# ICLARM REPORT
# 1985

## STATEMENT OF PURPOSE

". . . the corporation is organized exclusively for charitable, educational, and scientific purposes; and in furtherance of these purposes, the corporation is to establish, maintain, and operate an international aquatic resources center designed to pursue. . .the following objectives:

To conduct directly and to assist others in conducting research on fish and other aquatic organisms, on all phases of fish production, management, preservation, distribution, and utilization with a view to assisting the peoples of the world in rationally developing their aquatic resources to meet their nutritive and economic needs;

To improve the efficiency and productivity of culture and capture fisheries through coordinated research, education and training, development and extension programs;

To upgrade the social, economic, and nutritional status of peoples in the less-developed areas of the world through improvement of small-scale rural subsistence and market fisheries;

To work toward the development of labor-intensive systems to aid employment and of low energy systems to minimize capital and cost requirements;

To publish and disseminate research findings and recommendations of the Center; and

To organize or hold periodic conferences, forums, and seminars, whether international, regional, local, or otherwise, for the purposes of discussing current problems."

Articles of Incorporation
International Center for Living Aquatic Resources Management

# ICLARM REPORT 1985

Edited by

Jay L. Maclean
Leticia B. Dizon
and
Marie Sol M. Sadorra

1986

ICLARM
INTERNATIONAL CENTER FOR LIVING AQUAT C RESOURCES MANAGEMENT
MANILA, PHILIPPINES

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Edited by JAY L. MACLEAN
LETICIA B. DIZON and
MARIE SOL M. SADORRA

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*Cover: Tridacna derasa*, a member of the giant clam family, growing at the Micronesian Mariculture Demonstration Center, Palau. ICLARM has an international mariculture project on giant clams. See p. 44. Photo by Gerald Heslinga.

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## CONTENTS

# INTRODUCTION

## Purpose of ICLARM

The International Center for Living Aquatic Resources Management (ICLARM) is one of about 20 international, non-profit, autonomous research centers which concentrate upon those critical aspects of food production that are not covered adequately by other research organizations, and which are of wide importance, regionally or globally.

As an international organization, ICLARM's role is to complement and support the activities of national and regional research institutions in fisheries and aquaculture in tropical developing countries. The stimulation and strengthening of global research activities by the Center are directed toward the improvement of the nutrition, income and employment opportunities of lower income people in these countries. The Center's research is designed to increase utilization and promote rational management of aquatic resources toward these goals through four major interactive program areas: Aquaculture, Resource Assessment and Management, Education and Training and Information. ICLARM is the only international, non-governmental research center in the tropics that deals with the full range of interdisciplinary research issues in the fisheries and aquaculture continuum.

ICLARM is one of the smallest of the international agricultural research centers, and perhaps not coincidentally, very cost-effective. The flexibility that characterizes the Center's program is made possible not only by a small, dedicated and highly productive staff, but also by the unique way in which ICLARM carries out its research.

ICLARM's research activities are cooperative in nature, usually carried out in partnership with national and regional institutions. The "multiplier" effect of the Center's research, training and information activities is high and contributes to increased individual and institutional capabilities. This approach has produced high quality results and important conceptual advances in the fisheries management field. This focus upon cooperation is also highly appropriate in that it assists more of the Center's colleagues in the tropics to develop sustained careers for themselves in the fisheries and aquaculture field, an involvement that is essential if the complex development and management problems facing the sector around the world are to be dealt with successfully. ICLARM has found research, training and information networks to be particularly effective means towards this end.

During the first eight years of ICLARM's existence, its program in tropical fisheries research has had considerable impact. The Center's more significant accomplishments are the identification and pursuit of critical issues related to tropical fisheries problems and contribution to the shifting of thinking from resource development (expansion) to management concerns and approaches, the strengthening of developing-country research and training capabilities, and the demonstration of the usefulness of interdisciplinary research.

There has been a clear recognition for some time that research is a necessary component of the fisheries and aquaculture development process. The Technical Advisory Committee (TAC) of the Consultative Group on International Agriculture Research (CGIAR) stated in 1973 that "to improve existing culture practices . . . well organized scientific research is of utmost importance." The US Agency for International Development (USAID) has evaluated ICLARM's programs twice since it began funding the Center in 1979. The 1982 review team concluded "ICLARM's multidisciplinary approach to aquatic resources problems of a general nature in tropical areas, which includes a higher than usual socioeconomic component, is a fundamental step towards establishing the scientific and technical bases on which development and management (current and future) can be based." ICLARM also receives continuous feedback on the Center's usefulness from many individuals and institutions around the world.

Yet, despite this apparent success in fisheries research and information, ICLARM has been facing considerable uncertainty regarding its future due to the precarious nature of its financial support. The year 1985 has been a particularly difficult year which has put the Center's programs and staff under considerable stress, and from which we are only now beginning to emerge. Although the near-term future for ICLARM at the end of 1985 is looking somewhat brighter, the challenge remains of securing the necessary longer-term support that will permit ICLARM to remain true to its mandate and to rigorously pursue its major research themes.

## ICLARM's Crisis in 1985

ICLARM unfortunately was not established with an endowment from which it could draw an annual sustainable income; nor did it initially have a large number of institutional supporters. Additional donors have been attracted to ICLARM as the Center's research results and modus operandi have become known. While the number of donors that provide restricted project or program support was growing, the Center was dependent on three donor organizations, the Australian Development Assistance Bureau (ADAB), the Rockefeller Foundation and USAID, for unrestricted core support. Rockefeller support and regular USAID support ended in 1984. A "year end" grant from USAID, the ADAB grant and savings from 1984 carried the Center at a reduced level through the first nine months of 1985.

A minimum level of unrestricted core support, in contrast to restricted project support, is necessary for ICLARM to remain independent and flexible to pursue key issues in fisheries management and aquaculture development. The unrestricted funds, apart from paying basic scientific and information costs at headquarters, are the source of seed funds and in-house projects that have led to the Center's most successful cooperative research and information programs.

However, there has been a steep decline in popularity of multilateral approaches to research and development amongst donor organizations. In addition the generally depressed economic conditions in most donor countries during the 1980s have contributed to the fund-raising difficulties of research organizations everywhere.

A public statement of ICLARM's impending financial difficulties was made in the July 1984 issue of the *ICLARM Newsletter*. It drew attention to the fact that our financial problems were indeed serious. We debated for a long time whether to so publicly draw attention to our plight and risk losing even the support already in hand. In the end we decided that we must take this risk because of the difficulties to that date in attracting new unrestricted core support from other donors. We were having difficulty in convincing people that the Center's financial problems were real!

Under the leadership and guidance of the Center's Director General, Dr. Richard A. Neal (who resigned in February 1985), ICLARM had already begun in earnest its search for diversified support before the end of 1983. Not surprisingly, it is only now, two years later, that much of this effort is beginning to pay off. The major grants recently received for our research programs include Integrated Coastal Resources Management (USAID Asia and Near East Bureau), Integrated Agriculture-Aquaculture Farming Systems (German Agency for Technical Cooperation (GTZ) and United Nations Development Programme (UNDP)), Asian Fisheries Social Science Research Network (International Development Research Centre (IDRC) of Canada and Ford Foundation), Selective Information Service (IDRC), International Giant Clam Mariculture (ADAB, New Zealand and Overseas Development Administration (ODA) of UK), Network of Tropical Fisheries Scientists (FAO and FAO/Danish International Development Agency (DANIDA)) and Small-Scale Fisheries Management Options (Ford Foundation). All of these, fortunately, are well within the priority research areas of ICLARM, selected over the years with the guidance of the Center's Program Advisory Committee. However, these and several other smaller grants of a short-term nature are all for restricted purposes and while extremely helpful are insufficient by themselves to sustain all the core research and information activities of the Center.

Consequently, with the decline in unrestricted income experienced in 1985, the Center's small professional staff was forced into an increasing number of short-term consultancies outside our collaborative research projects in our efforts to survive as an institution and keep our core staff intact. Such a shift in focus is hardly desirable, except as a short-term survival measure, because it distracts from the longer-term research that is ICLARM's mandate.

The Center experienced several extremely severe cash flow problems during 1985, which greatly hampered planning and program development. Several projects and a number of publications had to be postponed due to fund shortages this past year. Most regretfully, we were unable to maintain our full permanent professional staff complement. Cost saving measures included moving ICLARM headquarters to cheaper rented facilities in Makati, Metro Manila.

Fortunately for ICLARM, some good news on the funding side arrived in the last two months of 1985 when the Center was on the verge of virtual collapse to little more than a project implementing and consulting body. ADAB, which has been supporting the Center since 1981, increased and advanced payment of its annual unrestricted core grant. Norway also provided, for the first time, an unrestricted contribution. These two very welcome grants tided the Center over until the last few days of the year when word was received that the Science and Technology and Asia Near East Bureaus of USAID had agreed to combine resources and provide ICLARM with a new two-year grant to begin in 1986. This grant is substantial enough, with other expected contributions, to sustain ICLARM at a minimum level at least for the short term while attempts continue to further diversify the Center's support base over the longer term.

The staff and Board of Trustees are exceedingly grateful for this tangible support for ICLARM which pulled us back from the brink of collapse. We would like to take the opportunity here to thank not only those individuals within the donor organizations who made these grants possible, but also to express our appreciation to all those colleagues around the world who provided moral support to us and who wrote so many letters to us and to donor organizations on our behalf. Without such support from these individuals both within and without, we very much doubt these grants would have materialized in time to help us survive. We would also like to acknowledge the very helpful fund-raising grant that we have receiving during 1984-1985 from the Rockefeller Foundation and especially the efforts of Dr. Richard Neal, then ICLARM DG, and Dr. James A. Storer, ICLARM Trustee.

## 1985 Research and Information Program

Financial uncertainty in 1985 has made research program planning very difficult. Nevertheless, ICLARM has numerous exciting activities underway and soon to begin, most made possible by generous restricted project and program support from a number of donors, including GTZ, the Ford Foundation, UNDP, USAID, the Skaggs Foundation, New Zealand and FAO/DANIDA. Full details of these activities can be found in the program sections of this Annual Report, but I would like to summarize major points here to give full flavor to the range of ICLARM's cooperative research programs.

The International Giant Clam Mariculture Project, headed by Dr. John Munro from his base at James Cook University in Australia, is progressing well and we expect soon to have finalized an agreement with the Solomon Islands Government for lease of a coastal site on Guadalcanal. With support from various agencies, a Coastal Aquaculture Center is to be established there as a long-term regional aquaculture research facility for the benefit of the countries encompassed by the South Pacific Forum. Dr. Munro has recently been designated ICLARM's Director, South Pacific to enable us to plan better and coordinate our expanding activities with South Pacific Forum member states.

USAID and the Association of Southeast Asian Nations (ASEAN) have selected ICLARM to be the executing agency for an Integrated Coastal Resources Management Project that will involve research, management planning and information activities with national teams in Indonesia, Philippines, Singapore and Thailand and further linkages with Malaysia and Brunei. This is a major project that will allow ICLARM to extend its past work on interdisciplinary approaches to coastal fisheries research and management and to develop, with our national counterparts, broader coastal resource systems frameworks for analysis and planning. We are delighted that this new project will be coordinated for ICLARM by Dr. Chua Thia-Eng, a Malaysian biologist well known and respected in Southeast Asia, assisted by Mr. Random DuBois, an American geographer and systems ecologist, as Technical Advisor.

At ICLARM's mid-1985 Board of Trustees meeting, the Resource Development and Management and the Traditional Fisheries Programs were combined into a single Resource Assessment and Management Program reflecting the Center's interdisciplinary approach to resource management issues. This does not mean that ICLARM is abandoning its small-scale fisheries work. A new grant from the Ford Foundation will enable us to hire Dr. Max Aguero Negrete, a Chilean resource economist, to further our development of bioeconomic methodologies appropriate for tropical small-scale fisheries and to establish new cooperative research linkages with selected institutions in South Asia. This South Asian program will be developed in close cooperation and with support from the FAO/SIDA (Swedish International Development Authority) Bay of Bengal Small-Scale Fisheries Programme.

