a high level of communication and interaction.

The mechanisms for communication have been built into ICLARM in an effective and functional way. Conferences and workshops are important mechanisms for communication of information on research and these are used extensively for planning and dissemination of results. Publication of workshop or conference proceedings is a valuable product of these meetings and together with ICLARM's other technical publication series (Studies and Reviews, Technical Reports, Bibliographies and Translations) constitute a second major vehicle for communication. The ICLARM Newsletter has proven to be another vehicle of major importance being used by developing-country scientists both as a source and a mechanism for reporting results quickly and informally. The Newsletter is used by our library staff to publicize recent publications of interest to developing countries. Other services provided by the library include computer searches of major databases, special library searches, copying and distribution of articles on request and assistance to visiting scientists. Person-to-person interaction between ICLARM staff members and other scientists ranges from exchanges of mail to special extended training at ICLARM headquarters. To an increasing extent Networks are becoming a major part of ICLARM's activities. They provide special mechanisms for communication, exchange of visits, comparison of results, and research collaboration. One, our Network of Tropical Fisheries Scientists, is strengthened through distribution of a special newsletter.

Outstanding Needs

The magnitude of the fisheries problems in relation to resources available to address these needs is still staggering. It appears as though the rapid increases in fish harvests realized during the 1950s and 60s created a false impression of the vastness of fish resources. It also not only discouraged research, but also led development organizations along the path of fishing technology improvement too far and too long, at least in Asia. Many still view the sea as an inexhaustible source of protein that only requires better technology to harvest and utilize. The trends of the 1970s have shown this not to be the case.

AQUACULTURE PROGRAM

Background

During 1983, ICLARM's Aquaculture Program has continued to address constraints which hinder the expansion of warmwater aquaculture in developing countries. The program is focused on species feeding low in the aquatic foodweb particularly the tilapias, carps, mullets, milkfish and bivalve molluscs. These groups, particularly the finfish, contain species which are highly adaptable to a wide range of culture conditions, from simple backyard and coastal ponds to intensive cage, tank and raceway systems.

Tilapias on which the program has placed major emphasis, have been dubbed potential 'aquatic chickens.' Tilapias are essentially omnivorous, opportunistic feeders and are remarkably tolerant to wide ranges of temperature and salinity and to low water quality. They have very few disease problems. Moreover tilapias can be sold whole or used for the preparation of value-added foods such as fillets, as they have excellent dressing weight characteristics and flesh quality.

The milkfish and the mullets are essentially microphagous, taking in plankton, detritus and micro-organisms from the pond bottom. They are also tolerant of wide ranges of salinity. The carps (common, Chinese and Indian major), while largely restricted to freshwater culture, can tolerate wide ranges of temperature and show very high growth rates with some species capable of growing 5 kg/yr in the tropics. Bivalve molluscs (cockles, mussels, oysters and clams) are 'self-feeding' and are very cheap to grow; the main constraints to production being marketing and market demand, post-harvest handling, and public health problems.

The tropical developing countries have distinct environmental advantages over the rest of the world for cost-effective production of these species. Expansion of tropical aquaculture can supply high protein foods for both domestic consumption and export. There are encouraging

indications that certain of the species mentioned here are gaining increasing international acceptance as food commodities, particularly the tilapias and bivalve molluscs. However, large scale aquaculture development projects often fail to achieve their targets. Government agencies, development banks and private entrepreneurs are learning by hard experience the constraints to successful, efficient aquaculture and the necessity for a professional, scientific approach, akin to other forms of animal husbandry.

Constraints can be summarized as the lack of an adequate biological research base on the genetics, reproduction, nutrition and pathology of warmwater species; the need for improved culture systems (particularly waste-fed aquaculture and integration of aquaculture with agriculture) and the poorly developed fields of aquaculture economics and socioeconomics (particularly market structure and demand), by comparison with agriculture. Implicit in all these constraints is a lack of trained manpower. It is essential that these biological, economic and socioinstitutional constraints are thoroughly investigated and removed.

Chief among the biological constraints is the need for stock improvement of cultured species. The so-called 'Green Revolution' in crop science was built on the development of high-yielding, adverse environment-tolerant and disease-resistant plant varieties. Aquaculture must investigate this approach to develop high performance, domesticated fish, as many of the stocks cultured at present are wild or not far removed from wild types.

No single agency is capable of tackling all these constraints, but ICLARM's mode of operation through co-operative projects and networks is a highly cost-effective way of making progress. The Aquaculture Program is designed to address key specific research problems for some of the most important commodities, while developing broad themes for sustained work. These themes are outlined below. They are not viewed as separate entities and are highly interactive and multidisciplinary. For example the biologists and economists involved in projects draw frequently on each other's expertise and data.

Progress of Work

The past year has seen significant progress in projects continued from 1982 and initiation of some important



Common carp broodfish (*Cyprinus carpio*), Dinnyés strain from Hungary at the Baluhar Baor Oxbow lake hatchery, Bangladesh. ICLARM is assisting the Asian Development Bank in improvement of carp hatchery and nursery technology in south and southeast Asia. Photo by Roger Pullin.



A giant clam (*Tridacna gigas*) vigorously rejecting a dose of a spawning-inducing chemical during research in Papua New Guinea. ICLARM has begun an international program of biological and aquacultural studies on giant clams. Photo by David Waites.

new projects. Progress is reported under program theme headings and a summary table of completed, active and upcoming projects follows.

Commodities/Economics

Tilapias

Research projects on tilapias have been undertaken in Kuwait, the Philippines and Taiwan. In Kuwait, ICLARM's cooperative project with the Kuwait Institute for Scientific Research has continued to generate important data for tilapia culture in saltwater in arid lands. Oreochromis spilurus, imported from Kenya, appears to have good potential for growth and reproduction under these harsh conditions and the successful test marketing of tilapias which started in 1982 has been continued.

Among the highlights of the 1983 Program activities were studies on the economics of tilapia culture and tilapia marketing which culminated in a 4-day workshop co-sponsored by ICLARM and the Philippine Council for Agriculture and Resources Research and Development (PCARRD). These studies involved ICLARM researchers and counterparts from a large number of Philippine universities and development agencies. While it is still difficult to arrive at an accurate figure for countrywide tilapia production, the total is probably around 50,000 tonnes/yr.

As an adjunct to the Philippine Tilapia Economics project, ICLARM hired Ms. Emma Escover as Junior Research Fellow in mid-1983 to conduct economic analyses of tilapia hatcheries to determine the most appropriate approach to development of this sector of the industry. Her studies cover both land-based and water-based hatcheries of the private sector and government managed hatcheries.

Significant progress was also made in the cooperative biological research projects on tilapia with the Institute of Fisheries Development and Research/College of Fisheries of the University of the Philippines in the Visayas (IFDR/UPVCF). The aquatic fern Azolla was assessed as a protein-source for Nile tilapia fingerlings and was found to be nutritionally-deficient: a negative result, but extremely important since some culturists in Southeast Asia have been tending to feed Azolla to their fish uncritically. Artificial incubation systems for tilapia eggs and larvae have been further improved in another project with IFDR/UPVCF completed in 1983.

A cooperative project with the Marine Sciences Center of the University of the Philippines (UPMSC) on the genetic characteristics of Philippine food fishes has concentrated initially on tilapias and has shown, by use of electrophoretic markers, that some experimental and commercial stocks of Nile tilapia (Oreochromis niloticus) in the Philippines are seriously contaminated through interbreeding with wild O. mossambicus.

The tilapias have also been the major focus in the program's publications and conference presentations and remain the main species used in ICLARM's integrated farming activities. Throughout 1983, major reviews on tilapia nutrition and tilapia as a worldwide commodity for future publication have been in preparation.

The worldwide interest in tilapias can be judged from brisk sales resulting in the reprinting of ICLARM's major publication on this group - "The Biology and Culture of Tilapias" (Conference Proceedings No. 7, 1982) and the reprinting and updating of "Applied Genetics of Tilapias" (ICLARM Studies and Reviews No. 6, 1981; second edition, 1983). "The Biology and Culture of Tilapias" topped the scientific books category in the awards for the best Philippine books of 1982, for which a plaque was presented to ICLARM by Philippine Prime Minister Cesar Virata. ICLARM's bibliography on the main species of cultured tilapias (ICLARM Bibliographies No. 2, 1983) has also been in great demand.

In Taiwan, ICLARM has continued a multidisciplinary cooperative project with the Council for Agricultural Planning and Development on the development of technology for saltwater culture of tilapias. Cooperating institutions include the National Sun Yat Sen University, Kaohsiung; the Taiwan Fisheries Research Institutes at Lukang and Tainan; the Institute of Zoology, Academia Sinica, Taipei; the National Taiwan College of Marine Science and Technology, Keelung and the National Pingtung Agricultural Professional School, Pingtung.

Important results during 1983 have included decreasing the average interval between spawnings from 40 to 20 days in Nile tilapia by egg removal and artificial incubation; successful spawning of tilapias in seawater and acquisition of hatching and rearing data over a wide range of salinities, from which spawning and incubation of eggs in saline water have emerged as powerful techniques for predisposing fry for saltwater rearing; comparisons of saline tolerance

between different tilapias and preliminary assessments of optimal protein content and protein: energy ratios for tilapia feeds.

Tilapia economics studies in Taiwan have included an economic analysis of secondary production and price data. This analysis was designed to identify economic issues for followup field research using farm level and market data.

Carps

During 1983, Dr. R.S.V. Pullin assisted the Asian Development Bank (ADB) with research planning for improvement to hatchery/nursery technology for common carp, Chinese carps and Indian major carps with visits to ADB and government projects in Bangladesh, Burma, Indonesia (Sumatra), Nepal, Pakistan and Sri Lanka. Dr. Pullin is co-authoring a carp hatchery/nursery manual with ADB-consultant Dr. V.G. Thingran and is assisting ADB in organizing a 1984 workshop to collate new findings and technology improvements in carp rearing.

Milkfish

A study of constraints to increased milkfish yields in the Philippines was completed in 1983. This study was contracted to ICLARM by FAO and was conducted with the Bureau of Fisheries and Aquatic Resources (BFAR) and the Bureau of Agricultural Economics (BAEcon). A host of technical, biological, economic, sociological and institutional factors were examined. The study confirmed the earlier work of ICLARM that farmers are responsive to relative prices in their production decisions and concluded that the major constraints are institutional in nature. These included high (and hidden) costs of credit, limited contact with extension workers and poorly developed extension materials. Specific action steps were recommended in each case.

A later study, the results of which were presented at the International Milkfish Aquaculture Conference, held at SEAFDEC Aquaculture Department, Iloilo in October, documented the major market constraints that inhibit expansion of milkfish production in Taiwan, Indonesia and the Philippines. Shifting consumer preference, high export prices for shrimp and higher profits from other species such as tilapia and crustaceans have combined with market saturation, in Taiwan and the Philippines especially, to reduce milkfish prices and milkfish's share of aquaculture pro-



A Nile tilapia (*Oreochromis niloticus*) hatchery near Laguna de Bay, Philippines of the type from which stocks are being sampled for electrophoretic analysis. A University of the Philippines-ICLARM project has revealed that Nile tilapia stocks are contaminated with the less desirable tilapia species, *O. mossambicus*.



Compost from waste vegetation is one of the organic wastes being investigated at the Asian Institute of Technology (AIT), Bangkok as a fertilizer for pond fish culture. The compost can be regarded as supplemental feeding and stimulation of the detrital food web. An ICLARM-AIT cooperative research project is investigating waste quality factors in such waste-fed aquaculture systems.



Aquarium systems used for bioassay experiments with Nile tilapia (*Oreochromis niloticus*) fingerlings in the cooperative project between ICLARM and the Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas.

duction and markets. Brackishwater producers throughout Southeast Asia appear to be shifting away from milkfish as a result. Consequently, while constraints to higher yields for individual farmers may be institutional in nature, the industry as a whole faces market limitations brought about by supply exceeding effective demand.

Mulletts and other finfish

Drs. C-M. Kuo and W.O. Watanabe have maintained ICLARM's interests in mulletts and in a number of other commercial brackishwater and marine finfish species through ongoing projects, advisory services and training activities in Egypt, Israel and Taiwan. As in previous years, the main thrusts of this work have been on development of controlled reproduction techniques through a better understanding of reproductive physiology and improvement of larval and postlarval survival.

Bivalve molluscs

The cooperative project between ICLARM and the Brackishwater Fisheries Division, Department of Fisheries, Ministry of Agriculture and Cooperatives of the Government of Thailand, entitled Applied Research on Coastal Aquaculture, and funded through the German Agency for Technical Cooperation completed its first 18-month phase in June 1983; the project, which was extended for a further 18 months, has involved multidisciplinary studies on the economics and biology of culture and harvesting of Thai commercial bivalve molluscs, principally the green mussel (*Perna viridis*), the cockle (*Anadara granosa*), oyster species (*Crassostrea* spp.) and the short-necked clam (*Paphia undulata*). Special studies and reviews completed in 1983 included marketing, product standardization and production costs studies, and assessment of the public health aspects of bivalve consumption in Thailand.

In addition to these activities, the project staff also held an in-country workshop for Thai researchers and culturists from institutions and agencies countrywide.

Waste-fed agriculture/integrated farming

Other important events of 1983 were the dissemination of the results of ICLARM's previous cooperative animal-fish research project with Central Luzon State University (ICLARM Technical Report No. 5) and the appointment of a Rockefeller Foundation postdoctoral research fellow to work

on water quality aspects in a wide variety of waste-fed aquaculture (compost-fed ponds, manured ponds and sewage-fed systems) in a cooperative project between ICLARM and the Asian Institute of Technology (AIT), Bangkok.

Plans have also progressed towards holding an international conference on "Detrital Systems for Aquaculture". Materials in preparation for publication include a review of sewage and waste-water use in aquaculture and a comprehensive bibliography on integrated farming. A review paper on the culture of herbivorous tilapias was presented at an international conference in Malaysia and is highly relevant to feeding waste vegetation to fish in integrated farms.

Stock improvement

The stock improvement theme has been the most difficult aspect of the aquaculture program in which to expand 'hands-on' project work. This is because fish stock improvement, like most genetics-related studies, requires special facilities and sustained project support. The year 1983 has been used largely to prepare the case for substantial future research support in this area. At the International Symposium on 'Tilapia in Aquaculture, Nazareth, May 1983, Dr. R.S.V. Pullin presented a strong case for tilapia stock improvement and convened a discussion workshop of the geneticists and fish breeders present.

In addition to this groundwork for a major program thrust in stock improvement, ICLARM's genetics project with the Marine Sciences Center, University of the Philippines has made substantial progress in characterizing cultured Philippine tilapia stocks. ICLARM has also maintained close liaison with the Freshwater Aquaculture Center of Central Luzon State University (FAC/CLSU) and the adjacent hatchery of the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) in their evaluation of culture performance of tilapia stocks from previous ICLARM - FAC/CLSU projects. These evaluations have shown some disquieting deteriorations of culture performance, probably attributable to interbreeding between wild and cultured fish.

Advisory Services

Dr. C.M. Kuo continued his advisory work on controlled reproduction of commercially important marine fishes, concentrating on mullets and gilthead seabream (Sparus aurata) in Egypt and Israel.

Dr. Ian Smith served as advisor to the Bay of Bengal Programme's (BOBP) shrimp-pen culture project in Killai Backwaters, Madras, India. With ICLARM assistance, a BOBP Consultant Mr. Rathindra Roy is examining the socioeconomic feasibility of this project as a household activity of the cast-net fishermen and gatherers who have traditionally exploited the backwaters.

Dr. Malcolm Beveridge, Institute of Aquaculture, University of Stirling, who was working in the Philippines during 1983 as an FAO Andre Mayer Fellow, studying the carrying capacity of Philippine lakes with respect to fisheries and aquaculture, served as an ICLARM consultant to USAID on the impact of water abstraction from Lake Buhi, Bicol Region on the culture and capture fisheries in the lake.

Aquaculture program staff have also been very active in handling enquiries from all over the developing world in relation to aquaculture research and development. Advisory services to the Cagayan Integrated Agriculture Development Project, Philippines on the exploitation and culture potential of stocks of the migratory mullet (Cestraeus plicatilis) known as ludong in Northern Luzon, have continued at a low level pending the establishment of working facilities by the various cooperating institutions.

Training

Drs. Kee-Chai Chong and R.S.V. Pullin assisted with the course for senior aquaculturists from Asia and the Pacific, organized by the UNDP/FAO Network of Aquaculture Centers in Asia (NACA). The course leads to a Masters in Aquaculture degree through affiliation with the University of the Philippines in the Visayas, Iloilo City. Dr. Chong taught the 2-week aquaculture economics component of the course at the Philippine Lead Center (PLC) for NACA, which is located at SEAFDEC, Tigbauan, Iloilo. Dr. Pullin delivered a series of lectures on broad aspects of warm-water aquaculture research and development.

Dr. C-M. Kuo was appointed visiting professor to both the Department of Zoology, National Taiwan University, Taipei and the Institute of Marine Biology, National Sun Yat Sen University, Kaohsiung, Taiwan. He offered lectures on special topics of fish physiology: reproductive physiology, to both institutions in the spring semester. In addition, Drs. C-M. Kuo and W.O. Watanabe have been involved in training and program development at the Taiwan

Fisheries Research Institute at Tainan and in supervising visiting students from the Agricultural University, Wageningen, Netherlands and National Sun Yat Sen University in advanced studies in aquaculture.

Dr. E.W. McCoy assisted the Faculty of Agricultural Economics and Business Administration of Kasetsart University, Bangkok, Thailand with in-depth training of graduate students. Staff and students were involved in marketing and production cost studies on green mussel culture. Dr. McCoy also gave a short course on marketing to staff and graduate students and classes on marketing economics to aquaculture economics students.

In September, ICLARM provided training awards to the 10 private tilapia hatchery cooperators who have been participating in ICLARM's record-keeping project in Laguna and Rizal Provinces, Philippines. A 3-day training session in hatchery management was conducted at the Bureau of Fisheries and Aquatic Resources hatchery on the campus of Central Luzon State University. The training was highly successful. Finally, Dr. Chong conducted a series of short courses for extension workers of the Philippines Bureau of Fisheries and Aquatic Resources on aquaculture economics and farm management.

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R.F. Ventilla. A note on recent shellfish genetics research.

R.F. Ventilla. Alternative mollusc species for culture in Thailand. A preliminary list and some biological data on abalones (Haliotis sp.) in Thailand.

R.F. Ventilla. Some biological data and background of common scallop (Amusium pleuronectus) in Thailand.

R.F. Ventilla. A preliminary list, some biological data, and background of pearl oyster culture (Pinctada maxima, P. margaritifera) in Thailand.

R.F. Ventilla. Natural spat collection or hatcheries?

The International Symposium on Tilapia in Aquaculture, Nazareth, Israel, 8-13 May 1983. (R.A. Neal and R.S.V. Pullin)

R.S.V. Pullin. Choice of tilapia species for culture.

Annual Meeting of the Taiwan Fisheries Society, Keelung, Taiwan, 30-31 May 1983. (C-M. Kuo)

C-M. Kuo. Application of sex control in aquaculture (invited resource speaker).