Dr. Daniel Pauly has recently been appointed Acting Director of the Resource Assessment and Management Program and we expect that ICLARM will be expanding its already well-established training role in this area. The Network of Tropical Fisheries Scientists continues to grow with over 600 members worldwide.

Our research in fisheries stock assessment and management with Southeast Asian colleagues will continue through several cooperative projects currently being negotiated. These include, among others, two projects with the Bureau of Fisheries and Aquatic Resources in the Philippines: one on stock assessment and management in the Samar Sea and another on stock assessment and economics of small pelagic fisheries.

At the end of 1985 we were near to finalizing a cooperative project with the Institute of Ecology, Padjadjaran University, Bandung, Indonesia, in which ICLARM will be providing technical assistance for reservoir management and aquaculture development for two reservoirs north of Bandung on Central Java which are being developed with World Bank funding.

ICLARM's Mr. Jan Michael Vakily who has been working for the past three years on our bivalve project with the Thailand Department of Fisheries, funded by GTZ, transferred at the end of 1985 to the Marine Sciences Faculty of Chulalongkorn University in Bangkok, where he will conduct bivalve growth and resources management studies with his Thai counterparts.

In addition to these new activities, the Asian Fisheries Social Science Research Network (funded by IDRC, Ford Foundation and ICLARM) has been shifted to our Education and Training Program and continues to expand; member institutions from Indonesia, Thailand, Malaysia and the Philippines now number nine including ICLARM. Dr. Brian Lockwood continues as ICLARM Coordinator for this Network and the first research results from Phase I, which ended in 1985, should be in publishable form soon.

The Aquaculture Program, with Dr. Roger Pullin as Director, continues its emphasis on integrated farming systems, genetics and economics. ICLARM staff and consultants will be travelling to Africa in early 1986 to establish our first major project on that continent; this is the GTZ funded Integrated Agriculture-Aquaculture Farming Systems Project to undertake research on farming systems for rural smallholders. The exact location and institutional host for the project is not yet chosen, but will be selected with the longer-term idea of possible expanded research and information activities from a strong institutional base.

To complement this work and another project on rice-fish culture being negotiated with Central Luzon State University, the International Rice Research Institute and the Asian Development Bank, ICLARM is most fortunate to be receiving in 1986 a "preparatory assistance" grant from UNDP through a trust arrangement with the World Bank. This new grant will permit us to further develop farming systems methodologies for aquaculture research and a longer-term fundable program for ICLARM in this area. We are anxious to build upon the successful collaborative investigations carried out in the Philippines with Central Luzon State University and in Thailand with the Asian Institute of Technology and our recent successful international conference on detrital systems in aquaculture. ICLARM's program in this area is being worked out in close consultation with the Aquaculture Development and Coordination Programme of FAO.

After establishing the above integrated farming projects, much of Dr. Pullin's time in the coming year will be devoted to development of our research program in aquaculture genetics to enable the Center to move ahead to address the key research and institutional questions that must be resolved before ICLARM can expand its genetics research. An important issue, for example, given ICLARM's stated priority on tilapias, is the extent to which the Center needs centralized research facilities under its own

management in order to be effective in this exciting field with great potential impact throughout the tropics.

At the mid-1985 Board of Trustees meeting, ICLARM's Information Service was upgraded to Program status and Mr. Jay Maclean was promoted to Director of this program. ICLARM has always been known for its high quality publications and its excellent library. The elevation of this program of the Center is not only a reflection of these attributes, but also the recognition that in this electronic and microcomputer age, information research and management is becoming a useful field of endeavor in its own right. The Information Program now runs the very successful Selective Information Service, funded by IDRC, which is providing extremely useful literature search and referral services to colleagues around the tropics. New fisheries information research of ICLARM will focus on citation analysis and evaluation of the impact of fisheries literature.

Also in midyear, Mr. Basilio Rodriguez, Jr. was hired as Manager, Administration and Finance, taking over these responsibilities from Mr. Angelito del Mundo who resigned from ICLARM to emigrate to the United States. Mr. Rodriguez brings strong financial management skills to his new position.

As Director General, I am extremely proud that all these activities have proceeded well amidst the uncertainty of the past year. ICLARM has fortunately been blessed with a very hard-working and dedicated staff, and considerable credit should go to every one of the Center's professional and support staff for having remained committed to the Center over this difficult period despite the recurring risk of unemployment on short notice. Indeed, it is this commitment that has kept morale high and sustained the efforts of those of us on the staff and Board of Trustees entrusted with raising funds for the Center's operation.

The past contributions of the Center's Program Advisory Committee should also be acknowledged here. Since its inception, ICLARM has received valuable guidance from this Committee composed of internationally known scientists and administrators. During 1985, however, it became apparent that financial constraints and the continuing transition of ICLARM to new financial and program arrangements that are not yet fully defined, necessitated a change in the structure of program advice. The Program Advisory Committee was dissolved upon action by the Board of Trustees at its October 1985 Executive Committee meeting. When finances permit, ICLARM plans to convene ad hoc Program Advisory Panels on selected topics. To assure thorough program review, evaluation and stimulation, the Board of Trustees is considering establishing a Program Committee from amongst its own membership. I would like to take this opportunity to sincerely thank the members of the Program Advisory Committee for their support of and contributions to ICLARM since 1977.

## What Lies Ahead for ICLARM

While the immediate future of ICLARM now looks reasonably bright, it remains true that the unrestricted support so far identified remains short-

term in nature. To retain its flexibility and to develop long-term research and information programs, ICLARM needs to further diversify its funding sources and to find mechanisms for sustaining this support.

Parallel with successful efforts to attract restricted funding and short-term resolution of our core cash flow problems, ICLARM has been pursuing over the past two years a longer-term strategy of seeking unrestricted core support from the Consultative Group for International Agricultural Research (CGIAR). Presentations have been made to the CGIAR delegates at each of the last three CGIAR meetings and to its Technical Advisory Committee (TAC). In early 1985, a position paper on aquaculture and fisheries research was prepared for the TAC. All these initiatives have been well received, although it is apparent that consideration of support for new research themes by the CGIAR will take some time yet to resolve. Aquaculture has been recommended by the TAC as among three new priorities, but the CGIAR is faced with funding constraints of its own. In the meantime, ICLARM and other international research centers outside the CGIAR system must develop funding frameworks of their own if they are to survive.

At the most recent of ICLARM's presentations to CGIAR delegates in Washington in late October 1985, there was general agreement among those attending that it would be well worthwhile for ICLARM to formalize a Support Group of major donors which would meet annually to consider ICLARM's program and financial requirements. We are aiming at such a meeting in late 1986. The Support Group concept seems particularly useful for ICLARM because formal consideration of fisheries and aquaculture by the CGIAR is bound to take some time yet. Dr. James Storer, ICLARM Trustee, will continue assisting us to develop this concept in consultation with some of our major supporters. We are also actively seeking the advice of the other half dozen or so international centers outside the CGIAR system; some of these centers have been able to prosper very well in this fashion.

In sum, there are many very exciting activities underway or soon to begin at ICLARM. The expansion of our cooperative research activities to South Asia, the South Pacific and Africa indicates the Center's global usefulness and role. Although ICLARM ended 1985 still under some considerable stress due to the very rapid adjustments that have been necessary as our financial support has shifted from predominantly unrestricted to predominantly restricted, we are optimistic about the future and about the potential of achieving at least some medium-term stability through our proposed Support Group framework. We are encouraged by the fact that our major supporters and so many of our professional colleagues share the view that if ICLARM dissolves for lack of support, it will only have to be recreated.

In this atmosphere of optimism and excitement, it is with considerable pleasure and pride that I introduce the 1985 ICLARM Report.

IAN R. SMITH
Director General
January 1986

## AQUACULTURE PROGRAM

### Background

The Aquaculture Program has been through a difficult year as a result of ICLARM's increasing dependency on project-specific funds and much reduced core funds to support the Program's permanent staff and to seed the development of new activities. The year 1985 was largely spent completing projects, fulfilling commitments to cooperating institutions and donors and seeking support for new activities. Program Director, Dr. Roger Pullin, made visits to France, the Federal Republic of Germany, the Korean Republic and Norway to present details of past activities of the Program and to seek future support.

In 1985, major Aquaculture Program projects were completed in Kuwait, the Philippines, Taiwan and Thailand. ICLARM's project staff Drs. John Colman, Kevin Hopkins, Edward McCoy and Ms. Emma Escover left ICLARM for other career opportunities. 1985 also saw the departure of one of ICLARM's most able researchers, Senior Scientist Dr. James Ching-Ming Kuo. The services of all of these colleagues will be sorely missed.

Despite difficulties, the Program made some notable achievements in 1985 and prospects for future support are beginning to improve. The Program comprises cooperative research, training and advisory services in three main fields: fish genetics and controlled breeding; low-technology culture systems (including waste-fed ponds, integrated farming and coastal culture of bivalve molluscs) and aquaculture economics. Wherever possible, an interdisciplinary approach is followed combining biology and economics. The Program concentrates on warmwater finfish and molluscs which are cheap to feed (on plant matter, plankton and detritus) and for which the main outlets are domestic rather than export markets. This means principally the tilapias, carps, mussels, cockles (arc shells) and other bivalves.

The past year's research activities, training and advisory services are summarized below, followed by an outline of future plans and details of specific projects.

### Progress of Work

*Fish Genetics/Controlled Breeding*

The cooperative research project with the Marine Science Institute (formerly Center) of the University of the Philippines (UPMSI), which combines

laboratory-based genetics (stock diversity) studies, economic analyses of broodstock and hatchery management practices, and on-farm culture performance trials with different tilapia breeds, was continued throughout the year. The International Development Research Centre (IDRC) of Canada had supported this project through March. Useful data were collected on stock diversity of Southeast Asian tilapias and Philippine tilapia farm economics. In the Philippines, on-farm trials comparing Israeli, Philippine and Taiwanese tilapias were continued. Project results were presented at the International Conference on Warmwater Aquaculture, Brigham Young University, Hawaii, in February and further publications are in preparation.

UPMSI and ICLARM genetics researchers also increased their contact with other researchers through participation in conferences and workshops and through exchanges of information and research material, especially with the Freshwater Aquaculture Center of Central Luzon State University (FAC/CLSU), where geneticist Dr. L. James Lester of the University of Houston, USA, completed, with ICLARM support, his sabbatical studies on heritability of culture performance traits in tilapia. For the Philippine Bureau of Fisheries and Aquatic Resources (BFAR), UPMSI and ICLARM have continued assistance in establishing new tilapia founder stocks. Contact was maintained with tilapia researchers at the National Inland Fisheries Institute (NIFI), Thailand, and the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC), Philippines. UPMSI, NIFI, ICLARM and SEAFDEC researchers also participated in an

1. Checking the growth of tilapias from cages at a cooperator's farm. *Left to right:* Ms. Nelda Danetaras (UPMSI), Dr. James Lester (Houston University), M.. M. Afzal (ICLARM trainee, Pakistan), Ms. M. Josefa Pante (UPMSI), Ms. Josephine Capili (ICLARM).
2. Counting tilapia fry for stocking cages on an experimental farm. *Left to right:* Ms. Emma Escover (ICLARM), Ms. Josephine Capili (ICLARM), Mr. Rueben San Juan (cooperator farmer), Ms. M. Josefa Pante (UPMSI).
3. Weighing the tilapia harvest at a cooperator's farm. (All photos by Dr. R.S.V. Pullin.)

IDRC Fish Genetics Training Workshop in Singapore, in the Second International Symposium on Genetics in Aquaculture at the University of California (Davis) and in a Tilapia Genetics Workshop at FAC/CLSU organized by the Philippine Council for Agriculture and Resources Research and Development (PCARRD).

In Taiwan, ICLARM and researchers from Taiwanese institutions under the research cooperation agreement with the Council for Agricultural Planning and Development (CAPD) continued to work on controlled reproduction and mass fry production of a wide variety of commercial species.