C-M. Kuo. Induced breeding of grey mullet, Mugil cephalus L. with deoxycorticosterone.

International Conference on Development and Management of Living Aquatic Resources, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia, 2-5 August 1983. (R.S.V. Pullin)

R.S.V. Pullin. Culture of herbivorous tilapias.

Workshop on Tilapia Economics in the Philippines, University of the Philippines at Los Baños, Laguna, Philippines, 10-13 August 1983. (E.M. Escover, R.S.V. Pullin, I.R. Smith)

L. Yater and I.R. Smith. Economics of private tilapia hatcheries in Laguna and Rizal provinces.

E.M. Escover and R.L. Claveria. Economics of cage culture in Bicol freshwater lakes.

E.M. Escover, O.T. Salon and C.P. Lim. Tilapia marketing in Bicol.

Research Seminar, Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon, U.S.A., 16 August 1983. (K.D. Hopkins)

K.D. Hopkins. Integrated farming and tilapia culture in Kuwait.

Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. (K-C. Chong, C-M. Kuo, I.R. Smith and W.O. Watanabe)

C-M. Kuo, W.O. Watanabe and Y-Y. Ting. Deep-water culture of milkfish in Taiwan (poster).

C-L. Lin, Y-Y. Ting and C-M. Kuo. Description and treatment of vibriosis (red spot disease) in milkfish, Chanos chanos (poster).

I.R. Smith and K-C. Chong. Southeast Asian milkfish culture: economic status and future prospects (invited paper).

ROC-USA Colloquium on Marine Sciences, Taipei, 1924 October 1983. (C-M. Kuo)

Program Plans for 1984

The 1984 program will again emphasize the main themes already established: stock improvement, waste-fed aquaculture/integrated farming and economics. The program will also continue to focus on species chosen for their suitability for low-cost aquaculture.

The concept of an International Network for Stock Improvement in Warmwater Aquaculture will be promoted with proposals for a planning workshop and initial Network activities. The project with UPMSC on the Genetics of Foxfishes will be extended for a further year and the project will be visited by leading geneticists to assess progress. Network establishment will be further assisted by Dr. L.J. Lester, who plans to work with ICLARM and CLSU in the Philippines on determination of realized heritabilities for growth rates in tilapias. The development of tilapias for mariculture will be extended throughout 1984 in the ongoing projects in Kuwait and Taiwan and research/advisory services to controlled marine fish reproduction studies in Egypt, Israel and Taiwan will be continued.

In waste-fed aquaculture/integrated farming, research cooperation with AIT will be strengthened to enable detailed investigations of the detrital foodweb and water-quality factors. Efforts will also be continued at AIT and by liaison with other tropical aquaculture institutions to investigate the potentials of aquatic macrophytes and waste vegetation for fish nutrition, particularly for the microphagous and herbivorous tilapias.

ICLARM has also identified an area of integrated farming in which a new research initiative is called for - the integration of ruminant livestock husbandry with fish culture. Ruminant livestock-fish integration has been hitherto largely restricted to the use of cattle manure to fertilize fish ponds, and has ignored the ruminant livestock of greatest importance in many tropical developing countries, particularly small ruminants (sheep and goats) and the water buffalo. The small ruminants are particularly important in Muslim countries. While these animals produce relatively "nutrient-poor" manures compared to pigs and poultry, their wastes do represent a potential input for aquaculture which has not been adequately investigated.

The proposed conference on "Detrital Systems for Aquaculture" will likely be delayed into 1985 to allow for preparation of major review contributions.

In aquaculture economics, ICLARM is exploring possibilities of a staff assignment in South Asia in affiliation with the Bay of Bengal Programme in Madras, India. If funding is allocated, the individual in this position will work in affiliation with the ICLARM Fisheries Social Science Research Network and national research institutions and universities in Bangladesh, India and Sri Lanka. Likely topics for research include aquaculture project feasibility and impact studies and assessment of market potential for cultured species, especially those such as tilapias which are not yet popular with South Asian consumers. Economic analysis of tilapia hatcheries in the Philippines will continue.

Integrated sheep-fish farming in Tasikmalaya, Indonesia. Small ruminants are potentially widely useful in integrated farming.



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Project Title : Azolla in Tilapia Nutrition

Cooperating Institution : The College of Fisheries of the University of the Philippines in the Visayas (UPVCF), through its research arm, the Institute of Fisheries Development and Research (IFDR)

Duration : May 1982 - December 1983

Key Personnel ICLARM : Dr. Roger S.V. Pullin
 UPVCF/IFDR : Dr. Gaudiosa J. Almazan,
 Mrs. Teresita A. Manalo,
 Mr. Ramon R. Agbayani,
 Ms. Aurora F. Angeles,
 Ms. Ma. Theresa B. Trono

Objectives

- To determine the nutritional value of the aquatic nitrogen-fixing fern Azolla pinnata as a protein source for Nile tilapia (Oreochromis niloticus).

Results

A 28-day nutritional assay was developed for Nile tilapia (Oreochromis niloticus) fingerlings using 20 fish/60-liter aquarium and a control diet of 40% marine fish meal; 40% rice bran; 10% corn starch; 9% corn meal and 1% Afsillin (micronutrient premix; E.R. Squibb, Manila). Feeding at 5% body weight/day gave a mean specific daily growth rate of 2.4% and a mean feed conversion ratio of 1.66 at ambient temperature (24-30°C).

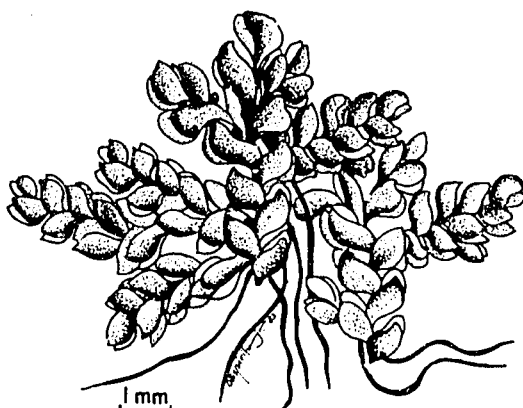
The aquatic nitrogen-fixing fern, Azolla pinnata (Bangkok strain) was grown in soil/water cultures in plastic pools. Fish fed on fresh Azolla alone at 10% and 20% body weight/day and excess lost 24-28% body weight over 28 days, although the Azolla was readily consumed.

Sun-dried Azolla was fed as a powder, in pellet form and as a feed ingredient. Growth responses and food conversion ratios were significantly worsened by increasing the level of dried Azolla in the tilapia feeds.

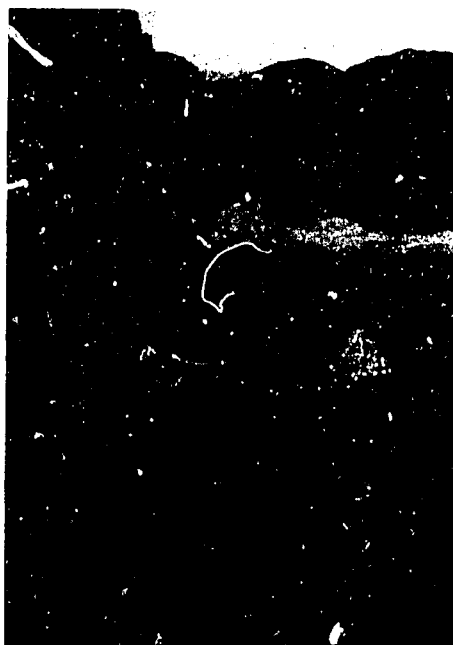
Analyses of Azolla are being conducted to determine the reasons for its inadequacy as a food component for tilapia. Meanwhile, it is difficult therefore to recommend incorporation of dried Azolla in O. niloticus fingerling diets at any level. Supplementation may make this possible once its nutritional deficiencies have been determined. These negative results with Azolla are important as it has been assumed hitherto that feeding fresh Azolla to O. niloticus and other microphagous tilapias in fish ponds and integrated rice-fish culture is beneficial. It remains to be seen whether the macrophyte-feeding tilapias, Tilapia rendalli and T. zillii can grow well on Azolla-based diets.



Research Assistant Mr. Ramon Agbayani (IFDR) demonstrates a small-scale solar drier for the preparation of dried Azolla for inclusion in tilapia diets.



Azolla pinnata



Azolla growing in rice terraces near Banaue, Ifugao Province, Philippines, where rice-fish integrated farming is under consideration.

Project Title : Tilapia Incubation Systems

Cooperating Institution : The College of Fisheries of the University of the Philippines in the Visayas (UPVCF), through its research arm, the Institute of Fisheries Development and Research (IFDR)

Duration : May 1982 - December 1983

Key Personnel ICLARM : Dr. Roger S.V. Pullin
 UPVCF/IFDR : Dr. Gaudiosa J. Almazan,
 Mr. Ramon R. Agbayani,
 Mrs. Teresita A. Manalo,
 Ms. Ma. Theresa B. Trono,
 Ms. Aurora F. Angeles

Objectives

- To investigate the factors affecting survival of tilapia eggs and larvae in a variety of artificial incubation systems using water flow, aeration and mechanical movement.
- To design tilapia egg and larval incubators to give maximum survival under tropical developing country conditions.
- To investigate the use of disinfectants on tilapia eggs, as used for disease control in salmonid egg shipment.

Results

The artificial incubation of tilapia eggs is now an established practice in a number of commercial hatcheries in Taiwan and Israel. This project has made progress towards an incubator design for situations in which electric power supplies are unavailable or unreliable and on development of a system for continuous supply of tilapia

fry from eggs collected at various stages of development from mouthbrooding female Nile tilapia (Oreochromis niloticus).

A variety of incubators have been tested using water upflow in jars and funnels, with or without supplementary aeration. Hatching success rates were generally unsatisfactory, averaging 27% (water flow only) to 39% (water flow + aeration) with very high larval mortalities thereafter. These were attributed to excessive movement from poorly controlled water and air-flow, and frequent power failures. A system similar in principle to salmonid egg incubation in which eggs and larvae were maintained in a shallow trough with water flow-through and no aeration gave superior results (average hatching success, 50% and larval survival to free swimming, 35%) and similar results were obtained using aerated basins (average hatching success, 57% and larval survival to free swimming, 35%).

An interesting new development was the construction of a cylindrical incubator (Fig. 1) rotated by a small water-wheel, and therefore independent of power supply. This device was conceived as a "rolled up version" of the shaker table, which is a well-known type of fish egg incubator (the mechanical movement of eggs ensures adequate oxygen supply and discourages attack by fungi and other pathogens). The incubator has provision for three "life support" systems - aeration, water flow and mechanical movement, on the assumption that any one of these can ensure survival if the others fail. Initial trials have given hatching successes of up to 84% but larval survival to the free swimming stage has been very poor (0-14%). This has confirmed earlier project results that mechanical damage to larvae can be a serious problem in incubation systems.

Data on the use of iodophore disinfectants to treat tilapia eggs are still being analyzed.

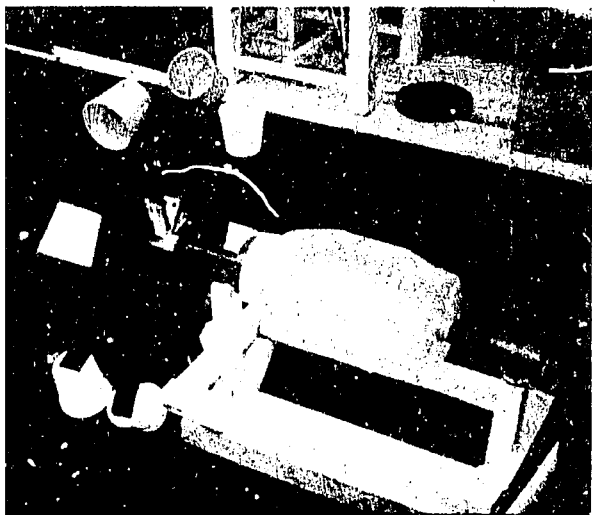


Fig. 1. A cylindrical rotating incubator for tilapia eggs developed during the project. The eggs are kept in the plastic barrel in shallow water with aeration and water flow supplied through the axial shaft. Slow rotation is achieved by the cupped waterwheel, which gives independence from electrical power supply.

- Project Title** : Research and Workshop on the Economics of the Philippine Tilapia Industry
- Cooperating Institutions** : Philippine Council for Agriculture and Resources Research and Development (PCARRD) and several other research groups and individuals
- Duration** : 1 year, ending with a workshop in August 1983
- Key Personnel**
- | | | |
|--------|---|---|
| ICLARM | : | Dr. Ian Smith, Dr. Roger S.V. Pullin, Ms. Luz Yater, Ms. Emma Escover |
| PCARRD | : | Dr. Elvira Tan |
| | : | Researchers from various Philippine institutions |

Objectives

The Philippine tilapia industry has clear potential for providing income to small-scale producers and protein to consumers. However, an economic analysis was needed to document its current structure, the response of producers to potential profits and the response of markets to recent increases in production. Possible constraints to further expansion of the industry need to be identified, whether they be in the form of input (feed and seed) supply limitations and costs, overcrowding of available production areas, distribution bottlenecks or limited market absorptive capacity. An in-depth analysis of selected production and marketing systems based on data provided by private input suppliers, producers and middlemen was necessary due to the shortage of reliable secondary data on tilapia. This analysis was especially important to guide government agencies such as the Ministry of Human Settlements which, through its Kilusang Kabuhayan at Kaunlaran [National

Livelihood Program] (KKK), is encouraging private investment by small-scale producers in tilapia production, particularly in cage-culture systems.

Results

PCARRD and ICLARM provided small grants to twelve researchers throughout the Philippines, each of whom conducted research on a selected topic related to the tilapia industry. Studies included those on hatcheries, cage and pond culture, rice-fish culture, backyard fishponds, marketing and community case studies. The results of these research projects were presented and discussed at a very successful PCARRD-ICLARM workshop in August 1983. The published proceedings are expected to provide the first comprehensive analysis and overview of the Philippine tilapia industry.

The economic analyses presented at the workshop provided an extremely encouraging picture of this dynamic industry. Fueled by increased consumer acceptance of tilapia, all participants in the industry, including small-scale hatchery operators, grow-out farm and cage operators and marketing intermediaries were found to earn high profits. Nevertheless, several serious problems face the industry. Paramount among these are deterioration of broodstock and consequently poor quality fingerlings in several locations. Lack of appropriate feed for cage culture is a further constraint. Also overcrowding of some small lakes with cages has occurred. High consumer demand prevails primarily on the northern island of Luzon in the Philippines and production is somewhat limited in the southern part of the country. The workshop participants unanimously endorsed the establishment of a national broodstock management center which would seek to maintain and genetically improve tilapia broodstocks in the country.

A summary report of the workshop was published at the end of 1983 to be followed later in 1984 by the edited proceedings. Several aspects of tilapia economics work are continuing under the initiative of individual researchers, including those of ICLARM (see p. 48).

- Project Title** : Milkfish Production
Dualism in the Philip-
pines: A Socioeconomic
Perspective
- Cooperating Institutions** : Bureau of Agricultural
Economics (BAEcon),
Ministry of Agriculture,
Philippines; Bureau of
Fisheries and Aquatic
Resources (BFAR), Minis-
try of Natural Resources,
Philippines; Food and
Agriculture Organiza-
tion (FAO) of the United
Nations
- Duration** : 21 months, 15 July
1981-15 April 1983
- Key Personnel**
- | | | |
|--------|---|---|
| ICLARM | : | Dr. Kee-Chai Chong,
Dr. Ian R. Smith |
| BAEcon | : | Ms. Maura Lizarondo |
| BFAR | : | Mr. Cesar Guerrero |

Objectives

The majority of Philippine milkfish farmers continue to rely on extensive methods. The purpose of this ICLARM/BAEcon/BFAR study, which was supported by a grant from FAO, was to examine why milkfish farmers have not been adopting the available technologies at a more rapid rate. The study hypothesized that a mixture of physical, socioeconomic, technical and institutional factors constrain the majority of producers (but not all) and that as a result a dualistic structure exists in the industry. The analytical model specified for the study was placed in the broad context of various theories of agricultural stagnation and growth.

The project had two phases. The first was to prepare a report for FAO on the results of an extensive survey of producers in selected provinces in the Philippines conducted in late 1981 and early 1982. The second phase was

to conduct a series of seminars for BFAR extension personnel, based upon the results of this project's and earlier surveys of producers.

Results

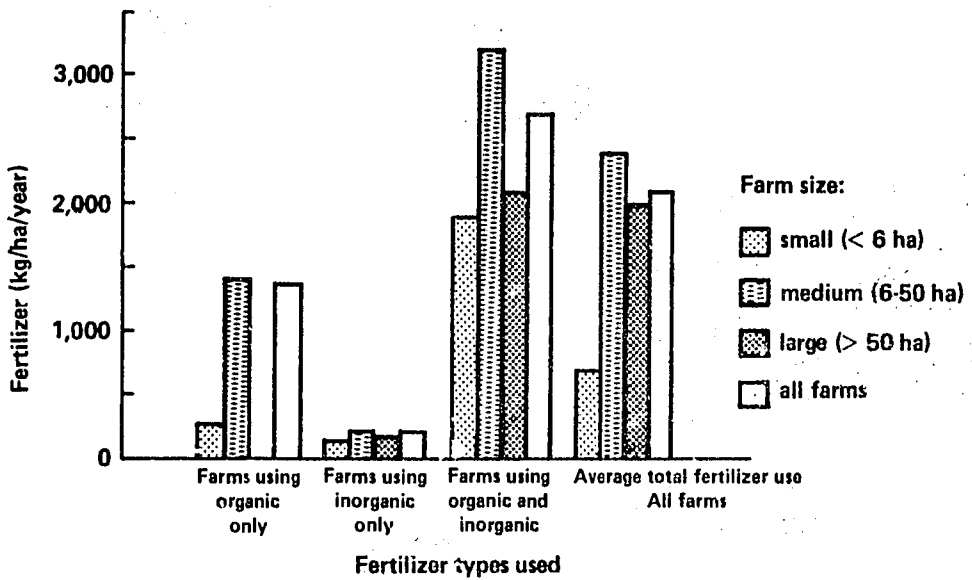
The final report for the first phase of this project was submitted to FAO in mid-1983. The report confirmed information previously published that Philippine milkfish ponds are generally underutilized. Perennial low milkfish yields from underutilized brackishwater ponds were thought to be primarily the result of the difference between fertilizer application rates followed by most milkfish farmers and those higher rates which would duplicate the results achieved on experimental farms and also on a small number of private farms.

The study focused on farmers' perceptions of constraints. Data were collected from 447 milkfish farmers in seven provinces. Additional data from a previous survey involving 324 farmers from seven provinces were also included. Using multiple regression techniques, eight of 56 explanatory variables explained 75% of the variation in fertilizer expenditure. The four explanatory variables which were statistically significant at the 1% level were: ratio of milkfish price to organic fertilizer price, ratio of milkfish price to inorganic fertilizer price, interest in working on other milkfish farms and belief in the effect of fertilizers on the taste of milkfish. The other four variables, significant at the 5% level were: salinity of pond soil sample, interest in seeking consultation, family size and farmers' estimates of a "fair" collateral requirement for loans.

Based on these results it was concluded that milkfish farmers are responsive to relative prices of inputs and output and adjust their fertilizer expenditure accordingly. However, high costs of credit and of organic fertilizers in some locations coupled with declining real prices of milkfish inhibit many farmers from increasing fertilizer use.

One major reason why milkfish farmers were not applying more fertilizers was because they claimed not to have the necessary financial means to obtain them. A dual-pricing fertilizer subsidy scheme to encourage more intensive use of fertilizers merits an evaluation by the government to determine its practicality.

The second phase of this project involved the preparation of a series of short courses for BFAR extension officers based on the above findings of the first phase and supplemented by additional concepts of farm management and production economics. Between January and March, Dr. Kee-Chai Chong conducted a total of 12 such short courses for over 300 extension agents and supervisory staff.



Types and average quantities of fertilizers used (kg/ha/yr) in milkfish culture by farm size (ha) in the Philippines.

Project Title : Economic Analysis of the
Tilapia Industry of
Taiwan

Cooperating Institution : National Chung Hsing
University, Taichung,
Taiwan

Duration : 1 year, beginning July
1982 (first phase)

Key Personnel
National Chung Hsing
University : Dr. Lee Chaur-Shyan

Objectives

The general objective of this study, which is part of ICLARM's collaborative research on tilapia with the Council of Agricultural Planning and Development (CAPD) in Taiwan, was to analyze the economics of the Taiwanese tilapia industry based on secondary data. The one-year first phase involved an overview of the industry in terms of (1) regional distribution of current production; (2) classification of different rearing systems by species; (3) numbers and locations of feed and fry suppliers; (4) markets, marketing practices and prices; and (5) major government policies and policy issues. Dr. Lee's report has been completed in Chinese and is currently being translated into English. The report documents the rapid growth of tilapia production in Taiwan during the past few years and the species' popularity with domestic consumers and export markets in Japan.

A second phase may be initiated in 1984, depending upon availability of funds and will consist of an in-depth analysis of selected input supply, rearing systems and marketing sectors of the industry.

- Project Title** : Aquacultural Trends and Development Prospects: Country Case Studies
- Cooperating Institution** : Studies are individually commissioned
- Duration** : First country case studies began in mid-1981
- Key Personnel**
- | | |
|--------|---|
| Taiwan | : Dr. Lee Chaur-Shyan,
National Chung Hsing
University |
| Israel | : Dr. Dan Cohen, Aquaculture Production Technology Ltd. and Hebrew University |

Objectives

There is an important role for research institutions such as ICLARM to play in clarifying the potential for and the impact of aquacultural development in developing countries. The major socioeconomic issues that need attention in this context are those related to technology transfer and constraints to its adoption, market potential, externalities and competition with other sectors, and equity and distribution of benefits from expanded aquaculture production. These can best be addressed at the national level. As an initial step, ICLARM commissioned two case studies in countries where aquaculture is an important activity and where data are available to permit analysis without resorting to extensive field surveys.

Results

Studies in Taiwan and Israel were commissioned in 1981. In both countries, developmental constraints are already apparent. Competition for aquacultural inputs has increased from other sectors, such as for water in Israel. Industrial development has created rural labor shortages and pollution problems in Taiwan. Also, international market changes have resulted in species shifts in both

countries. The Taiwanese manuscript is currently in press; the Israeli manuscript is expected by early 1984.

The report by Dr. Lee showed that the aquaculture sector in Taiwan is undergoing dynamic growth and by 1982, approximately 20% of total fisheries production of almost 1 million tonnes came from aquaculture. Since 1978, much of this increased aquaculture production has been for the export market. In fact as real per capita incomes have risen, domestic fish protein consumption has levelled off in recent years at slightly less than 40 kg annually and per capita meat consumption is now greater than that of fish (Table 1).

Table 1. Changes in per capita income, per capita fish consumption and per capita consumption of other selected protein products in Taiwan, 1965-1980. (NT\$39 = US\$1.0 in 1981)

Year	Real per capita income (1976 NT\$)	Per capita consumption of selected protein products (kg)			
		Fish	Meat	Eggs	Vegetable/fruits
1955	11,895	18.7	16.3	1.7	72.0
1970	26,582	34.2	25.3	4.1	130.1
1976	39,468	35.3	31.6	5.9	180.5
1977	42,167	35.1	35.3	6.3	179.8
1978	46,295	36.5	36.1	7.6	169.3
1979	48,921	38.1	40.3	7.8	194.1
1980	50,095	38.7	39.6	8.0	199.7

In Taiwan, between 1965 and 1982, brackishwater farming expanded by 30% to over 20,000 hectares while freshwater area increased by 230% to 17,650 ha. Milkfish production from brackishwater ponds increased until 1969, but declined rapidly by 1982 to 85% of the production level of 18 years earlier. In contrast, freshwater pond production increased by 841% between 1965 and 1979. Coupled with increased production from coastal and reservoir culture, this increase in production of freshwater species, particularly tilapia, reduced the milkfish share of the aquaculture sector in Taiwan from 51% in 1965 to only 14% by 1982. Milkfish production as a percentage of total production from the brackishwater area has declined from 92% in 1965 to 46% in 1982 with the balance now provided primarily by shrimps and crabs. While the aquaculture sector is thus growing rapidly, milkfish which historically was the premier cultured species in Taiwan, has now been surpassed by tilapia.

Project Title : Economics of Snakehead Culture in Thailand

Cooperating Institution : National Inland Fisheries Institute (NIFI), Bangkok, Thailand

Duration : 16 months, March 1982 - June 1983

Key Personnel ICLARM : Dr. Edward W. McCoy
NIFI : Dr. Mali Boonyaratpalin

Objectives

This research project had two parts. The first was the study of the economics of aquacultural production of snakehead (*Channa striata*), an important freshwater fish in Thailand. The second was an analysis of the competitive structure of the market for trash fish, the most important food source for cultured fish in Thailand. Growth and changes in the industry were analyzed from secondary data. Production functions and short- and long-run cost functions were estimated from primary data and producer response to varying changes in both demand and cost of inputs was estimated. A descriptive analysis of the trash fish industry was also conducted.

Results

The study was conducted in six provinces of Thailand with data collected through a survey of randomly selected producers. Analysis of variance, multiple regression techniques and simultaneous-equation systems were used in analyzing the data. The project report has been written in Thai and is presently being translated for later publication in English.

Project Title : Intensive Mariculture of Tilapia

Cooperating Institution : Mariculture and Fisheries Department, Kuwait Institute for Scientific Research

Duration : 3 years beginning January 1982

Key Personnel ICLARM : Dr. Kevin D. Hopkins
KISR : Dr. Tani Al-Ahmad

Objectives

- To screen and select species and hybrids of tilapias suitable for intensive culture in coastal zones.
- To develop suitable methods for the mass production of tilapia fry under conditions existing in arid lands.
- To evaluate intensive saltwater growout systems for tilapia, including cages and raceways.

Results

Initial yield trials with Oreochromis aureus and O. spilurus in seawater raceways were completed in April 1983 after approximately 240 days of culture. The species showed comparable growth rates until water temperatures dropped below 25°C when O. aureus growth almost stopped (Fig. 1). Additionally, O. aureus were susceptible to a chronic infection caused by a bacterium, tentatively identified as a Vibrio species. O. spilurus appears to be a superior candidate for seawater culture under Kuwaiti conditions. Yield trials with large hand-sexed males of both species and sex-reversed males are currently underway.

A brackishwater (3 ppt) fingerling production system consisting of 4-m² brood tanks, upflow incubation bottles

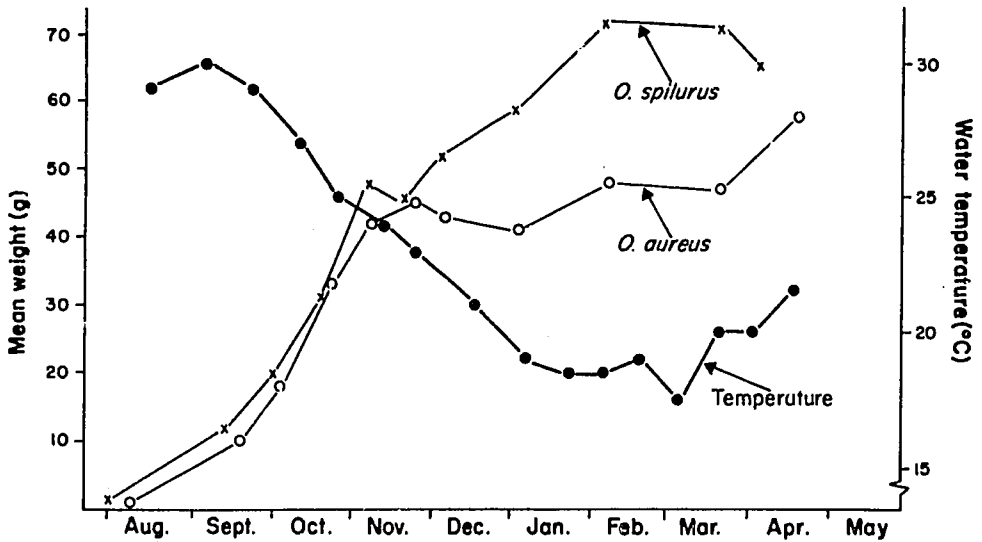


Fig. 1. Mean sample weights of *Oreochromis spilurus* and *O. aureus* in seawater raceways in Kuwait, 1982-83.

made from inverted 750-ml mineral water bottles, and 450-liter conical tanks for sex-reversal was constructed in a shaded greenhouse. During the approximately 120-day fry production season in 1982, 4 fry/m²/day of *O. aureus* were collected by sweeping the margins of the brood tanks with fine mesh nets. In 1983, eggs were collected weekly from mouthbrooding females and incubated in the upflow bottles. Yields in the first 90 days of the 1983 season were considerably higher than in 1982 (Table 1). *O. aureus* pro-

Table 1. Production of tilapia fry by egg collection and incubation in upflow bottles in brackishwater, 3 ppt.

♀	Species	♂	Stocking rate kg ♀/m ²	Fry/day per m ²	per kg ♀
<u>aureus</u>	X	<u>aureus</u>	0.870	19	22
<u>aureus</u>	X	<u>spilurus</u>	1.005	20	20
<u>spilurus</u>	X	<u>aureus</u>	0.475	3	7
<u>spilurus</u>	X	<u>spilurus</u>	0.595	111	187
<u>spilurus</u>	X	<u>spilurus*</u>	0.205	6	27
red	X	red	0.338	40	119

* In seawater

duced 19 fry/m²/day, but O. spilurus in brackishwater showed the highest potential followed by a red tilapia from Taiwan.

An experimental simple recirculating system for tilapia was constructed and tested using brackishwater, again 3 ppt. The system uses artificial aeration to supply all of the oxygen requirements and "new" water is added to dilute metabolic byproducts and other wastes. The basic design consists of a cylindroconical tank with external airlifts for aeration (Fig. 2). The results of preliminary trials were highly promising with average monthly yields of 2.3 to 3.1 kg/l or 6.2 to 10.3 kg/m³ (Table 2).

In order to obtain indications of the market acceptability of tilapia in Kuwait, about 500 kg of live O. aureus were sold through a retail fish store in Kuwait City

Table 2. Fish loads, densities and yields of Oreochromis aureus attained in 118 days using three water exchange rates in brackishwater (3 ppt.)

	Water exchange rates (times per day)		
	3	5	7
Fish load (kg/l/min)			
Initial	19.3	11.5	7.9
Mean	26.6	20.6	14.5
Final	31.5	22.4	16.6
Fish density (kg/m ³)			
Initial	38.7	38.0	37.0
Mean	53.7	58.0	57.6
Final	63.0	74.6	77.5
Monthly mean yields			
kg/m ³	6.2	9.3	10.3
kg/l/min	3.1	2.8	2.3

at \$6.00 per kg. Fish ranging in size from 150 g to 800 g were readily sold. About 50% of the customers were Egyptians who were already familiar with tilapia while 8 other nationalities, including Kuwaitis, also bought the fish.

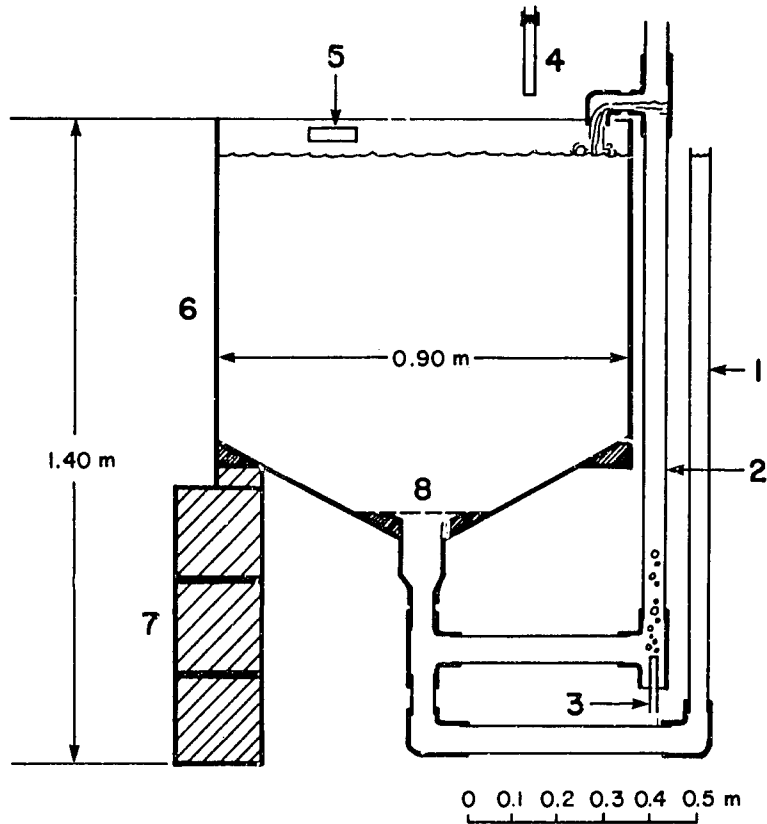


Fig. 2. Schematic diagram for a simple recirculating system for tilapia culture: 1. 50-mm internal diameter (ID) PVC turndown pipe/drain; 2. 50-mm ID PVC airlift; 3. air supply from compressor; 4. 'new' water inlet; 5. overflow; 6. 450-l cylindroconical fibreglass tank; 7. tank support; 8. base grid.

Project Title : Cooperative Tilapia Research Project

Cooperating Institutions : Council for Agricultural Planning and Development (CAPD), Taiwan and National Sun Yat Sen University, Kaohsiung

Duration : 3 years, beginning July 1982

Key Personnel ICLARM : Drs. Ching-Ming Kuo and Wade O. Watanabe

CAPD : Dr. Jen-Chyuan Lee

National Sun Yat Sen University : Ms. Huang Mei Tsun

Objectives

- Development of saline-tolerant tilapia strains and hybrids suitable for culture in coastal regions and associated technology packages for mass seed production and growout.
- Evaluation of survival, growth and reproductive performance of tilapias with potential for saline water culture in Taiwan.
- Improvement of salinity tolerance of cultured tilapias through genetic methods, such as hybridization and selective breeding, and also through physiological acclimatization.
- Development of efficient feeds for growth and maturation of tilapias cultured in seawater, through studies on their nutritional requirements in varying salinities.

Results

1. Development of procedures in freshwater

Reproductive performance in freshwater was first monitored for Oreochromis niloticus and O. aureus. For

females spawning on consecutive occasions, the mean intervals between spawning were 26 days for O. niloticus and 27 days for O. aureus, from broodstocks in which eggs were removed from some mouthbrooding females and left in others. The mean numbers of eggs spawned per individual were 881 (\pm S.E. = 125; n = 13) for O. niloticus and 715 (\pm S.E. = 94; n = 10) for O. aureus.

Thereafter, eggs were normally removed from the mouth of the female 1-2 days post-spawning and incubated artificially in 1.2-l bottles fitted with a perforated round disc bottom, through which was provided a continuous current of filtered recirculated water. Average hatching successes of 84.0% (\pm S.E. = 4.7%; n = 21) for O. niloticus and 98.0% (\pm S.E. = 1.93%; n = 3) for O. aureus were obtained during artificial incubation (non-fertile spawnings excluded). For O. niloticus the mean interval between spawnings was reduced from 40 days (range 27-52) with normal mouthbrooding to 20 days (range 14-37) with egg removal and artificial incubation.

2. Reproductive performance of O. niloticus in seawater and hatchery work at various salinities

Fish from a single brood, spawned and reared in freshwater until 248 days old, were acclimatized to seawater (32 ppt) at a rate of 5 ppt per day. Spawning was first observed in the seawater-acclimatized group after 272 days although successful hatching in seawater was never achieved. Seawater-acclimatized individuals of mean initial length 9.9 cm and weight 16.2 g were subsequently distributed to different salinities and their reproductive performance monitored. Eggs were artificially incubated at equivalent salinities (Table 1). The results were similar at 5, 10

Table 1. Reproductive performance of Nile tilapia (*Oreochromis niloticus*) broodstock^a at various salinities, 30 May – 30 August 1983.

Salinity at spawning (ppt)	No. of spawnings ^b	Mean interval between spawnings (days)	Mean no. of eggs per spawning	Mean hatching success (%) ^c	Total egg production	Total fry production
32	4	42	302	0	1,208	0
15	14	25	174	33.9	2,436	826
10	13	19	284	35.9	3,692	1,325
5	11	17	239	47.6	2,629	1,251

^a For each salinity a group of 3 females and 3 males was maintained.

^b Total spawnings observed per group; not necessarily from the same individual.

^c Non-fertile spawnings included.

and 15 ppt, but spawnings were less frequent at 32 ppt. Hatching successes were similar at 10 and 15 ppt, but significantly greater at 5 ppt, which compared favorably with those obtained in freshwater.

3. Evaluation of salinity tolerance of freshwater-spawned tilapia fry

Several indices were evaluated as practical measures of salinity tolerance: (1) Median Lethal Salinity - 96 hours (MLS-96), defined as the salinity at which survival falls to 50%, 96 hours following abrupt transfer; (2) Mean Survival Time (MST), defined as the mean survival time for all individuals in an experimental group over a 96-hour period, following abrupt transfer to full seawater (32 ppt) and (3) Median Survival Time (ST50), defined as the time at which survival falls to 50% following abrupt transfer to full seawater (32 ppt). Of these, MST was the most reliable index for assessing salinity tolerance.

Salinity tolerance tests on freshwater-spawned O. niloticus and O. aureus at 24-31°C showed that MST values remained low until day 45 when survival began to improve with maximum tolerance by 120 days. The hybrid O. mosambicus ♀ x O. niloticus ♂ showed improved salinity tolerance from day 7 and attained much better MST levels than either of the species tested. The increase in salinity tolerance appeared to be more closely related to length than to age. Work still underway indicates that salinity tolerance is greater at a lower temperature (20°C).