*Waste-fed Aquaculture/Integrated Farming*

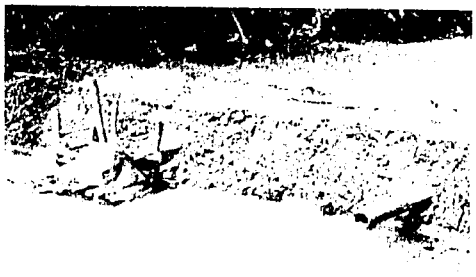
The main event of the year was the ICLARM Bellagio Conference on Detrital Systems for Aquaculture, held in August at the Bellagio Conference and Study Center of the Rockefeller Foundation in Italy and sponsored by the German Agency for Technical Cooperation (GTZ). The 'Detritus Conference', as it came to be called, had been planned since 1980 through the collaborative efforts of Dr. Richard Neal, formerly ICLARM Director General, Dr. Roger Pullin and Dr. David Moriarty, Division of Fisheries Research, Commonwealth Scientific and Industrial Research Organisation, Australia, who was designated conference Chairman. ICLARM convened this conference to summarize and analyze available information on detrital food chains and the means for their manipulation in aquaculture. By bringing together workers in aquaculture, aquatic microbial ecology, and organic waste utilization, ICLARM sought to bring new multidisciplinary perspectives to bear on the future of waste-fed aquaculture and to catalyze new research initiatives and cooperative programs. The participants presented 15 major reviews and held two full days of discussions. The focus was on waste-fed finfish ponds with less attention given to crustaceans and the implications of detritus use in more intensive systems. The interaction of scientists from diverse disciplines worked admirably and considerable progress was made towards the definition of future research priorities. In particular, a more analytical approach was proposed, both to reevaluate existing data (for example, by systems modelling) and to design critical experiments to investigate key biological and chemical factors.

Like most conferences in an expanding field of investigation, this conference posed more questions than it answered. However, it will likely be recognized as a major event in the progress towards energy-sufficient waste recycling through aquaculture. The research and technology development which it will stimulate could have a major impact on aquatic food production, especially in developing countries. ICLARM is publishing the entire proceedings, including records of the discussion sessions.

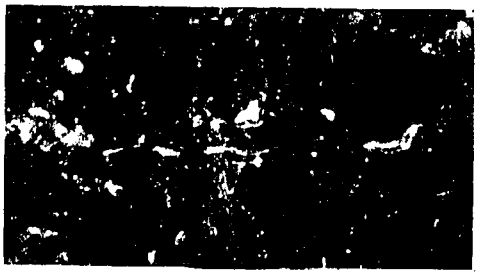
In November, Dr. John Colman completed his two-year Rockefeller Foundation postdoctoral fellowship with ICLARM, during which he was researching on nutrient flows and aquatic chemistry in fertilized fish culture systems at the Asian Institute of Technology (AIT), Bangkok. Dr. Colman also presented some of his results at the Hawaii conference mentioned above

and prepared with Dr. Peter Edwards of AIT a major review paper for the Bellagio Detritus conference. Some twelve additional technical publications by Dr. Colman and AIT researchers are in preparation.

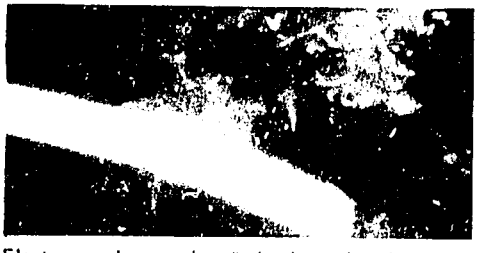
Also in November, ICLARM embarked on the first phase of a new GTZ-funded project entitled Research for the Development of Tropical Aquacultural Technology Appropriate for Implementation in Rural Africa. This project will afford opportunities to transfer and adapt Asian waste-fed aquaculture technology to Africa and to explore and develop new culture systems based on African livestock wastes and agricultural residues. An operational base and linkages with cooperating institutions will be established in 1986.



Detrital foodchains are an important source of fish production in waste-fed aquaculture, for example this Indonesian fishpond with a household toilet on the pond bank. Other photos (by Dr. D.J.W. Moriarty) depict the microscopic composition of detritus.



Epifluorescence photomicrograph of detritus from a seagrass sediment (sand removed), showing filamentous and other bacteria against a background of clay and organic material.



Electron micrograph of detritus showing clay surrounding a bacterial colony with two living and four degrading bacteria in a slime matrix.

Epifluorescence photomicrograph of a large filamentous blue-green alga and smaller bacteria in an inorganic detrital matrix.

*Economics/Commodities*

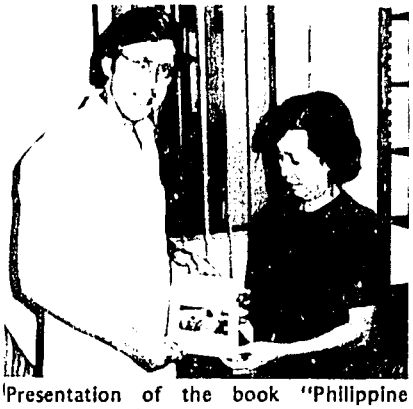
The Asian Fisheries Social Science Research Network (AFSSRN) team in the Faculty of Economics and Business Administration at Kasetsart University conducted a national study of the marketing system for shellfish products. This study, which included a major survey of producers and marketing agents conducted in 1983, and covered fresh in-shell and processed shellfish products, was funded jointly by the AFSSRN and GTZ. Dr. E.W. McCoy of ICLARM worked closely with the AFSSRN Team on this study.

Following the shellfish marketing project, the AFSSRN team studied the economics of the processing industry for cockle, green mussel, short-necked clam and giant African snail.

In addition to AFSSRN activities, Dr. E.W. McCoy worked with AIT researchers on economics of integrated farming and with NIFI researchers on the socioeconomics of snakehead *(Channa striata)* culture in Thailand.

## Tilapias

ICLARM's cooperative research projects on saltwater tilapia culture with CAPD, Taiwan and the Kuwait Institute for Scientific Research (KISR), Kuwait, were concluded successfully in mid-year. The results of both projects have been widely published. Further CAPD culture trials with saltwater tilapia culture are expected in Taiwan, while at KISR the selection of the Kenyan species *Oreochromis spilurus* seems likely to start a new and successful commercial culture industry. Plans for a 100 tonnes/year production farm are being finalized.

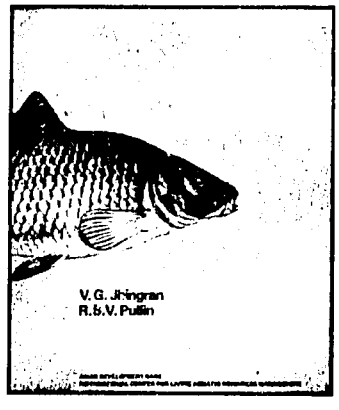


Presentation of the book "Philippine Tilapia Economics" by ICLARM Director General Ian Smith to PCARRD's Director for Fisheries Research Dr. Elvira Tan. The book is a joint PCARRD-ICLARM publication.

ICLARM views this work on saltwater culture of tilapias as also being key research for the development of small-scale coastal tilapia culture in the poor arid nations of the world. ICLARM Affiliate Scientists, Dr. Wade O. Watanabe, formerly with the CAPD-ICLARM project and Dr. Kevin D. Hopkins, formerly with the KISR-ICLARM project are preparing for publication a review of this field. Other work on the tilapias and the economics of tilapia culture included the studies on Philippine tilapia farm and hatchery economics by Ms. Emma Escover under the UPMSI-ICLARM project; publication of the proceedings of a PCARRD-ICLARM conference on Philippine tilapia economics and several other publications by ICLARM staff on tilapias as a major food commodity.

## Carps

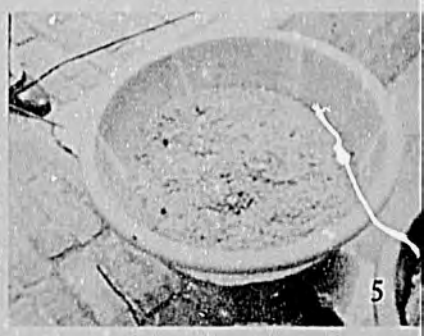
The most important product of 1985 was the publication of a hatchery manual for the common, Chinese and Indian major carps by Drs. V.G. Jhingran and Roger Pullin, prepared and published through the Asian Development Bank's Regional Technical Assistance Project for Research and Training in Aquaculture. It is expected to see wide use in carp hatcheries throughout the developing world.



ICLARM has promoted the tilapia as an international commodity, the "aquatic chicken" because, amongst other things, tilapia can be processed into a variety of value-added products.

Pictures show (1) fresh tilapia in the market, Philippines; (2) entering a conveyor belt to be electrocuted and automatically filleted, Israel; (3) as packaged frozen fillets, Sri Lanka; (4) dried, Sri Lanka; and (5) as fish meal for incorporating into fish feed for carps, Pakistan.

4



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Dr. Pullin also gave the keynote address on the worldwide status of carp culture to the International Symposium on Aquaculture of the Common Carp and Related Species in Paris in September. Dr. Pullin was in France at the invitation of the French Ministry of Foreign Affairs to participate in this meeting and visit French aquaculture research groups. Dr. Pullin and Dr. Jacques Moreau of the Ecole Normale Superieure Agronomique, Toulouse, also worked together on the preparation of a review of the history and consequences of introductions of exotic carps for aquaculture in Africa and Asia.

## Bivalve molluscs

ICLARM's four-year cooperative project with the Brackishwater Fisheries Division of the Department of Fisheries of Thailand (DOF) on Technical Assistance for Coastal Aquaculture was completed in November. The project has been supported throughout by GTZ. Among its numerous achievements, the completion of a research hatchery for bivalve molluscs at the Prachuap Khirikhan Brackishwater Fisheries Station and the resulting studies on induced spawning and larval rearing of commercial bivalves are particularly important. The project has completed a wide variety of studies on the biology, culture, economics and socioeconomics of Thai commercial bivalves and associated harvesting and processing industries. The DOF has also benefitted through the project in training and in the provision of new laboratory equipment, microcomputers and vehicles by GTZ.

ICLARM is preparing reviews on the biology and culture of tropical molluscs. The first review, on tropical cockles by Dr. Malcolm Broom, was completed in 1985. The DOF-ICLARM-GTZ project also prepared and published a translation by Dr. E.W. McCoy of an important paper on Thai cockle farming by Siri Tookwinas.

Dr. John Munro, Director, South Pacific, devoted most of his time to developing the International Giant Clam Mariculture Project. As a result of his efforts, new assistance for the project was announced late in the year by the Overseas Development Administration (ODA) of the UK and the Skaggs Foundation to supplement that portion of the annual Australian Development Assistance Bureau grant that ICLARM uses to support Dr. Munro. Between visits to several Pacific Island nations and negotiations towards an ICLARM coastal aquaculture center in the Solomon Islands, Dr. Munro also served as joint coordinator of the project's Australian module at James Cook University of North Queensland (JCUNQ), and prepared with W.J. Nash a bibliography of giant clams, published by ICLARM.

## Advisory Services

Advisory services supplied during 1985 closely followed the Program's research themes and commodity focus. Numerous enquiries were handled

requesting advice on choice of tilapias for different culture environments and on approaches to genetic improvement. In waste-fed aquaculture, Dr. Pullin assisted with appraisal of a World Bank-GTZ supported sewage-fish culture project in Lima, Peru, which is part of a UNDP Global Resource Recovery Program. Dr. Pullin also assisted the Bay of Bengal Programme (BOBP) of FAO/SIDA in the appraisal of its project with the Department of Fisheries, Malaysia, on development and management of the cockle *(Anadara granosa)* industry. ICLARM also supplied the services of Mr. Charles Angell as a hatchery consultant to this project. Aquaculture project staff supplied a wide range of advisory services to cooperating institutions. In particular, Dr. E.W. McCoy assisted the Thai Department of Fisheries in planning future economics activities and Dr. C-M. Kuo worked closely with Taiwanese universities and fisheries research stations, advising on controlled fish reproduction. Dr. John Colman, based at AIT, Bangkok, continued his cooperation with staff of the Marine Sciences Department of Chulalongkorn University, Bangkok, on preliminary studies of the barium levels in long-lived corals from the Gulf of Thailand. The study is attempting to relate fluctuations in barium levels to past changes in primary productivity.