4. Incubation of freshwater- and saline water-spawned O. niloticus eggs in saline water and evaluation of the salinity tolerance of resultant fry

Survival of freshwater-spawned O. niloticus eggs incubated at various salinities are shown in Fig. 1. Mortality occurred primarily during early embryonic development and was particularly pronounced in the higher salinities. In full seawater, there was no survival during this period. Survival generally stabilized after hatching, although some mortality continued at 15 ppt. Survival patterns during incubation at 5 and 10 ppt were very similar to those observed in freshwater and MST's for 6-day old hatchings revealed that salinity tolerance was increased with increasing incubation/hatching salinity.

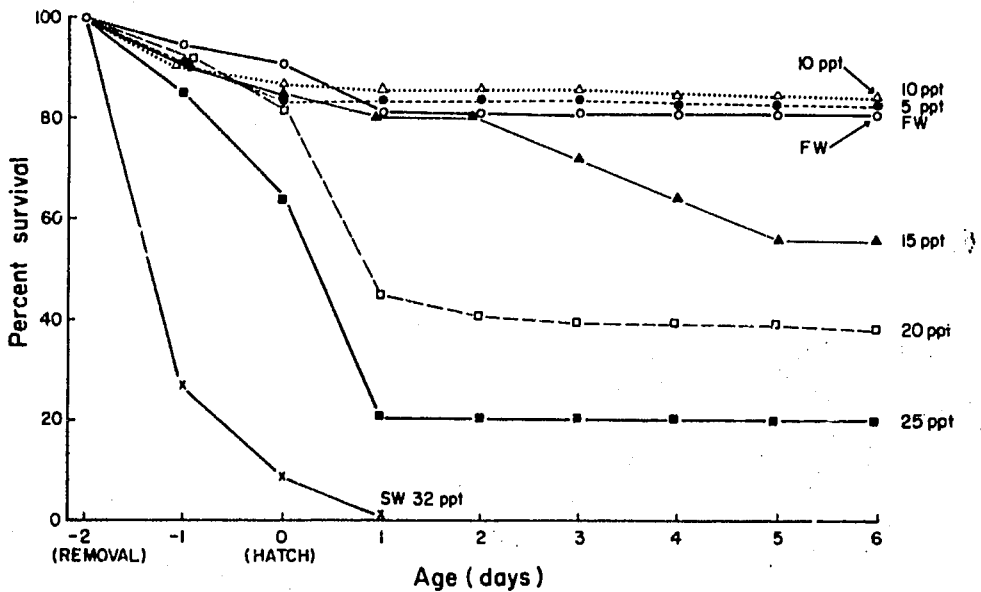


Fig. 1. Survivorship of freshwater-spawned *Oreochromis niloticus* eggs, artificially incubated at various salinities. Each plotted point represents the mean value for four trials. FW = freshwater; SW = seawater.

For saline water-spawned eggs, increased spawning salinity improved salinity tolerance. Their relationship was very similar to that observed between MST and incubation salinity. However, at equivalent salinity, early exposure (spawning) produced progeny with comparatively greater salinity tolerance than those spawned in freshwater and incubated at elevated salinity.

The results suggest that a combination of genetic (hybridization) and non-genetic methods (spawning and incubation at elevated salinity) may allow the successful culture of tilapias in seawater. During the coming year, these techniques will continue to be evaluated and refined.

The development of feeds for tilapia growout in seawater will also be studied. So far, nutritional assays with red tilapia (*Oreochromis* hybrids) in freshwater suggest that feed conversion efficiency is optimal with a 35% crude protein and 101 mg/kcal protein/energy ratio feed.

The project has provided an opportunity for 6-months overseas training for Mr. Anne Van Dam, a Masters student from the Agricultural University, Wageningen, the Netherlands. Mr. Van Dam has worked closely with ICLARM, CAPD and university staff on all aspects of the research.

currently the most important cultured tilapia species. *O. niloticus* were sampled from experimental collections of cultured 'strains' in Central Luzon and from commercial farms in Rizal and Laguna Provinces. Samples of *O. mossambicus* were obtained from Malabon and Bulacan province. Samples of *O. aureus* are still to be collected from Philippine and Taiwanese stocks.

Starch gel electrophoresis was used to select diagnostic genetic markers for recognition of mixed stocks. Twenty-seven loci were investigated from eye, heart, kidney and liver tissue samples. In addition, isoelectric focusing of skeletal muscle proteins on polyacrylamide gel was used. It is well known that differentiation between *O. niloticus*, *O. mossambicus* and their hybrids is difficult using electrophoretic markers as these two species are closely related and their electrophoretic patterns are very similar.

Here, phosphoglucose isomerase (PGI) provided the only clear diagnostic marker. Two loci were detected in tilapia eye and heart tissue samples (Fig. 1). PGI - 1 appears as a single band in both species. PGI - 2 also stains as a single band, but *O. niloticus* displays a slower allele than *O. mossambicus*. Heterodimers of intermediate mobility are expressed in both species with proportional differences in mobility.

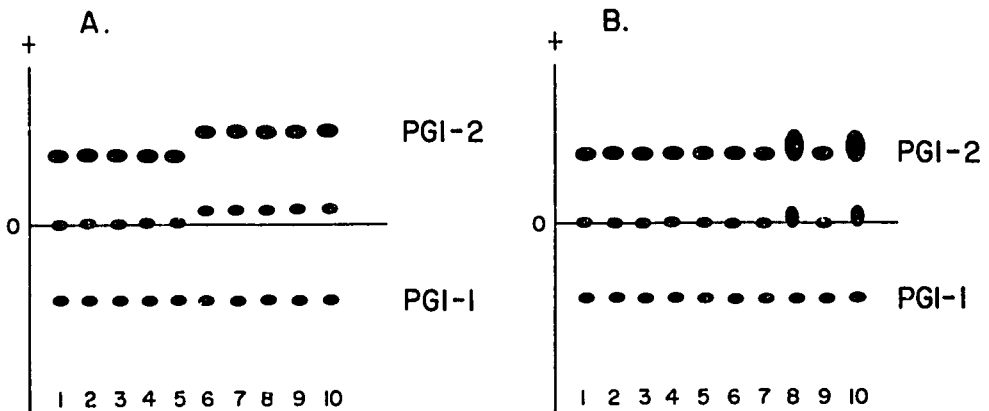


Fig. 1. A. Starch gel electrophoresis of phosphoglucose isomerases (PGI) in tilapia heart tissue. PGI-1 shows identical patterns for *Oreochromis niloticus* (samples 1-5) and *O. mossambicus* (6-10), whereas PGI-2 shows interspecific differences. B. As for A. for samples of Philippine tilapia stocks: samples 8 and 10 are from hybrid stocks, the remainder from *O. niloticus*.

However, isoelectric focusing of skeletal muscle proteins provided the best diagnostic technique. Fig. 2 shows a typical polyacrylamide gel plate comparing samples of *O. mossambicus*, *O. niloticus* and mixed stocks. The most useful markers appear to be the low-molecular weight sarcoplasmic calcium-binding proteins called parvalbumins. They are characterized by acid pI isoelectric points (pH 4.4 to 5.0 in this study) and are very robust markers, always showing strong, consistent staining patterns. It is probable that other useful markers will appear as investigations using this technique are continued.

Results obtained so far indicate that some experimental and commercial stocks of *O. niloticus* in the Philippines are contaminated with *O. mossambicus*. Additional sampling and analysis through 1984 will serve as a first step toward identification and standardization of commercial stocks.

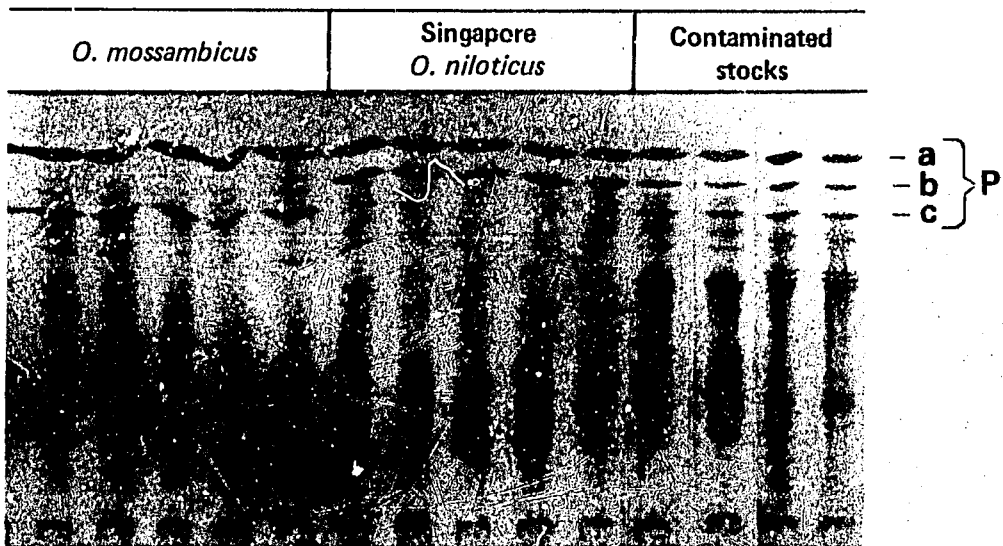


Fig. 2. Typical skeletal muscle sarcoplasmic protein patterns of Philippine tilapias examined by isoelectric focusing on an Ampholine polyacrylamide gel plate at pH gradient 3-10. The parvalbumin region is designated P. Three banding positions are observed: a, pI = 4.4; b, pI = 4.7 and c, pI = 5.0.

Project Title : Tilapia Seed Supply and Management in the Philippines

Cooperating Institution : Marine Sciences Center, University of the Philippines (UPMSC), Diliman, Quezon City

Duration : 1 year beginning July 1983

Key Personnel

ICLARM	:	Ms. Emma Escover, Dr. Ian R. Smith, Mr. Orestes T. Salon
UPMSC	:	Ms. Julie M. Macaranas

Objectives

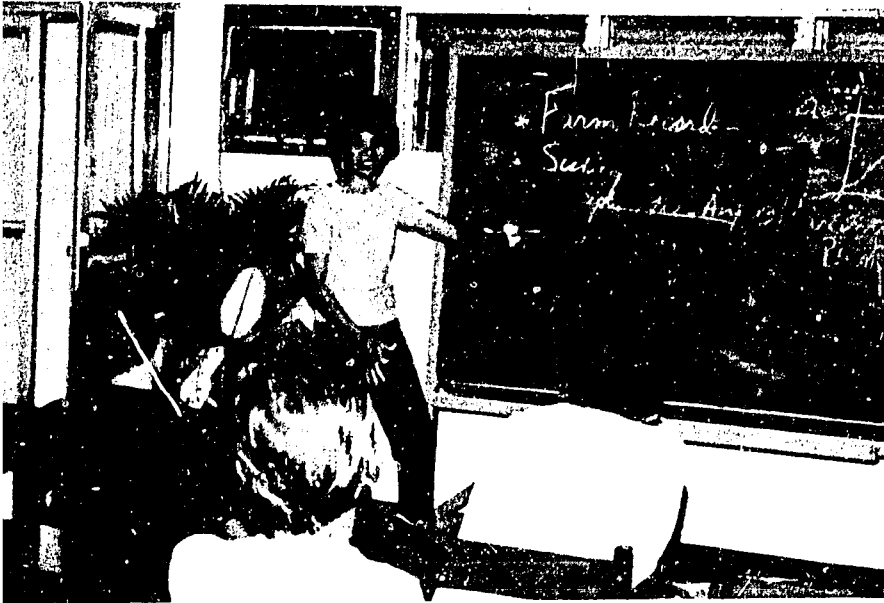
- To analyze the relative profitability and costs of fingerling production of various land-based and water-based tilapia hatcheries operated by the private sector.
- To compare these results with those of government tilapia hatcheries. In so doing, it is hoped that some insights can be gained as to the advantages and disadvantages of large government-run centralized hatcheries vis-à-vis small-scale private decentralized hatcheries.

This economic analysis of tilapia seed supply in the Philippines is a continuation of the work initiated under the PCARRD-ICLARM Philippine Tilapia Economics project (see p. 28). It is also complementary to the UPMSC-ICLARM project on Genetic Characteristics of Food Fishes (Philippines) which is described on p. 45.

Data for the study are gathered from surveys of land-based and water-based hatcheries and a record-keeping project with 10 private hatchery operators which has been underway since October 1982. Sample broodstock from these 10 hatcheries will be examined by UPMSC to determine their

genetic characteristics and the probable need for better broodstock management control.

ICLARM has provided the seed money for this project during 1983. A proposal to cover the 1984 costs of this economics study and the UPMSC component of the genetics studies has been submitted to a donor.



Above: Researcher Emma Escover stresses the importance of accurate record keeping to private hatchery operators taking part in the project. *Below:* During a three-day training course on hatchery management, hatchery operators were able to share experiences in visits to some of the hatcheries.



Project Title : Controlled Reproduction and Mass Fry Production of Commercially Important Fishes

Main Cooperating Institution : Council for Agricultural Planning and Development (CAPD), Taiwan

Other Cooperating Institutions : National Taiwan University, Taipei; National Taiwan Normal University, Taipei; Institute of Zoology (Academia Sinica), Taipei; Taiwan Fisheries Research Institute, Tainan

Duration : 3 years beginning July 1982

Key Personnel

ICLARM	: Drs. Ching-Ming Kuo and Wade O. Watanabe
CAPD	: Dr. Jen-Chyuan Lee
National Taiwan University	: Dr. Ho-Lieng Huang
National Taiwan Normal University	: Dr. Stephen H. Shih
Academia Sinica	: Mr. Y-L. Yu
Taiwan Fisheries Research Institute	: Mr. Y-Y. Ting

Objectives

- To develop improved methods for the controlled reproduction and mass fry production of commercially important cultured fishes in Taiwan.
- To establish pituitary banks; high quality broodstock of key species; techniques for induced maturation and induced spawning on demand; egg incubation; larval rearing; nursery procedures and de-

finned nutritional and environmental conditions for optimum fry production.

Results

ICLARM's major role in the project is to coordinate research activities and also to take responsibility for research on final oocyte maturation and ovulation.

Methods for purification and bioassay of fish pituitary gonadotropins have been developed. This is aimed at the development of a major program of hormone characterization and production to further our understanding of fish reproductive physiology.

Attempts at induced breeding often produce unpredictable results mainly due to the failure of culturists to assay accurately the potency of the preparations used. Difficulties have often been encountered in hormone bioassays because of species-specificity of fish gonadotropins. The system developed under the current cooperative project in which androgen production in rooster testis is used as a bioassay, has proved to be reliable and sensitive (Fig. 1).

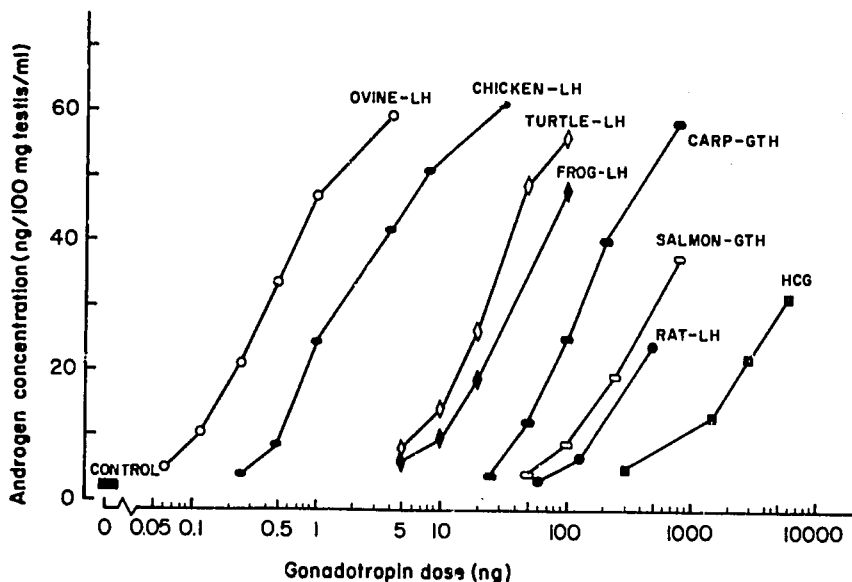


Fig. 1. Bioassay response curves for a series of vertebrate gonadotropins utilizing the androgen production response in rooster testis (from results first presented by J. Y.-L. Yu and L.-M. Wang, 29th International Congress of Physiological Sciences, Sydney, 28 August-3 September 1983).

Induction of gonadal maturation of the Pacific eel (Anguilla japonica) has been carried out in captivity by repeated administration of the analog of gonadotropin releasing hormone and methods for completion of spawning are now being refined. Success in the induced spawning of the skipper goby (Boleophthalmus chinensis) has been achieved and refined methods of larval rearing and improved survival of fry are being developed.

Project Title : Controlled Reproduction
of Commercially Important
Marine Fishes

Cooperating Institutions : New Jersey Marine Science
Consortium; United States
Agency for International
Development (USAID)
(Cooperative Marine
Technology for the Middle
East); Egyptian Academy
of Scientific Research
and Technology; Israel
Oceanographic and Limno-
logical Research Ltd.

Duration : Ongoing from 1980

Key Personnel ICLARM : Dr. Ching-Ming Kuo
Egypt : Prof. A.R. El Bolock
Israel : Hillel Gordin

Objectives

- To foster international cooperation between Egyptian and Israeli scientists working on the artificial propagation of cultured fishes, principally mullet (Mugil cephalus) and gilthead seabream (Sparus aurata).
- To investigate the reproductive physiology of these species and to apply the results in developing techniques for controlled maturation and spawning by endocrine and environmental manipulation.
- To develop hatchery and nursery technology for the mass production and distribution of high quality fry and fingerlings.

Results

This program of international cooperation has involved active research projects in Egypt and Israel and exchange

visits by Israeli and Egyptian investigators to participating American institutions: Auburn, Louisiana State and Texas A and M Universities. ICLARM's role has been to advise on project development, to establish working plans, to follow-up on the progress of the project, and to participate periodically in the research.

In Israel, captive gilthead seabream and mullet broodstocks have been established. Mature mullet of 4 years and older are now being held. Efforts have been focused on the control of gonadal maturation of the seabream by manipulation of the photoperiod regime; induced breeding (by administration of gonadotropic hormones or by manipulation of environmental conditions) and refinement of hatchery technology, gearing towards the mass production of fry and fingerlings.

To date, spontaneous spawning of seabream has been routinely obtained by priming injections of human chorionic gonadotropin. Efforts have been continued to control spawning by injections of luteinizing hormone-releasing hormone (LH-RH) analog. Procedures and systems for egg incubation and larval rearing have been also established. The major task of the hatchery work has been to improve larval survival through a comprehensive study of their ecological and energetic requirements and the development of intensive and controlled culture systems for live food organisms. In this regard, a small strain of the brine shrimp (Artemia salina) has been mass reared: a useful advance for feeding small-mouthed larvae.

Efforts have also been made to further comprehend the reproductive cycle of wild and cultured mullet populations and the roles of various hormones. The artificial propagation of mullet remains a major thrust of the project.

Project Title : Applied Research on Coastal Aquaculture

Cooperating Institutions : Department of Fisheries (DOF), Ministry of Agriculture and Cooperatives, Government of Thailand and the German Agency for Technical Cooperation (GTZ)

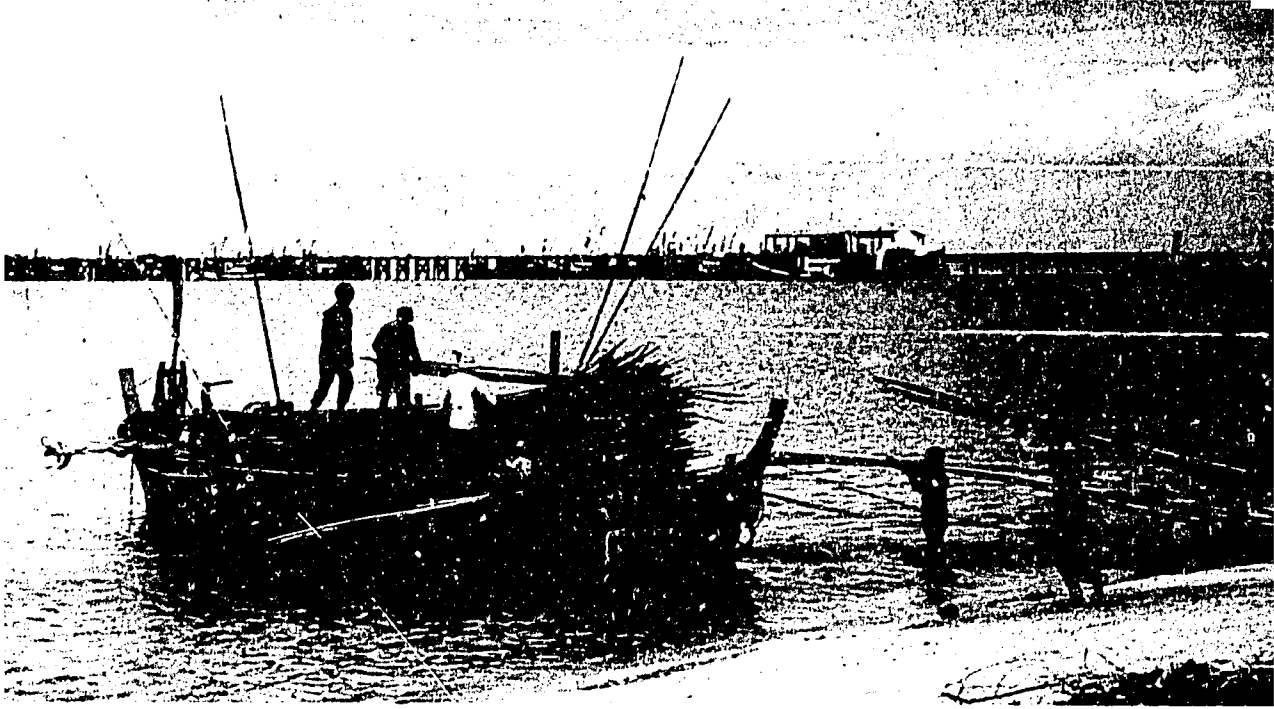
Duration : 3 years, December 1981 - November 1984

Key Personnel ICLARM : Drs. Edward W. McCoy, Ronald F. Ventilla, Richard A. Neal, Roger S.V. Pullin, Mr. Michael Vakily (assigned by GTZ)

Thailand : Pairoj Lipikorn, Dr. Anant Saraya, Dr. Yont Musig, Mr. Kosol Mutarasint, Mr. Kachernsak Wetchagarun

Objectives

- To identify technical, biological and economic constraints hindering successful expansion of bivalve mollusc culture in the coastal zone in Thailand, particularly of the green mussel (Perna viridis) and cockle (Anadara granosa).
- To assist the Department of Fisheries to initiate applied research aimed at eliminating identified constraints.
- To provide technical advice on mollusc culture, product handling and marketing.
- To assist the Department of Fisheries select and develop a lead station for research and development work on mollusc culture.



Aspects of the Thailand green mussel industry. *Above*, bamboo poles on which mussel seed will attach and grow. *Below left*, landing harvested mussels. *Below right*, steaming mussels for market. Photos by Ronald Ventilla.



- To assist the Department of Fisheries to initiate work on introduction and/or improvement of appropriate technologies for mollusc farming.

Results

During 1983, the first 18-month Phase of the project was completed and a comprehensive report on all Phase I activities provided to GTZ, which provided project funding.

Significant progress was made towards achieving all the project's objectives. The different bivalve species suffer from some specific and some common constraints to culture expansion. For the green mussel (*Perna viridis*) there are technical constraints, particularly the culture method used: unthinned culture of natural spat settlement on poles. Thinning mussels during growout and the use of longline culture methods would achieve significant improvements in production and product quality. Post-harvest handling is poor and product deterioration is widespread. Moreover there remains a general lack of information available to Thai producers on green mussel biology and culture. The project is helping to remedy this.

Several economics and marketing studies on green mussels were completed on a range of mussel products. The results showed seasonal movements of mussels between markets in coastal provinces and a lack of uniformity in measurement--producers sell by volume; consumers purchase by weight. In some earlier reports of excessive market margins, the problems associated with non-uniform measuring were not recognized. Low price remains a deterrent to expansion of green mussel culture. For example the market margin from producer to wholesaler for dried mussels processed into 'butterfly shape' was 6 Baht (about 27 US cents) per bucket of 12-15 kg. Net returns to producers were marginal. However, opportunity costs were low. Family labor was utilized in processing green mussels to increase income. There appears to be a large potential export market for frozen mussel meat, but attention to quality control will be required.

For the cockle (*Anadara granosa*), the biological problems affecting the culture industry are seed supply and seed survival through growout to market size. There is also a serious lack of information on cockle biology and culture. However, economic considerations are also of paramount importance since much of the Thai production

depends on Malaysian imports. Studies are underway to improve seed production and survival in Thailand and the cockle will be the major species during Phase II.

Work on other species has been limited to a study on the production, processing and marketing of the short-necked clam (*Paphia undulata*), the most valuable and arguably the most overexploited commercial bivalve species in Thailand, and oysters (principally *Crassostrea commercialis*).

In addition to economics and marketing studies, two very important special studies were completed in 1983 on pollution problems and post-harvest handling. A review of the literature on pollution and the public health aspects of bivalve consumption in Thailand led to an analytical study of trace elements (Table 1) in Thai bivalves and an investigation of microbial pathogen levels in culture area water samples and cultured molluscs. The trace metal results are encouraging and indicate no public health risks. The data on microbial pathogen levels are still being assessed.

Table 1. Summary results of trace metal analyses in bivalve mollusc homogenates from representative commercial culture areas and markets in Thailand: all values are ranges in $\mu\text{g/g}$; W = wet weight basis, D = dry weight basis.

		Cd	Cr	Cu	Fe	Pb	Ni	Hg	Zn
<i>Perna viridis</i>	W	0.15-1.00	0.03-0.19	1.5-2.5	34-170	0.05-0.29	0.05-0.90	<0.02-0.02	10-14
	D	0.88-6.84	0.16-0.88	9.38-15.63	179-1,000	0.31-1.52	0.26-3.88	<0.12-0.12	61-77
<i>Anadara granosa</i>	W	0.24-1.10	0.04-0.09	0.93-1.50	75-160	0.07-0.24	0.13-0.38	<0.02	13-20
	D	1.33-6.47	0.18-0.56	4.89-8.75	385-1,000	0.47-1.41	0.65-2.31	<0.10	94-125
<i>Crassostrea commercialis</i>	W	0.40-0.84	0.05-0.10	21-38	19-29	0.04-0.11	0.15-0.53	<0.02	120-220
	D	2.05-3.82	0.24-0.59	100-181	105-147	0.20-0.53	0.60-252	<0.10	571-1,048
<i>Paphia undulata</i>	W	0.05-0.16	0.07-0.27	0.83-1.40	84-190	0.11-0.25	0.26-0.38	<0.02	8.4-11.0
	D	0.25-0.80	0.32-1.50	4.55-6.50	442-1,056	0.65-1.39	1.35-2.00	<0.10	42-58

The post-harvest handling study was multidisciplinary and involved analysis of wastage during harvesting, methods to increase shelf-life and seasonal changes in the condition and biochemical composition of green mussels, cockles, oysters and short-necked clams. There are clear and very important condition cycles associated with gonad development, spawning times and environmental changes such as salinity reductions. These have important implications for harvesting times and sales value. Data from these studies are still being analyzed.

In addition to these studies, the availability of information on Thai bivalve culture was significantly improved by reviewing existing literature, with translations from Thai to English abstracts whenever possible and the convening of an in-country workshop. The latter comprised 25 papers presented, mainly in Thai, discussion sessions, and a tour of mussel and oyster production areas. This workshop involved contributions from Department of Fisheries station personnel and Thai university researchers.



Green mussels being shucked. Meats are washed in the bowl. Photo by Ronald Ventiila.

Project Title : Marketing Systems of Shellfish Products

Cooperating Institutions : Kasetsart University, Thailand; Department of Fisheries, Thailand; German Agency for Technical Cooperation (GTZ); International Development Research Centre of Canada

Duration : 12 months beginning August 1983

Key Personnel ICLARM : Dr. Edward W. McCoy
 Kasetsart University : Dr. Chamnien Boonma,
 Dr. Ruangrai Tokrisna
 Department of Fisheries : Mr. Kachornsak Wetchagarun

Objectives

- To assess marketing efficiency.
- To identify fresh and processed species marketed by a survey of wholesale markets, restaurants and processors.
- To carry out a detailed analysis of the shellfish marketing system to determine product distribution, role of marketing intermediaries and price determination.

This project is complementary to the larger project "Applied Research on Coastal Aquaculture Phase I: Mollusc Culture" described on p. 56 and represents the initial activity of the Kasetsart University under the Fisheries Social Science Research Network. These activities are described in detail under the ICLARM Traditional Fisheries program statement and Fisheries Social Science Research Network project description beginning on p. 77. Survey work was initiated in September 1983.

Project Title : Economics of Shellfish Processing in Thailand

Cooperating Institutions : Kasetsart University, Thailand; Department of Fisheries, Thailand; International Development Research Centre of Canada

Duration : 12 months beginning October 1983

Key Personnel ICLARM : Dr. Edward W. McCoy
 Kasetsart University : Dr. Chamnien Boonma, Dr. Ruangrai Tokrisna and other faculty members
 Department of Fisheries : Mr. Kachornsak Wetchagarun

Objectives

This study is related to the study "Marketing system of shellfish products in Thailand" (see p. 61). Its purpose is to analyze the processing sector to complete the economic analysis of the shellfish marketing system. Specifically, the study will estimate current demand for raw material used in shellfish processing and evaluate existing techniques and potential for expanding shellfish processing in the future. Industry structure, processing costs and constraints to market diversification will be analyzed.

The project is partially funded by the Agriculture, Food and Nutrition Sciences Division of IDRC.

TRADITIONAL FISHERIES PROGRAM

Background

ICLARM's Traditional Fisheries Program is undergoing transition. Prior to 1983, the exclusive emphasis of the program was upon collaborative research with national institutions. This approach was exemplified by small-scale fisheries sectoral reviews in the Philippines, Malaysia and Indonesia and by the multidisciplinary investigation of the small-scale fisheries of San Miguel Bay in the Philippines which was undertaken in 1979-1982. All of these projects are substantially complete with final publications already out or due out soon. During 1983, the program has expanded to include a more formal training element.

Discussions with the International Development Research Centre (IDRC) of Canada and national institutions with which both ICLARM and IDRC had historically worked indicated that there was a pressing need to develop a core of professionally trained fisheries and aquaculture social scientists in Southeast Asia. The belief in the necessity of developing such a group of professionals derived not only from the all-too-common observation that shortages of trained social science researchers existed but also from the conviction of ICLARM that many of the critical issues of traditional fisheries (and small-scale aquaculture) are of a politically sensitive nature and can often best be addressed by national researchers. The latter perception is due to the fact that it is no longer possible to talk about increasing the harvest from most Asian fisheries through technological interventions; rather, management interventions must now be made to maintain the harvests and to allocate them equitably among competing users.

Because of the perceived need for additional social science researchers to address complex management issues in fisheries, ICLARM's traditional fisheries program has thus been shifting from its exclusive focus on research to an increased emphasis on training and development of institutional research capacity at national centers of excellence in fisheries social science.

Progress of Work

As a culmination of discussions with IDRC and select universities in Southeast Asia during 1981 and 1982, ICLARM launched the Fisheries Social Science Research Network in April 1983. The network has both research and training components, and consists of Universiti Pertanian Malaysia, Kasetsart University (Thailand) and the University of the Philippines in the Visayas in addition to ICLARM. An Indonesian university will be invited to join the network in early 1984. The Social Science Division of IDRC is funding the research component of the network's activities during 1983-1985 and additional support is expected from IDRC for a second 2-year phase. The Training Division of IDRC has provided a limited number of M.Sc. scholarships to the Network with additional funds for scholarships coming from other IDRC Divisions.

Universiti Pertanian Malaysia is contributing to network goals by offering a 2-year M.Sc. in Resource Economics (Fisheries Specialization), the first of its kind in Asia, if not all of the tropics. UPM also offers a 5-month course in fisheries and aquaculture economics and a short course in economics for aquaculturists. With these activities underway, UPM is rapidly becoming the center for professional fisheries economics training in Southeast Asia. Each of the other network institutions is sending young faculty to UPM for training.

The progress of the network to date has been excellent. The Malaysian and Thai research groups have been able to attract additional funding to complement that available through the IDRC grant to the network. Seven faculty members of network institutions have completed or are now enrolled in the UPM training programs.

In addition to the network activities, 1983 has been a year of proposal preparation to secure long-term funding for social science activities and ICLARM's own staff component in such work, as well as completion of projects begun prior to 1983.

All five reports on the small-scale fisheries of San Miguel Bay, Philippines have now been completed and four have been published. The impact of this project continues to be considerable, especially in the area of the multi-disciplinary research methodology which has already been adopted by several other institutions in their own research programs. The Indonesian Review manuscript is substantially

complete and final chapters for the Malaysian Review are now underway after some delay. "A Japanese joint venture: worker experience and national development in the Solomon Islands" by Sarah Meltzoff and Edward LiPuma was published in October. A Fisheries Economics Reader (two volumes to be published by the Obor Foundation in Bahasa Indonesia) is now almost ready for press with all but 2 of 26 articles now translated. Finally, a Fisheries Social Science Research Reprint Series was initiated and the first reprints were ready at the end of 1983.

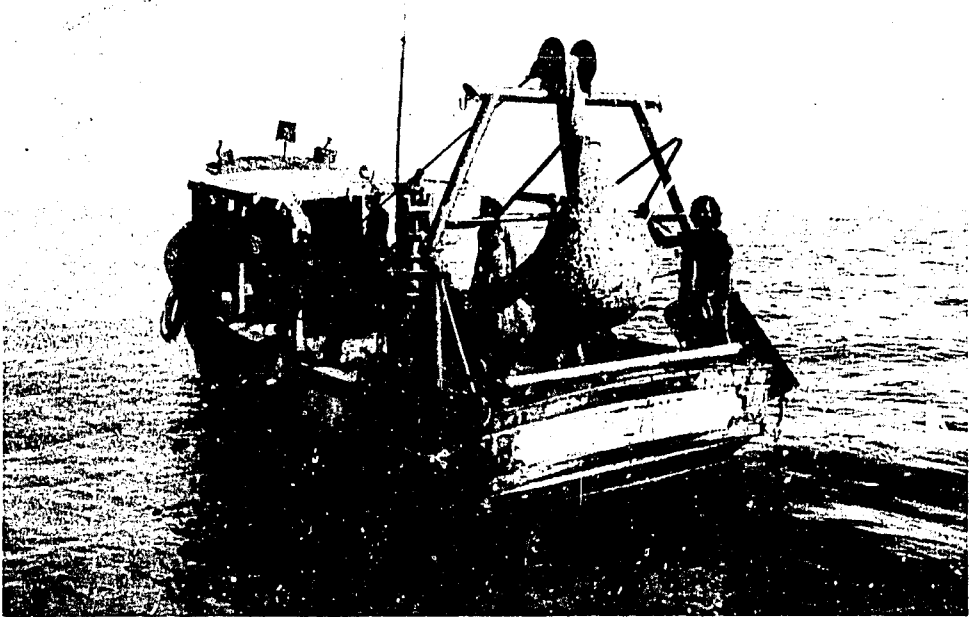
Advisory Services

Two consultancies were undertaken during the year. First, ICLARM provided 145 man-days of consulting time (J. Munro, I. Smith and D. Thomson, consultant) for a joint USAID-Farm Systems Development Corporation project to introduce gasifiers and ice-making plants in remote Philippine fishing communities. Second, Dr. Lockwood spent one month late in 1983 undertaking a survey of socioeconomic data collection and information systems for fisheries in Malaysia, Thailand and the Philippines on behalf of FAO.

In addition to these two consultancies, Dr. Smith visited the Bay of Bengal Programme in Madras, India to advise on the BOBP-State Government of Tamil Nadu shrimp pen project in Killai Backwaters south of Madras. This project is designed to benefit small-scale fishermen who currently use the backwaters. BOBP retained Mr. Rathindra Roy as project consultant for the socioeconomic feasibility study of this project. He and Ms. Ediltraud Drewes of BOBP visited the Philippines for one week in October and consulted further with Drs. Ian Smith and Daniel Pauly regarding their final report. Subsequently, Dr. Pauly visited Madras in November to advise on the seed supply component of this study.

Training

The formal training activity of the Traditional Fisheries Program in 1983 was support for the M.Sc. and module programs offered by Universiti Pertanian Malaysia. These activities are described above and in the project description for the Fisheries Social Science Research Network (p. 77).



Fishing operations with experimental trawls in Tamil Nadu, India. In most fisheries, management interventions are becoming necessary. Professionally trained social science researchers are needed to address sensitive social and political issues involved in management decisions. Photo courtesy of the FAO/SIDA Bay of Bengal Program.

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Meetings Attended, Papers Presented

Workshop to Develop a Research Proposal/Workplan for a Comprehensive Study of the Fish Marketing System of Peninsular Malaysia. Fraser's Hill, Malaysia, 21-23 January 1983. (B. Lockwood)

ACMRR Working Party on Management of Living Resources in Nearshore Tropical Waters, Rome, Italy, 28 February - 4 March 1983. (I.R. Smith and D. Pauly)

I.R. Smith and D. Pauly. The research process and communication of results: lessons learned from a multidisciplinary analyses of a tropical small-scale fishery.

International Conference on Development and Management of Tropical Living Aquatic Resources, Universiti Pertanian Malaysia, 2 - 5 August 1983. (B. Lockwood)

B. Lockwood. The ICLAPM fisheries social science research network.

Ishak Hj. Omar, B. Lockwood and Nik Mustapha Raja Abdullah. Fish consumption patterns in a multi-racial society: a case study in Kuala Lumpur and Petaling Jaya, Malaysia.