## Training

Most training was performed, as in past years, through cooperative projects, usually as on-the-job training in laboratory and field techniques. Under the DOF-ICLARM-GTZ bivalve project, Mr. Jan Michael Vakily gave a training course in microcomputer techniques for bivalve age, growth and population analysis to DOF personnel. Dr. Pullin lectured to the IDRC Fish Genetics Training Workshop in Singapore and the Network of Aquaculture Centers in Asia (NACA) Training Course for Senior Aquaculturists in Asia and the Pacific Region at the NACA Regional Lead Centre, Iloilo, Philippines.

Dr. John Colman continued to serve as an AIT Faculty Member and taught with Dr. Kok Leong Wee a course on "Analytical aquaculture techniques" in the May-June term 1985. Two Masters students supervised by Dr. Colman graduated in August 1985: Mr. Raul Angeles with the thesis "Primary and secondary production efficiency in inorganically fertilized fish tanks" and Ms. Rohini Santha with the thesis "Assessment of algal nutrients using critical tissue nutrient concentrations."

## Publications and Consultancy Reports

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Munro, J.L. and W.J. Nash. 1985. A bibliography of the giant clams (Bivalvia: Tridacnidae). ICLARM Bibliographies 5, 26 p.

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Phillips, D.J.H. and K. Muttarasin. 1985. Trace metals in bivalve molluscs from Thailand. Marine Environmental Research 15: 215-234.

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Smith, I.R., E.B. Torres and E.O. Tan, editors. 1985. Philippine tilapia economics. ICLARM Conference Proceedings 12, 261 p. Philippine Council for Agriculture and Resources Research and Development, Los Baños, Laguna and International Center for Living Aquatic Resources Management, Manila, Philippines.

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## Meetings Attended, Papers Presented

Second International Conference on Warm Water Aquaculture: Finfish, Brigham Young University, Hawaii, USA, 5-8 February 1985. (J.A. Colman and E.M. Escover)

Papers presented:

J.A. Colman, P. Edwards, M. Yomchinda and C. Pacharaprakiti. Potential of tilapia for tropical algal biomass recovery.

E.M. Escover, O.T. Salon and I.R. Smith. The economics of tilapia fingerling production and marketing in the Philippines.

J.M. Macaranas, N. Taniguchi, M.J.R. Pante, J.B. Capili and R.S.V. Pullin. Genetic aspects of tilapia culture in the Philippines.

Milkfish Research Workshop (Oceanic Institute, Hawaii, and United States Agency for International Development), Tungkang Marine Laboratory, Tungkang, Taiwan, 22-24 April 1985. (C-M. Kuo)

Paper presented:

C-M. Kuo. A review of induced breeding of milkfish.

Aquacultural Economics Research Methods Workshop, Asian Fisheries Social Science Research Network, Kasetsart University, Bangkok, Thailand, 6-10 May 1985. (E.M. Escover)

Workshop of Fisheries Research, Keelung, Taiwan, 19 June 1985. (C-M. Kuo)

Paper presented:

C-M. Kuo. Salinity tolerance of tilapias.

Tilapia Genetics Workshop, Freshwater Aquaculture Center, Central Luzon State University, Muñoz, Nueva Ecija, Philippines, 20-22 June 1985. (J.B. Capili, E.M. Escover and R.S.V. Pullin)

Presentations:

E.M. Escover. Economic importance of improved strains of tilapia.

R.S.V. Pullin. Tilapia genetic resources in Asia, with special reference to future tilapia culture research and development in the Philippines.

Second International Symposium of Genetics in Aquaculture, University of California at Davis, California, USA, 23-29 June 1985. (R.S.V. Pullin)

Conference on Detrital Systems for Aquaculture, Rockefeller Foundation Study and Conference Center, Bellagio (Como), N. Italy, 26-31 August 1985. (J.A. Colman and R.S.V. Pullin)

Paper presented:

J.A. Colman and P. Edwards. Feeding pathways and environmental constraints in waste-fed aquaculture: balance and optimization.

Symposium on the Aquaculture of Carp and Related Species, Evry (Paris), 2-5 September 1985. (R.S.V. Pullin)

Paper presented (Keynote address):

R.S.V. Pullin. The worldwide status of carp culture.

Farming Systems Socioeconomics Research Monitoring Tour/Workshop, International Rice Research Institute, Los Baños, Laguna, Philippines, 16-28 September 1985. (E.M. Escover)

Australian Coral Reef Society Annual Meeting, James Cook University of North Queensland, Townsville, 2-3 November 1985. (J.L. Munro)

Paper presented:

J.L. Munro. Tropical mariculture: prospects and problems.

Fifth Meeting of the Advisory Committee of the Network of Aquaculture Centers in Asia (NACA), Kathmandu, Nepal, 26-29 November 1985. (R.S.V. Pullin)

Southeast Asian Fisheries Development Center Council Meeting, Bangkok, 19-21 December 1985. (J.M. Vakily)

## Program Plans for 1986

The Aquaculture Program will continue to focus on its major research themes (genetics, low-technology culture systems and economics) and commodities (tilapias, carps and bivalve molluscs).

The geographical scope of the Program is being enlarged, with increased activities in Africa. Activities within the major research themes will likely be organized under networks rather than as separate projects with individual cooperating institutions. A social sciences network (AFSSRN) that includes aquaculture economics research is already in place, supported by the Ford Foundation and IDRC. A similar network will be considered for waste-fed aquaculture, incorporating biological and economics activities in Africa and Asia. Where possible, these will be complementary to other projects and networks, such as those of AIT and NACA in Asia and FAO/UNDP worldwide. The year 1986 will be crucial for planning these long-term activities and seeking the required support.

For fish genetics, while ICLARM's cooperative research project with UPMSI on tilapia genetics will be continued in 1986, emphasis will be placed on planning new activities to link the exploitation of the tilapia genetic resources of Africa to research and development efforts worldwide. The Rockefeller Foundation has agreed to support a planning consultancy by Dr. Trygve Gjedrem of the Agricultural University of Norway and Dr. Pullin to prepare the required proposals.

For integrated farming systems, the GTZ-supported waste-fed aquaculture project in Africa, for which a full-time scientist will be recruited in early 1986, will provide the starting point for a research and information network linking African and Asian groups. A UNDP preparatory assistance grant to ICLARM in 1986 will be used to develop and strengthen linkages with other working groups, to develop a research framework for analysis of integrated agriculture-aquaculture farming systems and to secure the necessary support for future activities. For work in Africa, ICLARM will seek close links with the FAO Aquaculture Development and Coordination Programme (ADCP) projects while in Asia increased cooperation will be explored with those institutions with which ICLARM has worked successfully in the past, such as AIT. A joint proposal of ICLARM, the International Rice Research Institute (IRRI) and Central Luzon State University (CLSU) for a reevaluation of rice-fish farming systems is also being considered by the Asian Development Bank. ICLARM headquarters staff will concentrate on the development of aquaculture research methodologies and systems modelling.

For economics, in addition to interdisciplinary studies within future genetics and waste-fed aquaculture activities, aquaculture economics and socioeconomics will continue to be major topics for the AFSSRN (see Education and Training section). Moreover, ICLARM will be adding staff in 1986 with special skills in data processing and systems modelling, including the development of bioeconomic models for integrated farming systems.

For bivalve culture, the principal activity will be ICLARM's participation in the International Giant Clam Mariculture Project in association with the Australian Centre for International Agricultural Research (ACIAR). It is expected that a lease arrangement will be finalized early in 1986 with the Solomon Islands government for the development of a giant clam hatchery on Guadalcanal. It is planned that eventually the hatchery will be encompassed within a broader-based Coastal Aquaculture Center. The proposed work to be undertaken at this Center and the numerous cooperating institutions will include the development of hatchery technology, surveys of natural stocks and economics studies. The support of additional donors will be sought for the above activities, for stock diversity studies across the Indo-Pacific and for additional hatchery and grow-out studies.

For other bivalves, Mr. Vakily will work with the staff and students of Chulalongkorn University, Thailand, on microcomputer analysis of age and growth of commercial bivalves and the implications for culture practice and fisheries management.

Advisory and training services and publication of new reviews, technical reports and conference proceedings will continue through 1986. Advisory services to the BOBP Malaysian cockle project and the World Bank-GTZ sewage-fish project will continue; ongoing projects will include on-the-job technical training and staff development. The major publications will include reviews on saltwater tilapia culture, tilapia nutrition, carps as exotic species in African and Asian aquaculture; technical reports on bivalve culture and economics; bibliographies on integrated farming; and the proceedings of the detritus conference.

## Aquaculture Project Summaries

*Active during 1985*

STOCK IMPROVEMENT



WASTE-FED AQUACULTURE



COMMODITIES/ECONOMICS



*Upcoming*

*Project Title* : Economics of Philippine Tilapia Hatcheries and Evaluation of Farmed Stocks and Species

*Cooperating Institutions* : UPMSI with support from IDRC to March 1985

*Duration* : April 1984-December 1985

*Key Personnel* UPMSI : Mrs. Julie M. Macaranas
Ms. Ma. Josefa R. Pante
Ms. Nelda B. Danetares

ICLARM : Drs. Roger S.V. Pullin and Ian R. Smith, Ms. Emma Escover, Mr. Orestes Salon and Ms. Josephine B. Capili

*Objectives*

1. Genetics module:

   - To investigate the genetic characteristics of cultured tilapia stocks in the Philippines.
   - To identify electrophoretic and other genetic markers for diagnostic monitoring of experimental and commercial stocks.
   - To provide information for the initiation of stock improvement projects in Philippine tilapia culture.

2. Economics module:

   - To determine the costs and earnings of alternative hatchery systems, including various land-based and water-based designs.
   - To determine average production costs for each of these systems to uncover possible economies of scale.
   - To determine fingerling marketing channels, costs and technical efficiency
   - To analyze various policy issues related to government incentives for the industry, including possible need for and role of centralized government-run hatcheries.

*Results*

Electrophoretic analyses of tilapia populations were continued throughout 1985. Important preliminary investigations were made on red tilapias from Thailand and the Philippines. These particular samples were both found to be hybrids involving three species, *Oreochromis aureus*, *O. mossambicus* and *O. niloticus*. The *O. aureus* involvement was identified by the presence of a species-specific esterase (EST) marker. Moreover in some individuals a heterozygote pattern was observed for ADH, incorporating a –120 allele unlike the usual fixed pattern for *O. niloticus* and *O. mossambicus* (–100 allele) and *O. aureus* (–83 allele).

A further interesting observation was the duplication of MDH loci in the tilapias. This has been observed in other fish such as rainbow trout. It derives from the two MDH fractions from tissue samples–the supernatant (or cytoplasmic) fraction and the mitochondriai function–and has confused nomenclature of banding patterns.

It became apparent during the year that improved methodology was needed to enable more critical work in conjunction with breeding programs and culture performance trials. The various approaches followed were:

1. Evaluation of the use of meristic characters and morphometry to complement or substitute for biochemical marker analysis. Data sets have been assembled and sent to Dr. L. James Lester of Houston University for multivariate analysis.
2. Since tissue sampling from fish which can be kept alive is preferable to killing fish, both for research station and farm populations, attempts were made to define diagnostic markers from *O. aureus*, *O. mossambicus* and *O. niloticus* from blood samples and small muscle samples (taken by biopsy). In addition to the sarcoplasmic protein markers (Sp-2 and Sp-3) which differentiate *O. niloticus* from *O. mossambicus*, the specific esterase (EST) for *O. aureus* and specific PGI for *O. mossambicus*, it was found that CK and G-3-PDH are divergent between *O. mossambicus* (alleles 80 and –125) and *O. aureus* and *niloticus* (alleles 100 and –100). Screening for additional markers, particularly from serum, will be continued in 1986.
3. A need for new reference material was identified. Plans were made to obtain samples of long isolated populations of *O. aureus* (from Israel), *O. niloticus* (from Africa) and *O. mossambicus* (from Papua New Guinea). These will be effected in 1986. If possible, samples of *O. urolepis honorum* will also be obtained; this species was previously introduced to Malaysia and Taiwan and could be involved in some Asian hybrids.

   With the above improvements to methods and additional reference data, it is planned to make further studies on Asian red tilapias in 1986 and to collaborate further with Philippine institutions engaged in breeding programs and culture performance trials.
4. Cage culture performance trials were continued with a cooperator farmer at Pililla, Rizal, Philippines. The experimental design used

involved three sets of three cages, each containing a different genotype—'local' Philippine *O. niloticus*, 'Taiwanese' *O. niloticus* (derived from a 1984 introduction) and 'Israeli' *O. niloticus* (derived from a 1979 'Israeli' introduction). This design was found to be inappropriate since considerable variation occurred within replicates of the same genotype. In future a new design will be tried, mixing tagged fish of different genotypes within the same cage or pond. The results of the 1985 cage trials are still being analyzed. Table 1 shows that the Philippine and Israeli fish had significantly more admixture of *O. mossambicus* than the Taiwanese fish, which had been in the country the least time, an indication of introgressive hybridization increasing with time.

Table 1. Frequency of *Oreochromis mossambicus* genes found in three strains of Nile tilapia *(O. niloticus)* used in cage culture trials on a Philippine farm.

| *Locus* | Frequency of *O. mossambicus* genes in Strain | | |
|---|---|---|---|
| Isozymes | 'Israeli' | 'Philippine' | 'Taiwanese' |
| Gpi-1 | 0.012 | 0.188 | 0 |
| Sdh | 0.112 | 0.062 | 0.038 |
| Sod | 0.013 | 0.050 | 0 |
| Sarcoplasmic proteins | | | |
| Sp-2 | 0.025 | 0.112 | 0 |
| Sp-3 | 0.050 | 0.039 | 0 |
| Mean gene frequency | 0.0436 | 0.1072 | 0.0076 |

Methodological improvements and further investigations will be continued in all these areas of work in 1986. The project team will collaborate further with the Freshwater Aquaculture Center of Central Luzon State University to sample selected high and low growth lines of *O. niloticus* (developed in cooperation with Dr. Lester) and with the Philippine Bureau of Fisheries and Aquatic Resources in securing new African introductions of *O. niloticus* to broaden genetic diversity in Philippine stocks. Their potential will be evaluated in on-station and on-farm trials and breeding programs.

| | | |
|---|---|---|
| *Project Title* | : | Food Webs in Waste-fed Aquaculture |
| *Main Cooperating Institutions* | : | The Asian Institute of Technology (AIT), Bangkok, Thailand; The Rockefeller Foundation |
| *Duration* | : | October 1983-November 1985 |
| *Key Personnel* AIT | : | Dr. Peter Edwards |
| ICLARM | : | Dr. John A. Colman<br>Dr. Roger S.V. Pullin |

*Objectives*

- To investigate the chemical and biological basis of fish production in waste-fed aquaculture systems, concentrating on microphagous species (principally tilapias) dependent on plankton and the detrital food web.
- To determine the effects of water quality factors on fish yields in a variety of waste-fed aquaculture systems, including manured ponds, composted ponds, sewage-fed systems and waste vegetation-fed systems, including the use of aquatic macrophytes.

Organic waste-fed aquaculture, including integrated farming, has now spread throughout Asia and to other warm temperate, subtropical and tropical regions. With the expansion, the importance of determining feeding mechanisms in waste-fed systems has also increased. This information is necessary to fix optimal combinations of organic waste inputs and fish species for new farm locations without experimenting by trial and error in every case.

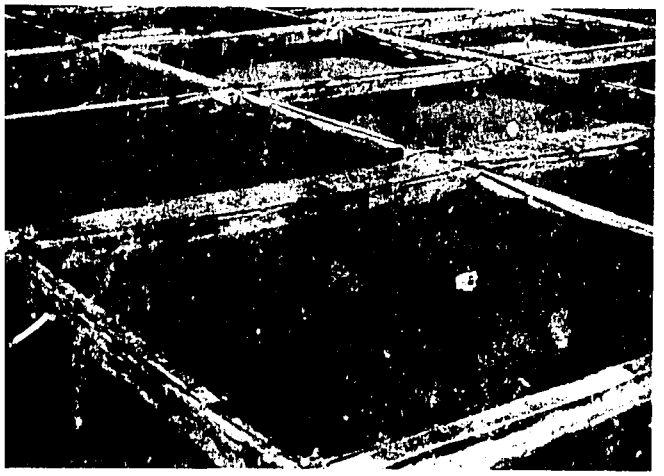
*Results*

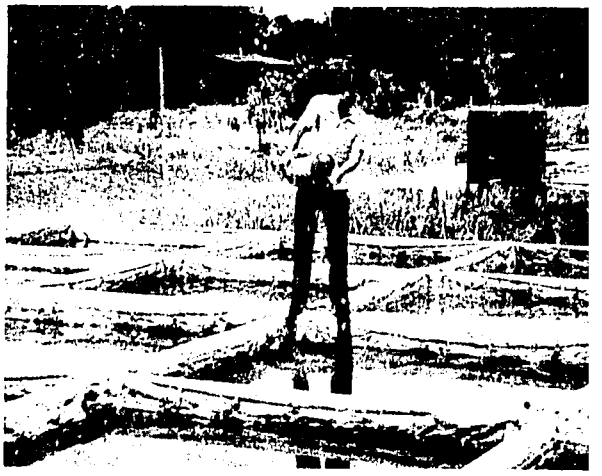
Experiments in fertilized concrete tanks were conducted to determine the potential of algae as feed for tilapia *(Oreochromis niloticus,* Chitrada strain). From comparison of measurements of algal density changes in the tanks and algal production during growth, it was possible to show that algae, rather

than nonalgal organic carbon present in the tanks at the onset of experiments, were the primary source of fish food and that the algae were consumed directly, rather than through food chains involving bacteria or zooplankton.

Fish growth in the tanks on an areal basis surpassed the highest reported growth rates from waste-fed tilapia culture in earthen ponds. It is concluded that direct cropping of algae could be the principal basis of production in waste-fed tilapia culture. This is in contrast to previous reports that tilapias cannot filter enough naturally growing algal populations to account for their growth. However, the tank results were somewhat fortuitous since different algal families are not equally useful in tilapia feeding. By chance in the initial experiments (and later by design) the blue-green genus *Microcystis* dominated. In later experiments, it was found that the green algae *Scenedesmus* did not support good fish growth. This supports the results of previous investigations on algal utilization by tilapia in Lake George, Uganda.

The investigation found that this difference between algal families need not be limiting in pond culture, because *Microcystis* can easily be propagated in earthen ponds by seeding before fish are stocked. If adequate amounts of organic fertilizer are added, *Microcystis* can be kept dominant in earthen





At AIT Campus.

1. *Microcytis* bloom in an experimental tank fertilized with cesspool slurry.
2. Adding a measured amount of cesspool slurry to an experimental tank.
3. An array of tanks used to replicate different treatments—tilapias feeding on algal blooms. Photos by Dr. Peter Edwards.

ponds through an entire six-month culture cycle. The tilapia-*Microcystis* culture system is the first example in aquaculture of a sustainable grow-out technique using cropping of a selected, algal inoculum.

The nutrition of *Microcystis* was examined so that its growth rate could be optimized. It was found that maximum growth occurred when levels of nitrogen and phosphorus in algal tissue were greater than 7.3% and 0.48%, respectively, on an element: dry-weight basis. In trials using septage (cesspool slurry) as a pond input, *Microcystis* tissue nutrient levels dropped below the optimal concentrations even at the highest loading rates used (450 kg COD/ha/day). Low tissue levels were found more frequently late in the experiments, presumably because algae were cropped at a faster rate as the fish grew larger. The implication of the tissue analysis work is that more *Microcystis* could be grown if organic fertilizers such as septage were supplemented with inorganic nitrogen.

The project team also continued its work with the National Inland Fisheries Institute, Bangkok, in investigating the occasional mass mortalities in intensive Thai catfish *(Clarias batrachus)* and snakehead *(Channa striata)* farms and the possiblity of water quality improvement by adding iron to control sulfide levels. Two culture cycles of *Clarias* grow-out were followed, using two treated ponds with iron oxide slurry added and two controls. Several tonnes of fish were harvested with no major mortality incidents in either treated or control ponds. Only low levels of sulfide were found in the untreated ponds. Yields were better in iron-treated ponds, but the experimental hypothesis was not proven because of lack of mortality and sulfide buildup in untreated ponds. However, it was shown that iron oxide, which colors the water a dark red, does not lower pond yields. The way is now open to test the treatment more widely, perhaps on farmers' ponds, to gain more data on possible sulfide/iron and mortality correlations.

*Left:* Harvesting catfish *(Clarias batrachus)* in a Thai farm. *Right:* Trash marine fish being minced to provide feed for catfish farmers. Photos by Dr. Peter Edwards.

*Project Title* : Research for the Development of Tropical Aquaculture Technology Appropriate for Implementation in Rural Africa

*Cooperating Institutions* : African institutions to be identified; German Agency for Technical Cooperation (GTZ)

*Duration* : Planning Phase, November 1985-April 1986
Startup Phase, May 1986-October 1986
Main Project, November 1986-October 1987
(with provision for extension)

*Key Personnel*

African institutions : to be identified

ICLARM : Project Leader (under recruitment)
Dr. R.S.V. Pullin

*Objectives*

- To develop aquaculture technology appropriate for implementation in rural Africa through a program of cooperative research with African and Asian institutions.
- To develop, through cooperative research, management guidelines for the implementation of waste-fed aquaculture systems in rural Africa.
- To train research and teaching personnel from African institutions to strengthen their capabilities for supporting aquaculture research and development.
- To strengthen research, training and information exchange activities between African and Asian institutions.
- To provide African cooperating institutions with relevant information for the furtherance of rural aquaculture research and development.
- To publish and disseminate widely the results of all cooperative research and training activities.

This project commenced its planning phase in November 1985. The rationale and background for the project are given here together with an outline of future activities.

*Background and Rationale*

In contrast to other regions of the world where aquaculture production is growing, African aquaculture production, according to FAO statistics, declined 12.8% per year over a five-year period (1975-1980) in which Africa's population increased by an average of 2.9% per year.

Aquaculture development in Africa has a long and varied history. Indeed research in support of tropical aquaculture began largely in Africa in the late 1940s and the 1950s, when field biologists and fisheries officers on overseas service from the colonial powers established a few field stations and research facilities to support development of tropical inland fisheries. They worked extensively on pond fish culture and lake fisheries and were exceptionally keen and observant fish biologists with the ability to combine basic and applied research, often under very difficult field conditions. Their work indicated that Africa has enormous living aquatic resources suitable for aquaculture, particularly fishpond culture of tilapia, a commodity which is now recognized as a potential 'aquatic chicken'. However, these early research and development initiatives have not been followed up and most aquaculture development efforts in Africa have been disappointing to date.

The reasons for this are complex but can be grouped into four categories: infrastructural inadequacies, associated with the backward and deteriorating economies of many African nations; concentration on the biological feasibility of development projects with insufficient attention to economic and sociocultural factors; lack of a strong research base and institutional support to ensure that chosen aquaculture systems are robust and can be implemented profitably over wide ranges of input and management levels in rural areas; and lack of trained personnel at all levels.

The resolution of each of these problems is extremely difficult. However, for aquaculture development the realization that research is necessary and that it must be multidisciplinary is an important first step.

The ICLARM project seeks to select, adapt and improve the most promising Asian aquaculture technology for use in rural Africa and will focus on low-cost systems. To ensure rapid progress, some of the basic work will be done using well established research facilities in Asia, while making parallel efforts to strengthen the capabilities of selected cooperating institutions in Africa and to pursue their further research and training activities.