University of the Philippines Diamond Jubilee - Advancing the Frontier of Science and Technology. Lecture Series III. Iloilo City, 7 September 1983. (I.R. Smith)

I.R. Smith. The status and significance of social science research in fisheries. (Invited speaker).

First National Social Science Congress, Philippine Social Science Council, Quezon City, 17-19 November 1983. (E. Escover)

Program Plans for 1984

The major program activity of the Traditional Fisheries Program in 1984 will be the continued expansion and

maturing of the Fisheries Social Science Research Network. The network coordinator, Dr. Lockwood, will transfer to Manila in mid-1984 to assume full-time coordination of the network. Research activities begun in 1983 will continue through most of 1984; additional network scholars will be sent to UPM for M.Sc. and module training in fisheries economics.

Plans to initiate a new project, "Management options for tropical small-scale fisheries" are being prepared. Also, ICLARM has responded to an invitation from the Training Division of the Australian Development Assistance Bureau (ADAB) to submit a proposal to initiate and staff ICLARM's Education and Training Program in 1984. This proposal, if approved, would provide additional support for social science research and training, among other ICLARM activities.

Finally, the International Food Policy Research Institute in Washington, D.C. and ICLARM plan to prepare a joint proposal for support of a full-time macroeconomist who would be based at ICLARM and who would analyze development trends and policy issues in fisheries and aquaculture.

Traditional Fisheries Project Summaries

Completed

Small-Scale Fisheries of San Miguel Bay: A Multidisciplinary Analysis	72
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Fisheries Social Science Research Network (Phase I)	77
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Upcoming

Fisheries Social Science Research Network (Phase II, pending funding)	
Management Options for Small-Scale Fisheries (pending funding)	
Macroeconomic Policy Issues of Asian Fisheries (pending funding)	

- Project Title** : Small-Scale Fisheries of San Miguel Bay, Philippines: A Multidisciplinary Analysis
- Cooperating Institutions** : Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas (UPV); the United Nations University (UNU), Japan; and Philippine Council for Agriculture and Resources Research and Development (PCARRD)
- Duration** : September 1979 to January 1982 (field work)
February 1982 to December 1983 (report preparation)
- Key Personnel**
- | | | |
|--------|---|---|
| UPV | : | Prof. Antonio Mines (Project Leader)
Mr. Gregorio Bañacia (Field Leader) |
| ICLARM | : | Dr. Ian Smith (Economics)
Dr. Daniel Pauly (Biology)
Dr. Conner Bailey (Sociology)
Ms. Luz Yater (Sociology) |

Objectives

The primary objective was to conduct an in-depth study of the San Miguel Bay fisheries to facilitate this sector's inclusion in the Bicol integrated area development program, a plan from which fishing communities have generally been excluded. A second objective was to develop a multidisciplinary approach to tropical fisheries research for application elsewhere.

Results

The biological segment of this project involved estimation of fishing effort and catch per effort for all gear types, leading to reliable estimates of catch by month and by species groups.

Catches from the Bay were found to be 3 to 4 times higher than official statistics suggest. About 59% of the catch, which totals 15,000 tonnes/year (excluding 4,000 tonnes of sergestid shrimp), is taken by some 5,100 small-scale fishermen, and the remainder by 95 trawlers of various sizes. Detailed assessments using surplus-production and yield-per-recruit models suggest that the Bay is overfished in the sense that an increase in effort by either the trawl or the small-scale fishery would not result in an increased catch from the San Miguel Bay as a whole, but rather exacerbate the present allocation problems between the small-scale and trawl fisheries.

This is confirmed by the economic analysis which shows that small trawlers, representing only 3% of the Bay's fishing units and employing 7% of the fishery's labor force, earn the largest share of catch value and 50% of the pure profits (resource rents). The government fuel tax and oligopoly/oligopsony power of fuel suppliers/processors also divert part of the resource rents to these sectors. The table below summarizes the distribution of costs and revenues in the fishery at the time of the study.

Serious consideration should be given to limiting effective fishing effort so as to maintain positive resource rents and to deal with the presently highly skewed distribution of benefits. The analysis of labor mobility showed that very limited alternative employment opportunities exist in the area, which explains the low opportunity costs of labor and the significant outmigration from the area. These complementary findings all argue for seeking solutions to the low incomes of the small-scale fishermen within rather than outside the fishery sector by reallocating use rights in their favor.

Four technical reports, dealing with biology and stock assessment, economics of production and marketing, social aspects, and occupational and geographical mobility, have been published. A fifth report, which synthesizes the results of the first four and discusses options for management and research, is in press. The need for the creation of management institutions and mechanisms that control the

level of effective fishing effort in the Bay and that address the equity issues related to distribution of benefits from the fishery is stressed. Enforcement is certainly one key element of successful management; a participatory mechanism for fishermen is equally important and may even facilitate enforcement. The final report examines a range of management goals and interventions and suggests that a combination of trawler licensing and area restrictions is more likely to be enforceable and produce a redirection of benefits to the majority of fishermen than would other techniques such as taxes and quotas. Given the overlapping jurisdiction of coastal municipalities and national government agencies, the creation of a single management authority for the Bay was recommended. This management authority would have responsibility for setting objectives, selecting interventions, enforcement and data gathering to monitor the impact of management interventions.

The fishermen, both small-scale and trawler operators, must participate in decisionmaking by this Authority if it is to deal successfully with the twin problems of overfishing and inequitable distribution of benefits that currently exist in San Miguel Bay.

Lack of fishermen's participation will most likely subvert any management plan; indeed, some measure of local decisionmaking and enforcement offer much better hope for fisheries management than do nationally centralized attempts at regulation.

The general features of what the research team has learnt about the San Miguel Bay fisheries apply to a large number of other fisheries throughout the Philippines, various Southeast Asian countries and, to a lesser extent, to many other tropical developing countries.

It was conflict of interests similar to that in San Miguel Bay, but involving much larger numbers of trawlers and small-scale fishermen, which prompted the Indonesian government to ban trawling in that country (see ICLARM Newsletter, Oct. 1980, p. 3). Other conflicts of this kind, often violent, have been reported from various parts of the Indo-Pacific. The lesson seems to be that in tropical demersal fisheries--because they generally involve shrimp that are caught inshore--conflicts between trawl operators and small-scale fishermen are almost unavoidable in the long run; projects of the type conducted in San Miguel Bay are indispensable for clarifying the issues involved and outlining some of the possible remedies.

Table 1. Summary of data on the San Miguel Bay fisheries (1980-1981). At time of study US\$1.00 = P8.50.

Characteristics	Non-trawl gears	Trawl gears		Totals for the San Miguel Bay fisheries (all fishing units)
		Mini	Small/Medium	
No. of fishing units	2,100	198	95	2,382
Total horsepower	2,592	3,008	13,200	18,800
No. of fishermen	4,825	376	600	5,600 in 3,500 households
No. of households owning fishing units	≈ 1,880	≈ 150	35	2,065
Average investment cost per fishing unit (P)	250-13,000	9,200	55-70,000	> 15 million current replacement cost
Percent of total catch				
including sergestid shrimps	44	25	31	19,133 tonnes
excluding sergestid shrimps	59	—	41	14,680 tonnes
Percent of total value				
including sergestid shrimps	44	14	42	P53.5 million
excluding sergestid shrimps	52	—	48	P46.2 million
Percent of pure profits (resource rents) ^a				
including sergestid shrimps	15 ^b	35	50 ^c	P3 million
excluding sergestid shrimps	23	—	77	P1.6 million
Crewmen incomes/mo (P)	164-218	342	339-810 ^d	
Owner (non-fishing) incomes/mo (P)	(-773) ^e -740	432	146 ^f -1,693	

^a Does not include resource rents earned by the government and by fuel suppliers/processors.

^b One-half of this is earned by fish corrals; 40% by motorized gill-netters.

^c Small trawlers only; medium trawlers did not cover their opportunity costs.

^d Highest incomes are earned by pilots on small trawlers.

^e Owners of stationary liftnets incurred losses.

^f Lowest incomes are earned by owners of medium trawlers.

KALAM TECHNICAL REPORTS 7

Small-scale fisheries of San Miguel Bay, Philippines: biology and stock assessment

Edited by
Daniel Pauly and Antonio N. Flores



KALAM TECHNICAL REPORTS 8

Small-scale fisheries of San Miguel Bay, Philippines: economics of production and marketing

Edited by
Jan R. Arnes and Antonio N. Flores



KALAM TECHNICAL REPORTS 9

Small-scale fisheries of San Miguel Bay, Philippines: social aspects of production and marketing

Edited by
Crisper B. Goy



KALAM TECHNICAL REPORTS 10

Small-scale fisheries of San Miguel Bay, Philippines: occupational and geographic mobility

Guest Editor



- Project Title** : Indonesian Small-Scale Fisheries: Research Review and Synthesis
- Cooperating Institutions** : Directorate General of Fisheries (DGF) and Research Institute for Marine Fisheries (BPPL), Indonesia
- Duration** : October 1981 to December 1982
- Key Personnel**
- | | | |
|--------|---|-------------------------------------|
| ICLARM | : | Dr. Conner Bailey
(Sociology) |
| DGF | : | Ir. Firial Marahudin
(Economics) |
| BPPL | : | Mr. A. Dwiponggo (Biology) |

Objectives

The project was a multidisciplinary review of Indonesian small-scale fisheries by scientists from the Indonesian Directorate General of Fisheries, the Marine Fisheries Research Institute and Dr. Conner Bailey, who was based in Bogor. It brought together information from the scattered published and unpublished reports, mostly in the Indonesian language, of the considerable research previously carried out on Indonesian fisheries.

Results

The authors spent 15 months reviewing the literature and preparing an English-language manuscript. Extensive field work, including interviewing fishermen and researchers was carried out to supplement the literature database. The English version of the manuscript is currently being reviewed and edited. A Bahasa Indonesia version will be prepared after the English version is finalized. Publication of both versions is expected in 1984.

- Project Title** : Fisheries Social Science Research Network
- Cooperating Institutions** : Universiti Pertanian Malaysia (UPM), Serdang, Selangor, Malaysia; University of the Philippines in the Visayas (UPV), Iloilo; Kasetsart University, Bangkok, Thailand; One Indonesian University (yet to be identified); International Development Research Centre (IDRC), Canada
- Duration** : 1983 to 1985 (First phase)
- Key Personnel**
- | | | |
|----------------------|---|--|
| UPM | : | Prof. Ishak Hj. Omar |
| UPV | : | Prof. Ma. Luisa Mabunay |
| Kasetsart University | : | Drs. Ruangrai Tokrisna and Chammien Boorma |
| ICLARM | : | Dr. Brian A. Lockwood (Coordinator currently based at UPM) |
| | : | Drs. Ian Smith and Edward McCoy |
| IDRC | : | Drs. Elwood Pye and David King |

Objectives

The underlying objective of this research network is to build national research capability. Only through sustained long-term involvement of national institutions can research have an impact on fisheries development and management policy. This project seeks to provide continuity and quality to fisheries social science research by addressing priority issues through a small network of affiliated institutions. Major purposes of the network are to

strengthen selected national research institutions, facilitate their long-term commitment to fisheries social science research, and forge links between the research community and policymakers.

Social scientists, particularly economists, have had little professional interest in fisheries and aquaculture in Asia and the Pacific. There are a number of notable studies by anthropologists, sociologists and geographers but very few by economists, whose involvement in the problems of the sectors has been mainly on a part-time or ad hoc basis. There are few economists in the region who would classify themselves, either by reason of training or occupation, as fisheries or aquaculture specialists. Consequently, in most countries of the region, no systematic program of economic research on the problems of fisheries and aquaculture has been carried out either by government fisheries agencies or in the universities.

Recently, the parallel interests of ICLARM and the International Development Research Centre (IDRC) of Canada came together in a joint decision to set up and fund the Fisheries Social Science Research Network. Both ICLARM and IDRC have histories of encouraging social science research in fisheries and aquaculture and, equally importantly, both have an interest in elevating such research from its present ad hoc status to that of a planned and sustained long-term program which would enable Asian and Pacific social scientists to make regular and constructive contributions to the management and development issues of the sector in their respective countries.

There are three pressing needs that must be addressed if fisheries social science research is to be effective. First, there must be continuity of effort and this implies strong institutional support over the long run. In attempting to meet this need the Network has selected co-operating institutions with care.

Second, only high quality research on issues felt to be relevant by fisheries agencies will gain for the program and institution the national recognition necessary to sustain the program in the long run.

The third need that the Network must address is for continuous working contact and cooperation between the researchers and fisheries program managers, government administrators and planners concerned with fisheries issues. This will help to ensure that the research and

teaching activities of the Network program are geared to national needs and that the research results will feed directly into the national planning process.

An important component of the Network is to help provide training facilities and opportunities in Asia for the teachers-researchers of the Network's cooperating universities. The aim, of course, is to improve research capacity and, in the longer run, to help each of the universities become the training center for its own nationals. For the foreseeable future, the main training center will be the Universiti Pertanian Malaysia, which now offers an M.Sc. program and a post-graduate non-degree course in fisheries and aquaculture economics. The UPM program is the first in Asia to offer a specialization in fisheries and aquaculture economics and it is expected to attract students from a wide range of fisheries institutions in Malaysia and the Asia-Pacific region.

Results

Training and research components of network activities are both underway. In the training area, several scholarships have been awarded. In the current academic year which commenced early in July, M.Sc. scholars from Bangladesh, Indonesia, Malaysia, the Philippines and Thailand have enrolled in the program. Four are sponsored by the ICLARM Network and funded by an IDRC grant to ICLARM.

For some years to come the Training component of the Network activities will be crucial to the overall objective of building research capacity. There exists no stock of trained fisheries or aquaculture economists at present and it is necessary, therefore, to train those who will lead the research teams and set up teaching programs in their own universities. The Network's funds are limited at present and additional sources are being sought. The Network has benefited from IDRC support for the four current Fellows and IDRC is expected to continue this support for a second group of Fellows in 1984. Moreover, the Network is a developing program that will need training assistance for many years to come.

The Network is already funding research projects in three cooperating universities. The fisheries economics group at Universiti Pertanian Malaysia is leading a major study of the fish marketing system in Peninsular Malaysia. The study is being conducted in cooperation with

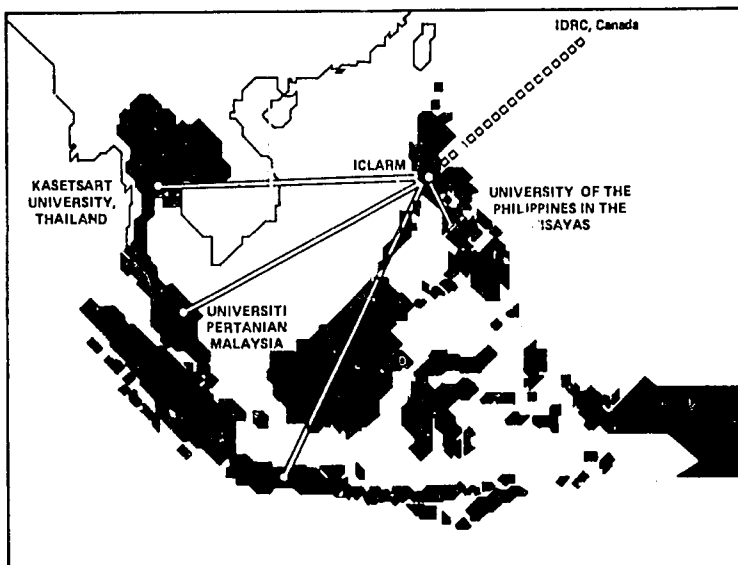
researchers from Universiti Malaya and Universiti Kebangsaan Malaysia. In addition to Network funding, the project has received a large grant from the Malaysian Fisheries Development Authority and is a good example of close cooperation with government fisheries agencies from planning through funding and implementation.

The fisheries economics group at Kasetsart University in Thailand is studying the marketing system for shellfish and will later expand the study to include fish and other marine animals. This study has also attracted additional funding from an ICLARM-GTZ (German Agency for Technical Cooperation) project to augment that provided by the Network.

The fisheries social science group at the University of the Philippines in the Visayas is an interdisciplinary group examining small-scale fisheries in Iloilo province. This group will examine household consumption patterns and preferences for fish and other meats, social relationships in the marketing system, management of fish processing industries, and the psychological characteristics of fishing households and attitudes towards their source of livelihood.

The second round of research in each university will include the thesis research of their staff member studying at UPM.

In due course it is hoped that the program can be extended to other countries and universities in the Asian and Pacific region. The Network aims to assist in the development of a fisheries economics profession in Asia capable of sustaining a long-term research and training program.



The fisheries social science research network. Three universities are presently involved with a fourth to be identified in Indonesia.

RESOURCE DEVELOPMENT AND MANAGEMENT PROGRAM

Background

The objectives of the Resource Development and Management Program continue unchanged; namely, to enhance the abilities of fisheries scientists in the tropics to assess fisheries resources and to translate the results of such assessments into recommendations for the management and conservation of the stocks. The great importance of social and economic factors in addition to the biological features of exploited stocks is constantly borne in mind.

There are encouraging signs of good progress in tropical fish stock assessment as a result of the adoption of length-frequency based stock assessment techniques and the concurrent development of relatively inexpensive programmable calculators and microcomputers. Some of this progress on a world-wide basis can be directly attributed to work conducted at and pioneered at ICLARM.

One of the most significant turning points reached in tropical fisheries science has been the recognition that recruitment to tropical reef stocks is highly variable and that some reef stocks may be recruitment limited. A possible avenue for future investigations is the degree to which recruitment could be enhanced by stocking specific reefs with hatchery-reared recruits of suitable, commercially important species.

In 1982, ICLARM's Program Advisory Committee recognized the economic potential of giant clams (family Tridacnidae) and approved the development of a project for rehabilitation of clam fisheries through a program of support of research on hatchery techniques and juvenile rearing, reef restocking or extensive mariculture, biological and socioeconomic studies. Giant clams are an everyday part of the diets of most Indo-Pacific coastal people. Additionally, the dried adductor muscles fetch high prices in Southeast Asia. However, the most important feature of the tridacnids is that by virtue of a symbiotic relationship with certain micro-algae, they are largely phototrophic and require no

external sources of food. They are thus the only "self-feeding" potential farm animal known to mankind. Yields of 60 tonnes of flesh/ha/yr are theoretically feasible, even at modest stocking densities.

Progress of Work

Operations of the Program during 1983 were grouped around four basic projects. These were the Tropical Fish Stock Assessment Research Project, the Network of Tropical Fisheries Scientists, the Management-Oriented Fisheries Research Project and the International Giant Clam Mariculture Research Project.

The Tropical Fish Stock Assessment Research Project has continued to concentrate upon the problems of multispecies, multigear fisheries. Major achievements of the project have included the completion of four length-frequency based stock assessment programs for microcomputers and the integration of these programs into a wider systems approach to the assessment of multispecies, multigear fisheries. The proceedings of the ICLARM/CSIRO workshop on the "Theory and Management of Tropical Fisheries" were published during the year, as was a volume on Caribbean coral reef fishery resources. Dr. Pauly's book entitled "Fish Population Dynamics in Tropical Waters: a Manual for Use with Programmable Calculators" was finalized during the year after being reviewed by numerous colleagues and will be published in early 1984.