The project is multidisciplinary, encompassing biological, economic and socioeconomic research, training and provision of relevant information to cooperating institutions. It will concentrate on culturing domesticated stocks in waste-fed ponds or cages in which the biological and chemical basis of fish production is well understood. Thus, the project will avoid the mistakes of many previous development efforts in Africa in which pond production trials were repeated for many years, changing numerous variables (species, stocking densities, feeds and fertilizer inputs) with little understanding of the mechanisms involved and with little attention to economic and sociocultural conditions at the actual farm level.

At this time, the most promising area of research appears to be the further development of waste-fed pond aquaculture and cage culture using low-cost supplemental feeds containing agricultural byproducts. The most promising species are the tilapias, carps and catfishes. In waste-fed aquaculture livestock manures, waste vegetation, composts and other agricultural residues are used to fertilize fish ponds. The definition includes systems popularly known as 'integrated farming'. Integrated farming systems could be adapted for implementation in African developing countries, provided that a program of applied multidisciplinary research and technology development is undertaken to backstop development projects. For Africa, the use of ruminant livestock wastes for pond fertilization appears particularly promising, but will require further research since most existing technology has been developed for pig- and poultry-fish integrated farming systems.

Fish cage culture has also emerged as a very productive system in rural Asian aquaculture and may be suitable for African adaptation. Fish in cages can be given low-cost feeds formulated largely from agricultural byproducts, especially when the fish have access to natural feeds like plankton and detritus as well. Moreover fish cages in lakes, lagoons or rivers offer landless rural people a chance to produce high protein food at low cost.

Aquaculture could be a useful component of African farming systems, particularly in development efforts to promote fixed rather than shifting cultivation.

*Outline of Future Activities*

1. Planning Phase

ICLARM senior aquaculture and economics research staff will undertake missions to selected African countries to establish linkages with suitable cooperating institutions. Following these missions, ICLARM staff and consultants will select one or more African cooperating institutions which will participate in the ensuing project activities. One institution will likely be invited to become the African Lead Cooperating Institution (ALCI) and the main center for project activities. One or more Asian counterpart cooperating institutions will also be identified.

2. Startup Phase

A Project Team Leader experienced in waste-fed aquaculture research will be recruited and stationed at the ALCI and counterparts designated in all cooperating institutions. Research, training and information activities will commence with assistance from other ICLARM staff and additional consultants as and when required. For research activities in Africa, particular emphasis will be given to economic and sociocultural factors.

## 3. Main Project

A major research program on waste-fed aquaculture will be pursued by the ALCI and cooperating institutions. The most likely thrust of this project will be the development of management guidelines for the use of available livestock wastes and agricultural byproducts as fertilizers and fish feed components.

Parallel studies will be made of relevant economic and sociocultural factors affecting the implementation of waste-fed aquaculture systems in African countries cooperating in the project. These may emphasize involvement of cooperator farmers in 'on-farm' trials and record-keeping.

At the Asian counterpart institutions, further basic research will be pursued to address related issues on the mechanisms of fish production in waste-fed systems and the nutritive quality of wastes available in tropical Africa.

Training activities will take place in Africa at the ALCI. A short course on waste-fed aquaculture research and development is envisaged for graduate researchers to include biological, economic and socioeconomic components. The course will be highly practical with a major emphasis on experimental aquaculture, laboratory and field studies.

*Project Title* : Applied Research on Coastal Aquaculture

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

*Duration* : December 1981-November 1985

*Key Personnel* DOF : Pairoj Brohmanonda, Kosol Mutarasint, Kachornsak Wetchagarun, Pongpen Rattagool, Songchai Sahavatcharint, Somying Rientriratana, Yuhd Hansopa, Taworn Tammasavate, Sunan Tuaycharoen, Thanittha Chongpeepien, Pongpat Boonchuwong, Sabaithip Amornjaruchit

ICLARM : Dr. E.W. McCoy, Mr. J.M. Vakily, Dr. R.S.V. Pullin

*Objectives*

- To identify technical, biological and economic constraints hindering successful expansion of bivalve mollusc culture in the coastal zone of Thailand.
- To assist the DOF to initiate applied research aimed at eliminating identified constraints.
- To provide technical advice on mollusc culture, product handling and marketing.
- To assist the DOF in developing a lead station for research and development work in mollusc culture.
- To assist the DOF to initiate work on introduction and/or improvement of appropriate technologies for mollusc culture.

*Results*

The third 12-month phase of the project was initiated in December 1984. Much of it was devoted to collation of data and preparation of reports,

which is still continuing. However, a number of project activities were continued from Phase II.

Studies on the areas selected for attempts to establish new cockle beds (Sawi Bay and Nakhon Bay) were continued. For example, 15.43 tonnes of cockles (25-35 mm) were transported from Malaysia to a 0.9-ha plot in Sawi Bay in January 1984. They had a growth rate of 1 mm/month over the following seven months and ripe gametes were present every month. Data collection was interrupted for four months but was reinstituted over the period January to November 1985. The growth rate during 1985 was 0.4 mm/month and the spawning season was June-July. The highest condition index occurred in May. Induced spawning experiments at Prachuap Khirikhan Brackishwater Fisheries Station also indicated that cockles from Sawi Bay could be spawned in June and July but the number induced to spawn averaged only 3% from each sample. Mortality on the cocklebed also increased slightly during 1985.

A natural seed settlement was found near the shore. Very high mortality occurred in the seed bed in which there were 18 to 60 empty shells and only 1-2 live cockles per $m^2$. The cause of mortality was not determined but the use of trawl nets and the presence of a freshwater inlet may have been contributing factors.

Cockle seed (average length 20.3 mm) from Phetchaburi Province were stocked in Sawi Bay in July 1985. Survival was approximately 80% during the period studied. Growth rate was 1.5 mm/mo. Parallel studies were made in Nakhon Bay and an in-depth seed survival study is planned.

Consultant Mr. Charles Angell returned to assist in the hatchery of Prachuap Khirikhan with problems related to larval survival up to settlement and with seed survival after transport. Construction of the hatchery designed in Phase II progressed well and the consultant advised on equipment needs and research activities.

A survey of all the types of commercial bivalve molluscs utilized in Thailand indicated the diversity of species consumed and the diversity of common names used to designate species. In some locations, a very large amount of one species might be sold locally under one name, while elsewhere a different species might be sold under the same name. This study also showed that natural populations of green mussel *(Perna viridis)*, cockle (*Anadara* spp.) and horse mussel (*Modiolus metcalfei* and other species) exist in locations previously unreported. Clams (*Meretrix* spp.) were forwarded to other laboratories for verification of identification. At present it seems that at least four species of cockle and three or more species of horse mussel are sold in Thai markets.

Completion of a major shellfish marketing study served as verification for data from this shellfish identification study. Green mussel and cockle were available in most major coastal markets. Short necked clam *(Paphia undulata)* was also common in markets. Most of the sellers sold more than one type of shellfish. The restaurant and foodshop demand for oyster and scallop *(Amusium pleuronectus)* essentially utilized all the available supply. Export markets presently exist for short necked clam. A very limited quantity of

other species is exported. Cockle in-shell from Malaysia is the only significant bivalve import.

Overall, economic studies have indicated research priorities that remain before definitive answers can be given regarding further development of bivalve mollusc culture. Marketing constraints presently limit expansion of green mussel production. Uncertainty regarding supply limits further development of short necked clam marketing. Oyster production, especially for large oysters *(Crassostrea lugubris* and *C. belcheri)*, is limited by present lack of suitable production areas.

Many problems remain but a significant step has been taken toward expanding bivalve mollusc production in Thailand. The DOF will build on this in future work. Several technical publications of the project are pending.

*Project Title* : Cooperative Tilapia Research Project

*Cooperating Institutions* : Council of Agriculture (COA), Taiwan and National College of Marine Sciences and Technology

*Duration* : July 1982-June 1985

*Key Personnel* COA : Dr. Jen-Chyuan Lee
ICLARM : Dr. Ching-Ming Kuo

*Objectives*

- Development of saline-tolerant tilapia strains and hybrids suitable for culture in coastal regions and associated technology packages for mass seed production and grow-out.
- 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*

The project was completed in June 1985. Continued efforts were made to evaluate the culture potential of tilapias and to develop culture methods in seawater. The survival, growth performance and salinity tolerance of the progenies of the intra- and interspecific crosses of *Oreochromis niloticus, O. aureus* and *O. mossambicus* were monitored over a four-month period from the time of hatching. The results of the improvement in salinity tolerance through physiological acclimatization in *O. niloticus* had been previously reported. The salinity tolerance of tilapias was registered by using the indices of mean survival time (MST), median survival time (ST-50) and lethal

salinity at 96 hrs (MLS-96). Among them, the MST was found to be most informative.

The growth and the salinity tolerance of the tilapia progenies are summarized in Table 1. Differences in the total length of all the crosses on the seventh and fifteenth day from the hatching were not significant, ranging between 8.2 and 9.8 mm, and between 9.9 and 11.9 mm, respectively. However, the salinity tolerance of the interspecific hybrids of *O. niloticus* and *O. aureus* was better than the intraspecific crosses. Remarkable improvements in salinity tolerance were observed in the progenies of *O. mossambicus* x *O. niloticus* and *O. aureus* x *O. mossambicus*.

The ontogenetic changes in the salinity tolerance of the tilapias were further monitored. The tolerance was closely related to the size of the tilapia fry (total length or body weight) (Fig. 1). No relationship between tolerance and the physical condition of the fry, measured by the condition

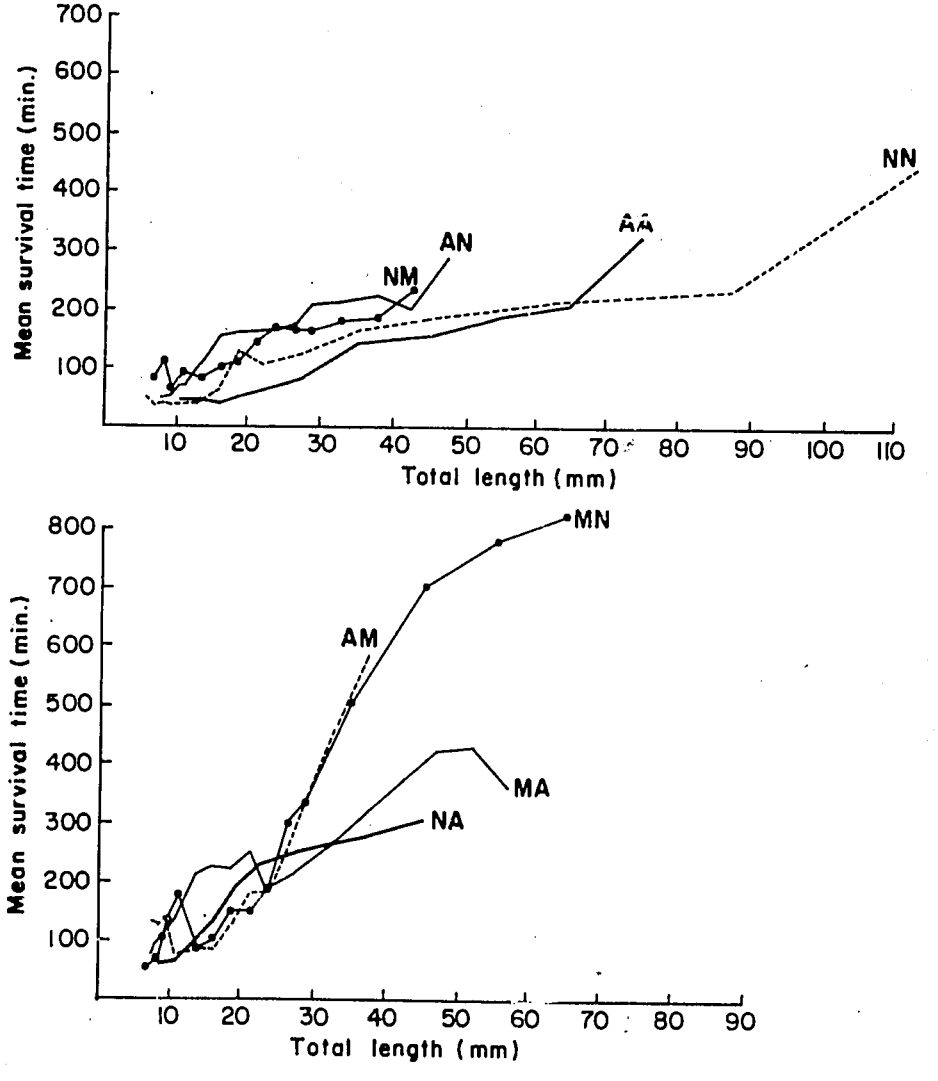



Fig. 1. Mean survival time of various tilapia hybrids of different sizes following direct transfer from freshwater to seawater (32 ppt). Each trial represents 25 fish. A = *O. aureus;* M = *O. mossambicus;* N = *O. niloticus*. Female parent given first.

Table 1. Growth and salinity tolerance of tilapias: *Oreochromis* species and hybrids.

| Days[a] | Intra- and interspecific crosses: total length (mean survival time)[b] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxN[c] | | NxA | | AxN | | AxA | | NxM | | MxN | | AxM | | MxA | |
| 7 | 8.3 | (43.0) | 8.6 | (54.3) | 9.4 | (53.1) | 9.8 | (35.0) | 8.2 | (92.0) | 8.8 | (62.1) | 9.2 | (131.3) | 8.6 | (81.7) |
| 15 | 9.9 | (52.9) | 10.4 | (68.6) | 11.9 | (76.8) | 12.5 | (52.8) | 11.9 | (93.1) | 10.0 | (89.7) | 11.7 | (84.6) | 10.0 | (128.7) |
| 30 | 11.5 | (43.4) | 14.5 | (75.2) | 14.4 | (129.4) | 14.7 | (45.5) | 17.5 | (103.2) | 14.4 | (86.3) | 13.2 | (78.9) | 16.1 | (175.1) |
| 45 | 15.2 | (77.7) | 16.4 | (152.5) | 23.3 | (139.6) | 18.4 | (54.4) | 25.0 | (176.4) | 20.9 | (151.5) | 19.3 | (113.0) | 21.2 | (226.8) |
| 60 | 26.9 | (92.4) | 18.4 | (182.8) | 27.6 | (206.9) | 22.9 | (64.5) | 32.3 | (184.2) | 25.4 | (211.7) | 25.9 | (232.2) | 23.8 | (265.8) |
| 90 | 32.2 | (98.7) | 20.4 | (222.4) | 31.1 | (222.7) | 37.3 | (126.6) | 33.3 | (173.5) | 29.9 | (543.2) | 31.3 | (500.0) | 34.4 | (260.0) |
| 120 | 46.9 | (136.5) | | | | | 45.3 | (135.2) | | | | | | | | |

[a]Days after hatching.
[b]Total length in mm and mean survival time in minutes.
[c]A = *O. aureus*; M = *O. mossambicus*; N = *O. niloticus*. Female parent given first.

factor, was observed. Elevated salinity tolerance was often observed at an earlier age; slight decline in the tolerance followed before increasing again to maximum salinity tolerance. The trend of the tolerance increase varied with the strains examined.

The existence of size-related differences in salinity tolerance in the tilapias has important practical implications for seawater tilapia culture. When freshwater is limited, it is economically advantageous to implement seawater transfer as early as possible by maximizing initial freshwater growth to the size of maximum salinity tolerance. A combination of hybridization (to increase salinity tolerance levels) and maximization of early freshwater growth through environmental manipulation and hormone application to minimize freshwater requirements should optimize conditions for economic culture of tilapia in brackishwater or seawater. Early salinity exposure, through spawning and incubation at elevated salinities can effectively enhance salinity tolerance levels in young tilapia fry and also provide the added benefits of reducing freshwater requirement associated with broodstock holding and early rearing.

Culture performance of the tilapia fry was further evaluated in 3 x 3 m net cage at varying salinities. Survival and growth performance in seawater were found satisfactory when the fry were transferred to seawater at a proper size to maximize subsequent survival. Continued efforts should be made for refining formulated tilapia feed suitable for culture in seawater. Tilapia culture in coastal regions appears to be economically feasible.

This project provided opportunities for the completion of graduate programs of Mr. Wen-Tsun Lo at National Sun Yat-Sen University (M.S. thesis entitled "Process and control mechanisms of osmoregulation in blue tilapia, *O. aureus*") and Miss Juen-Juen Lin at National Taiwan University ("Comparative studies on the effects of salinity acclimation on oxygen consumption and metabolic pathway of common carp, tilapia and milkfish fry").

*Project Title* : Intensive Mariculture of Tilapia

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

*Duration* : January 1982-June 1985

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

*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 grow-out systems for tilapia, including cages and raceways.

*Results*

The KISR/ICLARM project was completed in June 1985. Most of the project activities were directed at completing and analyzing experiments which were started in 1984 and finalizing a very detailed feasibility study of tilapia culture in Kuwait. Additionally, experiments using rotating biological contactors (RBC) in a recirculating culture system were conducted and marketing tests were continued.

Spawning experiments were conducted to determine the relative fecundity of yearling and older (2-3 years) *Oreochromis spilurus*, to compare the fecundity of *O. spilurus* in brackishwater (3 ppt salinity) and seawater, and the fecundity of *O. aureus* and 'red' tilapia in brackishwater. Fish seed (eggs and fry) from anesthetized broodstock were collected weekly. There was no significant difference in the fecundity of yearling and older *O. spilurus*. As in previous years, *O. spilurus* produced significantly more seed than *O. aureus* and the red tilapia (Table 1). The spawning of *O. spilurus* in seawater was much less successful than in brackishwater.

Table 1. Tilapia seed production in Kuwait in 1984[a]: *Oreochromis* species and a red hybrid.

| Species | Water type | Seed/kg female/day |
|---|---|---|
| *O. spilurus* | Seawater | 129 |
| *O. spilurus* | Brackish | 328 |
| 'Red' tilapia | Brackish | 80 |
| *O. aureus* | Brackish | 90 |

[a]May, June and July only.

Basic analyses of the 1984 yield trials of tilapia grown in seawater were completed. Five groups of tilapia were grown in tanks with flowing seawater (38-41 ppt) as part of a series of tests to evaluate the potential for culturing tilapia in seawater under ambient conditions in Kuwait. The red tilapia grew the fastest but had a low survival rate during the winter (Table 2). *O. aureus* grew the slowest and also survived poorly. *O. spilurus* and an *O. aureus* x *O. spilurus* hybrid demonstrated the highest survival and moderate growth rates. It was concluded that the latter two groups were best suited for seawater culture if winter water temperatures are substantially below 24-25°C. Where water temperatures are not so low, the red tilapia has the best potential for culture in seawater. Multivariate analyses of the data from these and earlier yield trials are currently being conducted in an effort to develop generalized models of growth and survival of these tilapias in seawater culture systems.

Table 2. Stocking and harvest data for tilapias grown in seawater in Kuwait from 15 August 1983 to 27 March 1984: *Oreochromis* species and hybrids.

| | Both sexes | | Testosterone-treated | | |
|---|---|---|---|---|---|
| | *O. spilurus* | hybrid* | *O. spilurus* | *O. aureus* | red hybrid |
| Stocking rate** | 102 | 102 | 101 | 154 | 106 |
| Stocking size (g) | 2 | 1 | 3 | 1 | 1 |
| No. males (%) | 50 | 70 | 75 | 85 | 80 |
| Ave. survival (%)** | $82^{a,b}$ | $95^{a}$ | $70^{b}$ | $23^{c}$ | $38^{c}$ |
| Ave. harvest size (g)*** | $70^{b}$ | $67^{b}$ | $80^{b}$ | $33^{c}$ | $132^{a}$ |

**O. aureus* female x *O. spilurus* male.

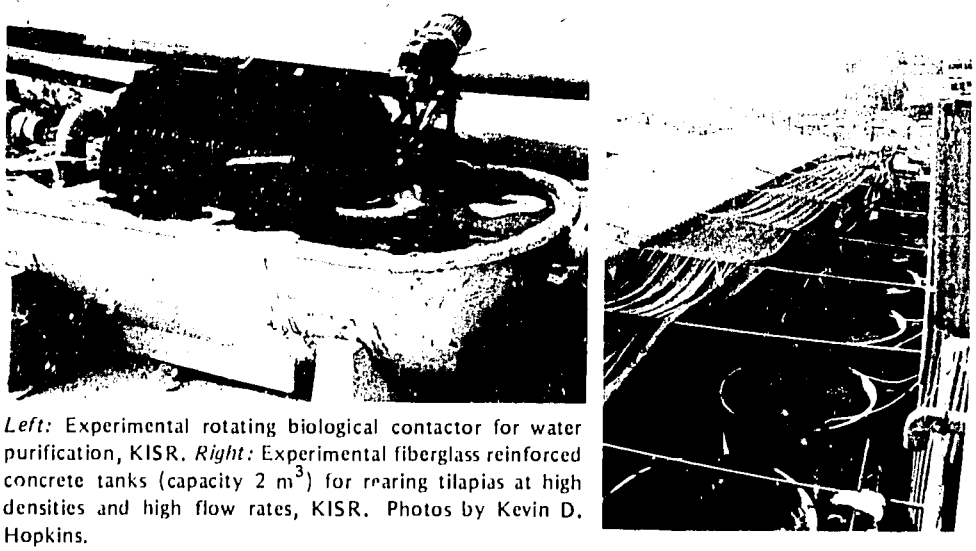
**Average total number of fish stocked. One hundred fish of each group were stocked on 15 August. Any mortalities within the first two weeks were replaced.

***Means in each row with the same superscript are not significantly different based on the Student-Newman-Keuls procedure.

Growth rates approximating those of local sea bream (Sparidae) have been obtained (1.28 g/day in tanks for fish of 23 g initial weight and 250 g final weight; 2.03 g/day in cages for fish with initial weight of 100 g and final weight of 323 g). Production was 4 kg/$m^3$ in cages and 37 kg/$m^2$ in tanks. Mortality was directly related to frequency of handling, about 4% in tanks and 18% in cages (due to prolonged handling at larger size during transfer to cages). Such mortality can be avoided in future by direct nursing in cages. Sea bream pellets (from France) of 45% crude protein were used as feed in these trials. Food conversion rate was 2:1.

A recirculating tilapia culture system was tested using an RBC, which is a type of biological filter in which the filter medium is rotated in the water to be treated. The system contained four fish tanks, a swirl separator to remove coarse solids and an RBC. The RBC used in these experiments was a 0.2-$m^3$ wire drum filled with plastic balls. Total system volume was 7.8 $m^3$ of which 4.2 $m^3$ were fish tanks with the remainder in filters and pipelines. The system was stocked with 195 kg of tilapia in February and operated for three months. Flow of freshwater into the system was 300 ml/min. Within one month, the biomass had increased to 240 kg. Thus, the loading rate increased from 650 kg/l min. to 800 kg/l min. during this one month period. During the last two months of the test, the growth rate slowed considerably with the biomass increasing to only 277 kg of tilapia by the end of the experiment. Water quality in the system was highly variable with total ammonia nitrogen varying between 5 and 32 mg/l. Detailed analysis of the data is being conducted.

The 1985 market tests compared the sales rate of cultured tilapia against the sales rates of cultured grouper and sea bream. Grouper and sea bream are preferred fish in Kuwait. The market tests were conducted at the same store where cultured tilapia had been sold since 1982 and in three stores in new areas. At the store where cultured tilapia had been sold previously, the customer preference was 50% for sea bream, 30% for grouper and 20% for tilapia. In the stores where tilapia was not familiar to the customers,



*Left:* Experimental rotating biological contactor for water purification, KISR. *Right:* Experimental fiberglass reinforced concrete tanks (capacity 2 $m^3$) for rearing tilapias at high densities and high flow rates, KISR. Photos by Kevin D. Hopkins.

sales rates for tilapia were much lower than for the other two species. These results indicate that tilapia can compete with other cultured fish in the Kuwait market but market development will be required at the neighborhood level.