The Network of Tropical Fisheries Scientists (NTFS) completed its first full year of operations with membership standing at over 200 in 52 countries. A substantial portion of the operating costs of the Network were met by the FAO/DANIDA Training Project in Fish Stock Assessment and by FAO. Two numbers of the newsletter "Fishbyte" were published and were received enthusiastically by members. The Network also distributes stock assessment and management manuals, reprints and computer programs gratis to members. Six scientists visited ICLARM during the year under the sponsorship of the NTFS Visiting Scientist scheme. These visits enable members to analyze data using the ELEFAN suite of programs developed at ICLARM and to generally develop their expertise in stock assessment methodologies.

One of the ancillary objectives of the Network is to create Stock Assessment and Management Modules (SAMMs) within the umbrella of our Management-Oriented Fisheries Research Project. A SAMM consists of a small number of NTFS

members in a particular country or institution provided with the necessary training, microcomputer and scientific support. The scientific support could range from periodic visits by ICLARM staff to stationing a staff member in a country for several years. The latter course requires outside funding. Operational modules are in Indonesia, Peru and the Philippines and all have enjoyed considerable success in the assessment of local stocks. Additionally, a formal request has been received for development of a SAMP in Zambia and this will be activated early in 1984.

The International Giant Clam Mariculture Research Project was launched in January 1983. Activities concentrated mostly upon catalyzing the necessary scientific interest and developing a comprehensive research proposal. In its final form, the proposal calls for the support of a major scientific initiative at James Cook University of North Queensland (JCUNQ) and at various institutions in the tropical Indo-Pacific, the development of a pilot scale hatchery in the equatorial Indo-Pacific and the investigation of economic and social problems which might arise in relation to various forms of giant clam cultivation.

The project is envisaged as a collaborative effort between JCUNQ and ICLARM with JCUNQ responsible for the major scientific program and ICLARM for the development of a pilot hatchery. A proposal for support of the Australian module, prepared in close collaboration with ICLARM, was submitted to the Australian Centre for International Agricultural Research (ACIAR) in November.

A potential hatchery site has been identified in the Solomon Islands and negotiations are in progress. A short-term appointment was made for preparation of a preliminary design of a giant clam hatchery and a review of processing techniques for tridacnid adductor muscle.

Advisory Services

Dr. Pauly visited Peru at the invitation of GTZ for consultations on assessment of the demersal fisheries in the period 30 April - 7 May 1983. Additionally, he spent two periods totalling 22 days in Burma as a consultant to the UNDP/FAO Burma Fisheries Development Project advising on the analysis of previous survey results, conducting preliminary training of Burmese scientists in stock assessment techniques and preparing plans for future research.

Three graduate students of the University of the Philippines, whose thesis work was supervised by Dr. Pauly, completed their theses in late 1982 and 1983 and graduated with MS degrees. Two theses were on aspects of growth in tropical fish; the third was on fishing hook selection in tuna. The students used approaches and methods not previously used in the Philippines.

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- Pauly, D. 1983. Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part 1). *Fishbyte* 1(2):9-13.
- Pauly, D. and K.D. Hopkins. 1983. A method for the analysis of pond growth experiments. *ICLARM Newsletter* 6(1):10-12.
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Pauly, D., A.N. Mines and N. Navaluna. 1982. Catch and effort in the small-scale fisheries, p. 56-64. In D. Pauly and A.N. Mines (eds.) ICLARM Technical Reports 7.

Pauly, D. and I.R. Smith. 1983. The research process and communication of results: lessons learned from a multi-disciplinary analysis of a tropical small-scale fishery, p. 37-55. In: Report of the ACMRR Working Party on the Management of Living Resources in Nearshore Tropical Waters, Rome, 28 February - 4 March 1983. FAO Fish. Tech. Rep. 284, 78 p.

Pauly, D. and I.R. Smith. 1983. Small-scale fisheries of San Miguel Bay, Philippines: resolving multi gear competition in nearshore fisheries. ICLARM Newsletter 6(4):11-18.

Peters, H.M. 1983. Fecundity, egg weight and oocyte development in tilapias (Cichlidae, Teleostei). Translated from German and edited by D. Pauly. ICLARM Translations 2, 28 p.

Skud, B. and D. Pauly. 1982. Inter- and intraspecific recruitment control. Amer. Inst. Fish. Res. Biol. Briefs 11(6):2.

Meetings Attended, Papers Presented

Roundtable Discussion of Increasing Benefits from African Reservoir Fisheries, Cairo, Egypt, 11-13 January 1983. (D. Pauly)

D. Pauly. Recent developments in the methodology available for the assessment of exploited fish stocks of reservoirs.

ACMRR Working Party on the Management of Living Resources in Nearshore Tropical Waters, Rome, Italy, 28 February - 4 March 1983. (D. Pauly)

D. Pauly and I.R. Smith. The research process and communication of results: lessons learned from a multidisciplinary analysis of a tropical small-scale fishery.

FAO Expert Consultation on the Abundance of Neritic Stocks, San Jose, Costa Rica, April 1983. (D. Pauly)

D. Pauly and N. Navaluna. Monsoon-induced seasonality in the recruitment of Philippine fishes.

D. Pauly and I. Tsukayama. On the seasonal growth, monthly recruitment and monthly biomass of the Peruvian anchoveta (Engraulis ringens) from 1961 to 1979.

International Conference on the Development and Management of Tropical Living Aquatic Resources, Universiti Pertanian Malaysia, 2-5 August 1983. (J.L. Munro)

J.L. Munro. A cost-effective data acquisition system for assessment and management of tropical multispecies, multigear fisheries.

International Recruitment Program, Workshop, Halifax, Canada, 26-30 September 1983. (D. Pauly)

D. Pauly. Recruitment variability of tropical fishes.

World Fisheries Conference, Rome, Italy, 10-19 October 1983. (J.L. Munro)

Gulf and Caribbean Fisheries Institute, Port-of-Spain, Trinidad and Tobago, 14-18 November 1983. (J.L. Munro)

J.L. Munro and I.R. Smith. Management strategies for multispecies complexes in artisanal fisheries.

Program Plans for 1984

It is envisaged that considerable effort will be devoted to expanding the Network of Tropical Fisheries Scientists. Activities will include increased distributions of manuals and other materials, publication of three numbers of the Newsletter, "Fishbyte", and visits to ICLARM of a large number of Network members under the NIFS Visiting Scientist scheme.

The suite of ELEFAN programs will be edited into a single volume. The major thrust will be towards integrating the ELEFAN programs into a single length-frequency based stock assessment system for microcomputers. Consideration is being given to preparing and distributing software packages for fisheries assessment and management.

A conference on length-frequency based stock assessment techniques is proposed for the fall of 1984, possibly co-sponsored by a major Middle-Eastern research institute.

In the Management-Oriented Fisheries Research Project, the Indonesian module will draw to a close around September 1984 and this will form the basis for several substantial publications co-authored by the Indonesian participants and Dr. D. Pauly. This module will receive support from the

Skaggs Foundation in 1984. A module is planned for Zambia and this will be initiated early in the year. Consideration is being given to continuing the Philippine module and it is expected that the Peruvian module will be greatly expanded, with substantial external support. Other possible modules are under consideration elsewhere in Africa, Asia and Latin America.

For the Giant Clam Project, plans call for the establishment of the major scientific program at James Cook University of North Queensland, and for identifying, funding and developing the hatchery. The most likely site is at Guadalcanal in the Solomon Islands, but firm arrangements have not yet been confirmed. Efforts will be made to obtain funding for a marketing investigation and for studies of the economics of various nursery and hatchery options. Additionally, the project will catalyze research on giant clams at a variety of Indo-Pacific institutions and seek funds for such research where necessary.



This photograph of four-month old giant clams (*Tridacna squamosa*) from a hatchery in Palau drew much attention to the ICLARM international clam project launched in 1983.

Resource Development and Management Project Summaries

Active

Tropical Fish Stock Assessment Research Project	90
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Management-Oriented Fisheries Research Project	95
International Giant Clam Mariculture Research Project	98

Project Title : Tropical Fish Stock Assessment Research Project

Cooperating Institutions : Predominantly in-house study, with informal linkages with various research institutions.

Duration : Continuous from July 1979

Key Personnel ICLARM : Dr. Daniel Pauly
 Dr. John L. Munro
 Mr. Morfeo Sumiran
 Ms. Maria Lourdes Palomares

Objectives

- To understand the dynamics of exploited tropical fish communities.
- To develop stock assessment methods which are straightforward, are readily applicable to tropical stocks and which do not require costly hardware for their implementation.

Results

The first two programs in the ELEFAN (Electronic Length Frequency Analysis) series have been distributed by Dr. D. Pauly and have now achieved wide recognition. They have been translated by their users into a variety of programming languages and for operation on a number of different models and makes of microcomputers and also for several mainframe computers. The Table on p. 92 shows the known countries and uses of ELEFAN program.

During the course of the year, the fifth and probably final program in the ELEFAN suite of microcomputer programs was completed, revisions were made of ELEFAN I and II and user's instructions for ELEFAN III and IV completed. Additionally, a program, ELEFAN 0 was developed for the handling of length-frequency data files. These programs and

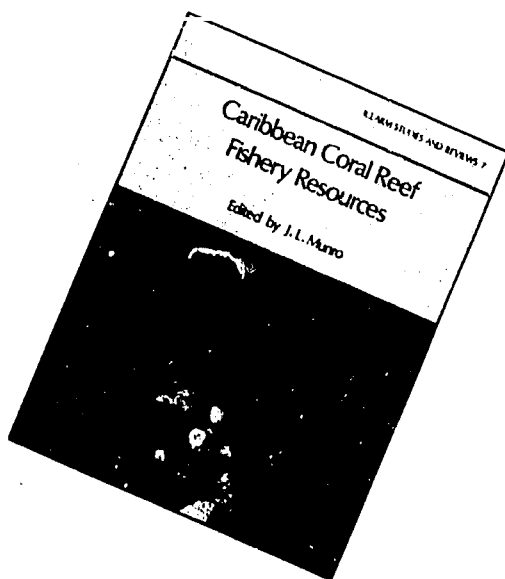
sets of user's instructions will be consolidated into a single volume and published in early 1984. Also, consideration is being given to distributing the ELEFAN suite as a complete software package suitable for a wide variety of microcomputers.

Work continued on basic stock assessment techniques and methods of parameter estimation. A method for estimating natural mortality rates from length-frequency and gear-selectivity data was presented by Dr. J.L. Munro at the Development and Management of Tropical Living Aquatic Resources conference in Malaysia. This method forms the basis of the ELEFAN IV program devised by Dr. J.L. Munro and M.L. Palmares.

Additionally, an integrated systems approach to length-frequency based stock assessments has been devised by J.L. Munro, and the development of this approach (which will incorporate the ELEFAN programs) into a single micro-computer based stock assessment program is now being contemplated.

Work in the final revision of the manual by Dr. D. Pauly on "Fish Population Dynamics in Tropical Waters: A manual for use with programmable calculators" was delayed by the pressure of other work and the volume is now expected to be published early in 1984.

A volume entitled "Caribbean Coral Reef Fishery Resources", edited by Dr. J.L. Munro was published in October. This is a reprinting and updating of a series of reports on investigations conducted in Jamaican waters in 1969-1973. The original reports had a verly limited distribution and the reprinting will ensure that a much wider distribution and readership are attained.



Countries in which ELEFAN programs have been adopted and their use.

Country	ELEFAN projects
Australia	Stock assessment research in several universities
Canada	Several uses dealing with anadromous alewife, northern shrimp and others
Costa Rica	Used to reduce backlog of length-frequency data on estuarine fishes, mainly sciaenids
Denmark	Used as a basis for further research on stock assessment
Germany (West)	University research on changes in North Sea fisheries
Indonesia	Re-analysis of existing data for stock assessment purposes
Kuwait	Routine fisheries stock assessment
Netherlands	Used for research on flatfish, shrimps and bivalves
Norway	Used for analysis of data on polychaetes and bivalves; also used in Mozambique-Norwegian fisheries project
Papua New Guinea	Assessment of baitfish stocks
Peru	Assessment of pelagic resources
Philippines	South China Sea Programme research on stock assessment of tuna; re-analysis of existing data for assessment of demersal stocks; analysis of survey data by German bilateral aid project
Seychelles	FAO stock assessment project
Solomon Islands	Assessment of baitfish resources
U.S.A.	Coral reef fish assessment in Hawaii; various research uses in other States.

Project Title : Network of Tropical Fisheries Scientists

Cooperating Institutions : Fishery Resources and Environment Division, Fisheries Department, FAO, Rome, Italy, plus individual member scientists in institutions throughout the world.

Duration : Continuous from April 1982

Key Personnel ICLARM : Dr. John L. Munro
Dr. Daniel Pauly
Ms. Ferdinandina Santos

Objectives

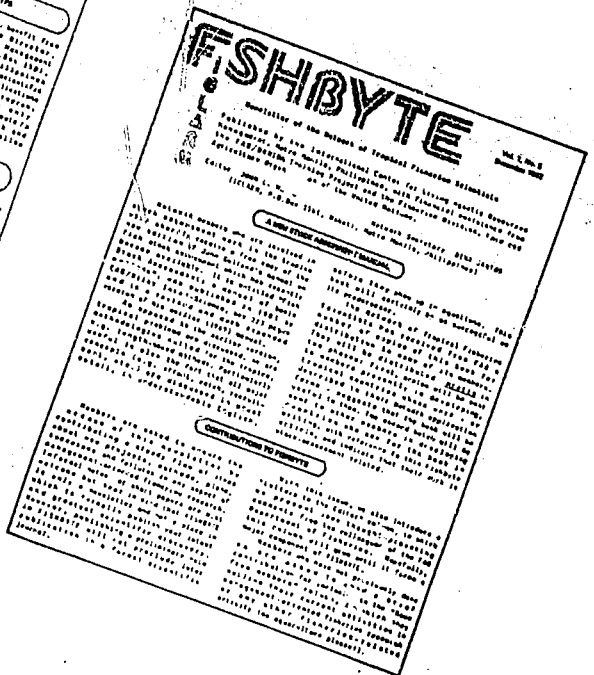
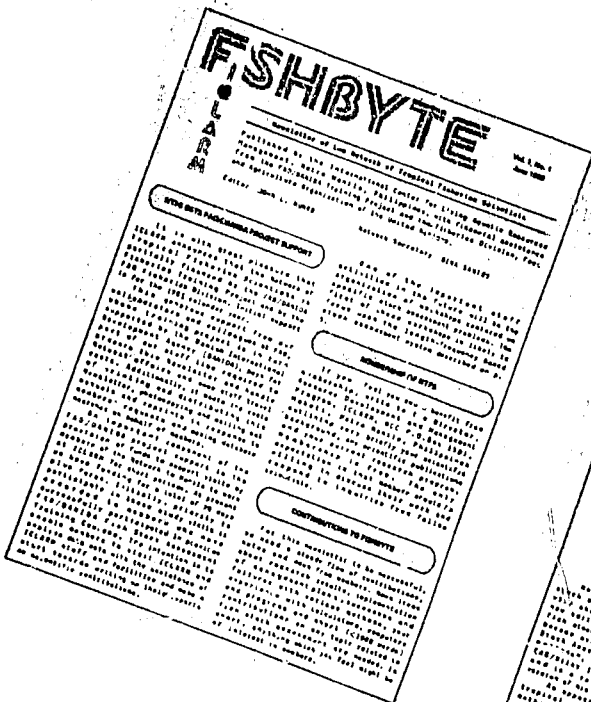
- To enhance communication between fisheries scientists working on the assessment, conservation and management of tropical stocks.
- To enhance the output of these scientists by improving access to literature, providing free database searches, distributing manuals and other literature and publishing a newsletter at regular intervals. The technical focus is on the estimation of the biological, fishery and socioeconomic parameters which determine the magnitude of harvests and the application of those parameters to models to arrive at scientifically sound management measures for tropical stocks.

During 1983, the Network benefited greatly from partial funding by the FAO/DANIDA Training Course in Fish Stock Assessment and by the Department of Fisheries of FAO.

Membership rose rapidly during the year and now stands at over 200 members in 52 countries. The increasing proportion of third-world national scientists is a pleasing feature of the membership.

During the course of the year, six members visited ICLARM to work on stock assessment problems. These visits totalled 36 man-weeks and were of great benefit to the participants.

Two numbers of the NIFS newsletter "Fishbyte" were produced and received an enthusiastic response from members.



Project Title : Management-Oriented Fisheries Research Project

Cooperating Institutions : Research Institute for Marine Fisheries, Indonesia (BPPL); Instituto del Mar del Perú (IMARPE); University of the Philippines in the Visayas (UPV)

Duration : Continuous from 1982

Key Personnel

ICLARM	:	Dr. Daniel Pauly
		Dr. John L. Munro
BPPL	:	Mr. Dwiponggo
UPV	:	Mr. N. Navaluna
IMARPE	:	Ms. I. Tsukayama

Objectives

- To strengthen the capabilities of the participating countries to manage their fisheries by creating stock assessment and management modules (SAMMs) in various countries and institutions. Each SAMM will develop a small nucleus of well-trained researchers.
- To train fishery scientists in the interpretation of fishery data (especially in extracting a maximum of information from available data) and in formulating implementable management options. This core of trained researchers will be the basis for future in-country training of additional workers, for improvement of university curricula and for interaction with fisheries administration.
- To help determine, in the countries involved in the project, the basic information requirements for stock assessment and fisheries management.
- To produce well-documented reviews of the various fisheries investigated and original studies on tropical fish population dynamics.

- To help establish a dialogue between the fishery managers and the fishery biologists, and between the fisheries departments and the universities of the project's host countries.

Results

Three modules were operational at the end of 1983; in Indonesia, Peru and the Philippines.

Indonesia

This module is based at the Research Institute for Marine Fisheries in Jakarta and scheduled to remain operational for a period of 18 months from March 1983. The members of the module have embarked on a program of analyzing accumulated length-frequency data to extract growth and mortality estimates using the ELEFAN I and II programs on a Radio Shack TRS 80 Model III microcomputer supplied by ICLARM. Dr. D. Pauly visited Jakarta twice during the year, the first time to purchase and set up the computer, train the participants and initiate the analyses and on the second occasion, in October, to review progress. To date, the module has generated estimates of growth parameters for over 60 species of fishes. Additionally, the microcomputer has been much used by a number of other Indonesian scientists and has clearly made its mark simply by virtue of its accessibility and ease of operation.

Peru

The work of the Peruvian module has concentrated very heavily upon the analysis, at ICLARM, of accumulated catch and length-frequency data for the Peruvian anchoveta (*Engraulis ringens*), using the ELEFAN I, II and III programs, in collaboration with Ms. Isabel Tsukayama at the Instituto del Mar del Perú.

A preliminary analysis of the available data provided estimates of anchovy biomass and recruitment on a monthly basis and of seasonal growth over an 18-year period for the northern stock of *E. ringens* (Fig. 1). Detailed estimates of this sort have never previously been available and the analyses illustrate the power of length-frequency based techniques, particularly when applied to short-lived tropical stocks. The module sponsored the participation of Ms. I. Tsukayama and Ms. H. Santander at the FAO Expert Consultation to Examine Changes in the Abundance and Composition of Neritic Stocks, held in Costa Rica in April

1983; a joint paper with preliminary results was presented by Dr. Pauly and Ms. Tsukayama.

The second phase of this module has centered upon an analysis covering 30 years of data for the northern and central stocks of the Peruvian anchovy and analyses of these data are rapidly moving ahead.

Philippines

The Philippine module has concentrated upon a small project involving the testing of a hypothesis concerning the relationships between wind-based turbulence and water transport indices and fish recruitment. This is being conducted as a joint project between Mr. N. Navaluna of the Institute of Fisheries Development and Research (IFDR) of the University of the Philippines in the Visayas (UPV) and Dr. D. Pauly. Dr. Pauly presented a preliminary joint paper on the topic at the FAO consultation in Costa Rica mentioned above.

An "Atlas of the Growth, Mortality and Recruitment of Philippine Fishes" by J. Ingles and D. Pauly is now in press and should be published in early 1984.

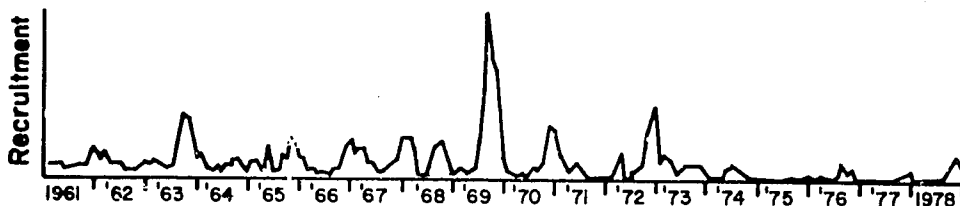


Fig. 1. Monthly recruitment of the Peruvian anchoveta (Northern stock, 1961-1978) as obtained by application of length-structured VPA to catch-at-length data. Based on work by D. Pauly and I. Tsukayama (IMARPE, Peru).

Project Title : International Giant Clam
Mariculture Research
Project

**Principal Cooperating
Institution** : James Cook University of
North Queensland, Australia (JCUNQ)

**Other Cooperating
Institutions** : Department of Primary
Industry, Fisheries Re-
search Branch, Queens-
land, Australia

University of Papua New
Guinea

De La Salle University,
Manila, Philippines

Silliman University,
Dumaguete City, Philip-
pines

University of the Phil-
ippines, Quezon City,
Philippines

Fisheries Division,
Ministry of Agriculture
and Fisheries, Suva,
Fiji

Ministry of Lands, Energy
and Natural Resources,
Honiara, Solomon Islands

IUCN/WWF Conservation for
Development Programme in
Indonesia

Duration : 1983-1988

Key Personnel ICLARM : Dr. John L. Munro
 JCUNQ : Prof. C. Burdon-Jones
 Dr. J. Lucas

Objectives

- To create a foundation of scientific knowledge which will enable giant clams to be raised in sufficient numbers in hatcheries to make reef restocking or extensive aquaculture feasible.
- To reverse the trend of the larger species towards extinction.
- To develop a new industry in the equatorial Indo-Pacific based upon the extensive cultivation of an esteemed traditional food resource, which will provide increased food supplies and exportable products.

Results

Principal activities have related to the development of a research proposal aimed at catalyzing research on tridacnid clams and laying the foundations for future work.

A close working relationship has been established with James Cook University of North Queensland and a proposal, prepared in collaboration with ICLARM, has been submitted by JCUNQ to the Australian Centre for International Agricultural Research (ACIAR). Additionally, a proposal has been made for development of a giant clam pilot hatchery and outline plans for the hatchery were developed.

Dr. R. Ventilla was seconded to the Giant Clam Project from ICLARM's Coastal Aquaculture Project in Thailand for a period of 2 months and conducted a postal questionnaire survey of the status of and degree of exploitation of tridacnid stocks throughout the Indo-Pacific. An excellent response was received, which confirmed that tridacnids are heavily exploited throughout the region and are a normal part of the daily fare of islanders and coastal people throughout the region, except the western coast of Peninsular Malaysia and Thailand, where they are not consumed and are exploited only for their shells. In most heavily populated areas, tridacnids are grossly overexploited, particularly in Indonesia and the Philippines, where many local stocks are now extinct.

INFORMATION SERVICE

During 1983, the Information Service has continued to increase its range of activities as well as its publication rate. Highlights include the successful launching of a Fisheries Forum proposal, approval of a selective information service and the first training course in aspects of information.

Publications

Volume. ICLARM's publication output in 1983 was the highest to date, with the production of a major publication in the Conference Proceedings series and another in Studies and Reviews, eight Technical Reports and one Translation, as well as the quarterly Newsletters and Annual Report. Further, continued demand for previous publications required the reprinting of five titles during the year. In the five technical series, the number of new titles (11) represents an increase of 50% over the total for 1979-1982.

Distribution. The overall dissemination of ICLARM publications is now an impressive figure. Over 26,000 books have been distributed in toto from the five technical series and well over 80,000 Newsletters.

The use of a distributor in the U.S.A. took effect in July with the air shipment of almost one tonne of ICLARM books to International Scholarly Book Services in Oregon.

Exhibitions. ICLARM books were included in a nationwide agricultural book display in China, beginning September; in "bookexpos" at various times in Singapore, Malaysia and the Philippines; and at the Frankfurt Book Fair in October, at two separate booths, sponsored by the Philippine Book Developers Association and the German Agency for Technical Cooperation, respectively. The latter was part of an exhibition of publications of the International Agricultural Research Centers.

Library

The library has grown in both acquisitions and user-ship. Book and monograph holdings total 4,300, serial

holdings increased from 1982 by nearly 100 titles to 390. Internal users of the library have increased from about 100 in 1981 to 590 in 1983.

ICLARM's Contribution Series, which includes all items published by ICLARM staff or by external authors on commission, was advertised for the first time in the April 1983 Newsletter. Many of the contributions are offered free, while others are at cost of xeroxing and postage. Response to this new service has been extremely good. It is expected to increase awareness of ICLARM's work on the part of Newsletter readership and the scientific community in general.

Computer Literature Searching

Through 1983, a free service continued for external users of the Center's online teletype connection with the DIALOG system of computer databases. Overseas as well as domestic enquiries were handled.

Review Competition

A \$500 prize was offered in the last Newsletter of 1982 for the best (unpublished) review received by the end of September 1983. The prize was won by Drs. Yap Siaw-Yang and J.I. Furtado, University of Malaya, for a review of reservoir fisheries in tropical Asia. A second competition has begun for 1984.

Audio-visuals

A comprehensive sound-slide show on ICLARM's objectives and programs was finalized early in the year. It has proven useful for visitors and staff alike. Copies have been made for members of the ICLARM Board and Program Advisory Committee.

A second audio-visual was made by a group of Indonesians during their 4-week visit to ICLARM (see Training).

Two audio-visuals on Philippine Municipal Fisheries and Community Adoption of Tilapia Hatcheries have been prepared for ICLARM by the Communications Department, Ateneo de Manila University, Quezon City, Philippines. Copies of these audio-visuals have been shown at numerous workshops and meetings during 1983 and distributed to various government and university groups.

External Information Services

In September, the Canadian International Development Research Centre (IDRC) confirmed its intention to support ICLARM's proposed Selective Information Service in which an Information Scientist will be appointed to ICLARM staff to provide a question/answer service in the Center's areas of expertise. The project will include preparation of bibliographies and reviews in identified areas. Assistance to other information centers will also be provided.

Involvement in other information systems in 1983 has included participation in the establishment of a Philippine Aquatic Science and Fisheries Information System and of the Philippine National Information System for Science and Technology.

Asian Fisheries Forum

As forecast in the 1982 Report, the enthusiastic response to a circular proposing a regular Fisheries Forum and Fisheries Society resulted in an ICLARM-sponsored meeting in Manila in May, attended by seven senior scientists from five countries. The group endorsed the concept of a regular scientific meeting, probably biennial or triennial, whose location would rotate around the region. Importantly, the group expanded the Forum from the originally proposed Southeast Asian region to include all of Asia, in order to reflect better the Indo-West Pacific faunal zone which encompasses most of Asia.

The Manila group formed itself into a Foundation Council to plan the first Forum and has sought additional members from other Asian countries. The first Forum meeting is expected to be in early 1986, at which it is planned to present a draft constitution for an Asian Fisheries Society. The proposals for both Forum and Society received unanimous support at an international aquatic sciences meeting in Malaysia in August. ICLARM was asked to provide a secretariat for the Foundation Council, pending elections of officers at the first Forum meeting.

Training

The first external training course in fisheries information by ICLARM was held in June. Four Indonesian officers from the Agency for Agricultural Research and Development (AARD) spent a month based at ICLARM. Training was

carried out in four modules: publication, librarianship, information and visits to other information centers.

Meetings Attended, Papers Presented

Working Group on the Proposed Development Plan for a Philippine Aquatic Sciences and Fisheries Information System Project, Manila, January, March, July, August 1983. (J.L. Maclean)

Seminar Workshop on the Design and Planning of the National Information System for Science and Technology, Manila, 25-28 April 1983. (J.L. Maclean)

J.L. Maclean. Impact of the national information system for science and technology on the training of users.

Philippine Library Association, Inc., National Congress on Library Development, Manila, 18-20 May 1983. (H.C. de Castro)

Congress of Southeast Asian Librarians (CONSAL), Sixth, Singapore, 30 May-3 June 1983. (R.M. Temprosa)

International Conference on the Development and Management of Living Aquatic Resources Management, Malaysia, 2-5 August 1983. (J.L. Maclean)

J.L. Maclean. An Asian Fisheries Forum.

Association of Special Libraries of the Philippines (ASLP), Seminar on Systems Study for Information Specialists, Manila, 15-17 September 1983. (H.C. de Castro)

UNESCO-UPILS Asian Regional Seminar on Local Data Bases and Their Use, Manila, 10-14 October 1983. (R.M. Temprosa)

First Meeting of Information Officers of the International Agricultural Research Centers, Frankfurt, 18-20 October 1983. (J.L. Maclean)

Third International Conference on Scholarly Publishing, London, 21-22 October 1983. (J.L. Maclean)

Copublication: Strategies for Multilanguage Publication in Agriculture, Los Baños, 28 November-1 December 1983. (J.L. Maclean)

ICLARM CONTRIBUTION SERIES

The Contribution series was introduced in the 1982 ICLARM Report, covering numbers 1 to 124. This continuation begins at 107 since details of some later publications were not available the previous year.

107. Pauly, D. 1982. Further evidence for a limiting effect of gill size on the growth of fish. *Kalikkasan Philipp. J. Biol.* 11(2-3): 379-383.
108. Bakun, A., J. Beyer, D. Pauly, J.G. Pope and G.D. Sharp. 1982. Ocean sciences in relation to living resources. *Can. J. Fish. Aquat. Sci.* 39: 1059-1070.
109. Pullin, R.S.V. 1982. Genetics undervalued. International symposium on genetics in aquaculture. Galway, Ireland, 29 March-2 April 1982. *Mar. Policy* 6(4): 345-347.
110. Smith, I.R. Mismanagement of inland fisheries and some corrective measures, p. 88-100. *In* T. Petr (ed.) IPFC Workshop on Inland Fisheries for Planners, Manila, 2-6 August 1982. FAO Fish. Rep. 288, 191 p. FAO, Rome.
111. IDRC-ICLARM. 1982. Aquaculture economics research in Asia. Proceedings of a workshop held in Singapore, 2-5 June 1981. International Development Research Centre, Ottawa, Canada and International Center for Living Aquatic Resources Management, Manila, Philippines.
112. Smith, I.R. 1982. Micro-economics of existing aquaculture production systems: basic concepts of definitions, p. 15-25. *In* IDRC-ICLARM Aquaculture economics research in Asia. See Contribution No. 111.
113. Chong, K-C. and M.S. Lizarondo. 1982. Input-output relationships of Philippine milkfish aquaculture, p. 35-44. *In* IDRC-ICLARM Aquaculture economics research in Asia. See Contribution No. 111.
114. Cruz, T.A., J.P. Thorpe and R.S.V. Pullin. 1982. Enzyme electrophoresis in *Tilapia zillii*: a pattern for determining biochemical genetic markers for use in tilapia stock identification. *Aquaculture* 29: 311-329.
115. Meltzoff, S.K. and E. LiPuma. 1983. A Japanese fishing joint venture: worker experience and national development in the Solomon Islands. ICLARM Technical Reports 12, 63 p.
116. Pauly, D. and J.L. Munro. 1982. On the development and dissemination of new methodologies for tropical stock assessments, p. 79-87. *In* Report of the third session of the Standing Committee on Resources Research and Development, Indo-Pacific Fishery Commission, Sydney, Australia, April-May 1982. FAO Fish. Rep. 275. 135 p.
117. Munro, J.L. 1982. Training in tropical fisheries science. ICLARM Newsletter 5(4): 3-4.
118. Munro, J.L. 1983. Some advances and development in coral reef fisheries research; 1973-1982. *Proc. Gulf. Caribb. Fish. Inst.* 35: 161-178.
119. Munro, J.L. and G. Heslinga. 1983. Prospects for the commercial cultivation of giant clams (*Bivalvia: Tridacnidae*). *Proc. Gulf. Caribb. Fish. Inst.* 35: 122-134.
120. Munro, J.L. and D. Pauly. 1982. The ICLARM network of tropical fisheries scientists. ICLARM Newsletter 5(4): 5.
121. Venema, S. and D. Pauly. 1982. Training courses in fish stock assessment: the past and the future. ICLARM Newsletter 5(4): 13-14.
122. Pauly, D., J. Ingles and R.A. Neal. Application to shrimp stocks of objective methods for the estimation of growth, mortality and recruitment-related parameters from length-frequency data (ELEFAN I and II). Proceedings of the NOAA/ FAO Workshop on the Scientific Basis for the Management of Penaeid Fisheries, Florida, November 1981. *In press*.
123. Pullin, R.S.V. 1982. Aquaculture training: needs and opportunities. ICLARM Newsletter 5(4): 7-12.
124. Pullin, R.S.V. 1982. The Galway international symposium on genetics in equaculture. ICLARM Newsletter 5(4): 20.
125. Munro, J.L., editor. 1983. Caribbean coral reef fishery resources. ICLARM Studies and Reviews 7, 276 p.
126. Bailey, C. Social science contribution to understanding the Bali Straits lemuru (*Sardinella longiceps*) fishery. Proceedings, Seminar Perikanan, Banyuwangi, 18-21 January 1982, Jakarta. Pusat Penelitian dan Pengembangan Perikanan. (In Indonesian). *In press*.

127. Pauly, D. and J. Ingles. 1981. (Printed 1983). Aspects of the growth and natural mortality of exploited coral reef fishes. Proc. 4th Int. Coral Reef Symp. 1: 89-98.
128. Munro, J.L. 1983. Giant clams—food for the future? ICLARM Newsletter 6(1): 3-4.
129. Pullin, R.S.V. and G. Almazan. 1983. Azolla as a fish food. ICLARM Newsletter 6(1): 6-7.
130. Hopkins, K.D. 1983. Tilapia culture in arid lands. ICLARM Newsletter 6(1): 8-9.
131. Pauly, D. and K.D. Hopkins. 1983. A method for the analysis of pond growth experiments. ICLARM Newsletter 6(1): 10-12.
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Brian A. Lockwood, Ph.D.	Economist, Coordinator, Fisheries Social Science Research Network ⁶



John Munro delivering a paper at an international fisheries conference in Malaysia, August 1983.



Luz Yater left ICLARM in April after fifteen months as a research assistant on a survey of Philippine tilapia hatcheries.



Kee-Chai Chong left ICLARM in May 1983 after 4 1/2 years of research on the economics of the Philippine milkfish industry. His work has had great impact in development planning of Philippine aquaculture.



Dr. James E. Johnston, Chairman, ICLARM Board of Trustees.



Ian Smith giving opening remarks at a workshop on Philippine tilapia economics, August 1983.



Some of the members of the Program Advisory Committee. *Clockwise:* Drs. Michel Girin, Th. Tienstra, John Bardach, Keishi Amano, John Liston, Colin Clark, Lucian Sprague with ICLARM scientist Roger Pullin, Messrs. William Ripley, Philip Roedel and Dr. Armin Lindquist.



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¹ Fixed term appointment ended on 15 May 1983; now affiliate scientist.

² Fixed term appointment.

³ Fixed term appointment ended on 31 August 1983.

⁴ Fixed term appointment commenced on 1 June 1983.

⁵ Commenced 15 October 1983.

⁶ Commenced 1 April 1983.

⁷ Resigned 31 March 1983.

⁸ Commenced 16 June 1983.

⁹ Commenced 17 October 1983.

¹⁰ Resigned 31 March 1983.

¹¹ Commenced 6 September 1983.

¹² Commenced 1 March 1983.

¹³ Resigned 27 June 1983.

¹⁴ Commenced 6 June 1983.

¹⁵ Commenced 2 August 1982.

¹⁶ Commenced 15 March 1983.

¹⁷ Resigned 5 October 1982.

¹⁸ Commenced 1 November 1982.

¹⁹ Resigned 15 September 1983.

²⁰ Resigned 12 June 1983.

**STATEMENT OF SOURCES AND APPLICATION OF FUNDS
(US \$)**

	1982	1983 ¹
SOURCES OF FUNDS:		
Carry over from Previous Years' Funds	141,517	269,879
Unrestricted Core		
Rockefeller Foundation	850,000	850,000
United States Agency for International Development (USAID)	320,000	320,000 ²
Australian Development Assistance Bureau (ADAB)	20,986	29,750
Restricted Core		
German Agency for Technical Cooperation (GTZ)	269,597	231,165 ³
International Development Research Centre (IDRC)	—	117,109 ⁴
Kuwait Institute for Scientific Research (KISR)	51,856	54,447
United Nations Development Programme (UNDP)	23,638	33,379
New Jersey Marine Science Consortium (NJMSC)	31,283	10,000
Philippine Council for Agriculture and Resources Research and Development (PCARRD)	10,426	—
Others:		
Consultancy Fees	12,072	28,339
Publication Income	17,342	25,423
Miscellaneous	4,526	47,994
	<hr/>	<hr/>
	1,753,243	2,017,485
APPLICATION OF FUNDS:		
Administration	300,163	296,126
Information Services	198,894	193,010
Capital Investment	20,261	12,262
Programs —		
Program Advisory Committee	39,202	9,725
Program Development Fund	6,989	40,091
Reserve Fund	—	60,000
Aquaculture	584,670	559,339
Traditional Fisheries	154,723	263,047
Resource Development and Management	178,462	253,874
Education and Training	—	5,434
	<hr/>	<hr/>
	1,483,364	1,692,908
FUND BALANCE, END OF YEAR	<hr/>	<hr/>
	269,879	324,577
	=====	=====

¹ Based on unaudited figures.

² August 1983-July 1984.

³ June 1983-May 1984.

⁴ April 1983-May 1984.