At the request of KISR, project personnel conducted a detailed feasibility study of tilapia culture in Kuwait. Under the environmental and economic conditions existing in Kuwait, integrating a brackishwater tilapia farm with agriculture was deemed to be most appropriate (Fig. 1). The tilapia farm should use a recirculating system with both physical and biological filters to minimize water requirements and discharge its effluent into an irrigation system. Based on the results of the feasibility study, steps are now being taken to establish a pilot facility with an annual production of 100 t of tilapia.

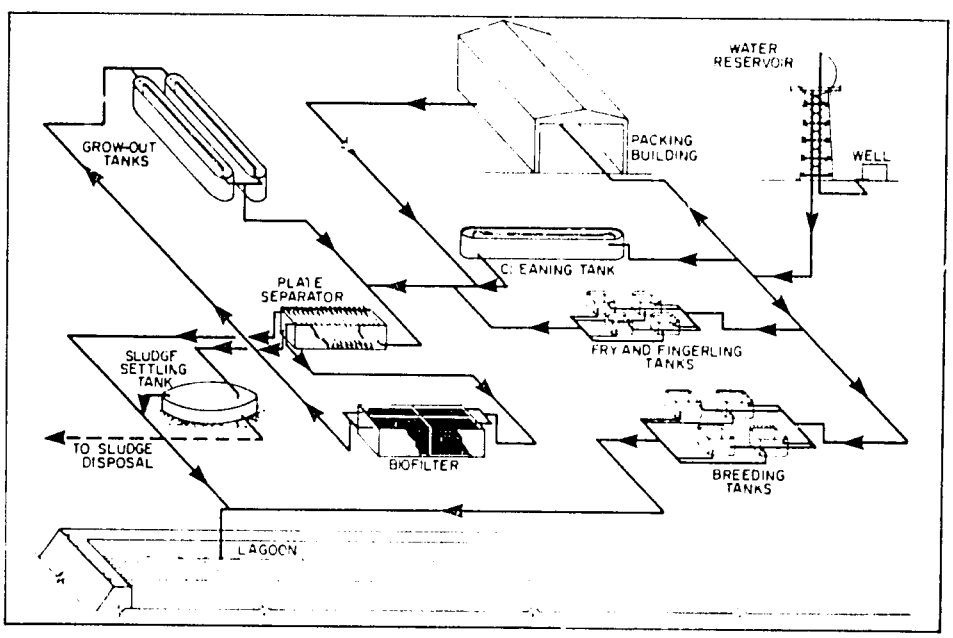



Fig. 1a. Water flow in proposed Kuwait tilapia farm.

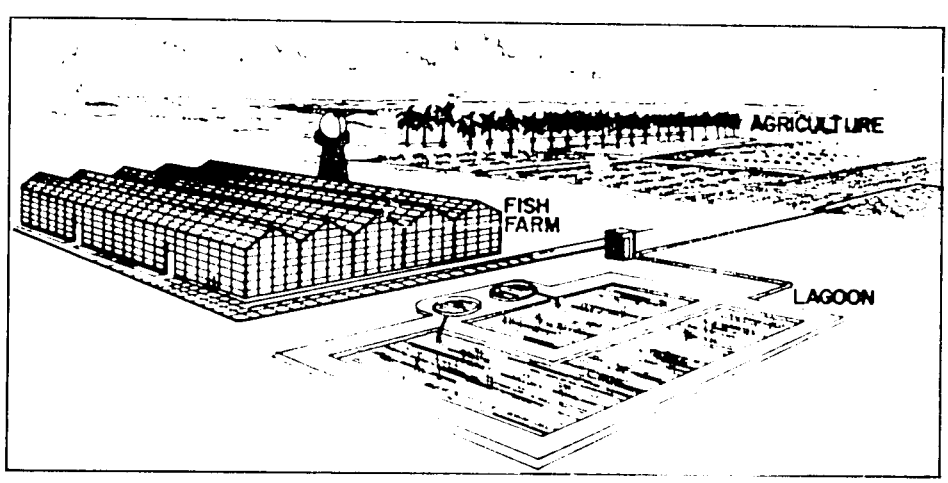



Fig. 1b. Summary of water utilization in proposed Kuwait tilapia farm.

This KISR/ICLARM project has now ended although analysis of project data will continue at both institutions for some time. Part of the research, particularly the work on recirculating systems, will have applicability only in arid areas where energy costs are not prohibitive, such as the Gulf Cooperation Council countries. The seawater work has much wider applicability and shows that *O. spilurus* and red tilapia can be cultured to market size in seawater. The market tests verified observations made in other countries that considerable market development is required before an unknown fish is accepted by consumers.

The key problems facing tilapia culture in seawater in Kuwait are:

- *Vibrio* infections: commercial vaccines will be tried in future; otherwise a vaccine based on local *vibrio* species will be prepared and tested.
- Low fecundity of breeders in seawater: fry will have to be produced in freshwater and acclimated to seawater.
- Only one crop can be produced per year in seawater due to water temperature problems: tilapia will have to be cultured during May-November as a bumper crop in a sea bream farm. Alternatively, heated effluent from power and desalination plants can be used for year-round culture if the problem of chlorine content (1 ppm) can be resolved economically.
- Tilapia culture in seawater cannot co-exist with freshwater tilapia farms, since the costs are higher and production is lower in seawater farming. However, marine tilapia could compete with cultured marine fishes (outside Kuwait) if the market price of the tilapia is similar to that of marine fish. This is because hatchery costs of tilapia are much lower.

| | | |
|---|---|---|
| *Project Title* | : | International Giant Clam Mariculture Project |
| *Principal Cooperating Institution* | : | James Cook University of North Queensland (JCUNQ) |
| *Other Cooperating Institutions* | : | Fisheries Research Branch, Department of Primary Industry, Brisbane, Queensland (DPIQ); University of Papua New Guinea, Port Moresby (UPNG); Silliman University, Dumaguete City, Philippines (SU); Marine Sciences Institute, University of the Philippines, Quezon City (UP); Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji (MAFF); Fisheries Department, Ministry of Natural Resources, Honiara, Solomon Islands (MNR) and the Zoology Department, University of Newcastle upon Tyne (UNT). |
| *Duration* | : | 1983-1988 |
| *Key Personnel* JCUNQ | : | Dr. John S. Lucas<br>Dr. Christine M. Crawford |
| ICLARM | : | Dr. John L. Munro |

*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 mariculture 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.
- To create maricultural systems for the only phototrophic, and thus self-feeding, potential farm animal known to humankind.

*Results*

The two major components of this project, operated by ICLARM and by JCUNQ, operate independently in that funding for the principal scientific work coordinated by JCUNQ is channelled directly from the Australian Centre for International Agricultural Research (ACIAR) to JCUNQ and then to four of the cooperating agencies (UPNG, UP, SU, MAFF). ICLARM has no financial involvement with JCUNQ or ACIAR. Separate progress reports are issued by the ACIAR-funded project.

Giant clam larvae have been reared at JCUNQ, SU and UPNG and juveniles of *Tridacna gigas* successfully raised to lengths of several centimeters at JCUNQ and UPNG. In Fiji, the MAFF has surveyed the clam resources of a large portion of Fijian waters and expects to cover the remaining area in 1986. Scientists at UP have made detailed transects of numerous sites and both the MAFF and UP groups have amassed much data on size-frequency distributions of the populations. The surveys have confirmed that *T. gigas* is extinct in Fijian waters and that stocks are extremely sparse and threatened with extinction in the Philippines. Scientists at JCUNQ have reared giant clam larvae in numbers using conventional bivalve culture techniques but the problem of mass mortalities at metamorphosis to the juvenile stages is yet to be overcome.

At the end of 1984 Prof. C. Burdon-Jones retired from his professorial position at JCUNQ and Dr. J. Munro became joint coordinator of the ACIAR-funded component of the giant clam project in addition to coordinating ICLARM's activities in giant clam mariculture.

As a result of a series of visits to the Solomon Islands a draft agreement between ICLARM and the Government of Solomon Islands was prepared covering the development of a Coastal Aquaculture Center on Guadalcanal,

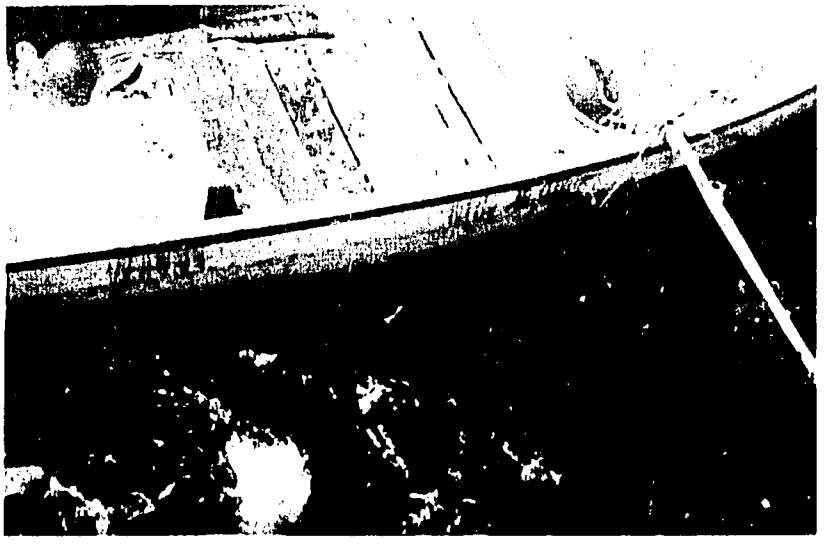
Giant clam research facility—Orpheus Island Research Station, James Cook University.

of which a giant clam hatchery would be the first component. The objective in developing a giant clam hatchery in the Solomon Islands is to test the methodologies developed by the scientific components of the project in a representative equatorial Pacific environment and to develop a pilot-scale hatchery for the production of juvenile clams. Formalization of the agreement with the Government of Solomon Islands is expected in early 1986.

The Overseas Development Administration of the United Kingdom (ODA) has contributed the services of a qualified aquaculturist, Mr. Graham Usher, to the project commencing in January 1986. After an initial period in Australia, he will be stationed in the Solomon Islands with responsibility for surveying the clam resources of the Solomon Islands, initiating development of the giant clam hatchery and undertaking work on product development. ODA also provides financial support for salaries, travel and equipment. Other commitments to the clam project include a grant from the Skaggs Foundation and dedicated core support from the Australian Development Assistance Bureau (ADAB).

During November 1985 a survey was made of the giant clam resources of the north-central atolls of the Gilbert Islands in Kiribati. This was a cooperative effort between ICLARM and the UNDP/FAO South Pacific Regional Fisheries Development Programme. The survey, which covered four atolls, revealed that giant clam stocks were relatively sparse and could easily be removed in a single systematic harvest; they would not support a sustained commercial fishery. However, the atolls investigated had substantial areas suitable for clam cultivation.

Analyses of growth and mortality rates of stocks of marked giant clams at Michaelmas Reef on the Great Barrier Reef and at Motupore Island in Papua New Guinea have provided parameters for inclusion in bioeconomic



Method of giant clam survey--Kiribati.

models of giant clam farms. Additionally, it is hoped that work by a post-graduate student (Mr. C. Shelley) at JCUNQ on the deposition of daily and other periodic rings in the shells of clams, will provide a more direct means of aging the clams. Work on all aspects of growth rates will continue as it is apparent that there are large regional variations in these parameters which will affect the viability of clam farming.

Some data on product values are already available as a result of work done by participating institutions. Additionally, the Forum Fisheries Agency will investigate current markets for giant clam adductor muscle and clam flesh in Southeast Asia during January and February 1986. Further economic data, such as wage levels, transport costs, power costs and taxes in various Indo-Pacific locations, will be gathered for inclusion in the bioeconomic models during 1986.

A bibliography of the giant clams was prepared in collaboration with W.J. Nash of JCUNQ and published by ICLARM.

*Tridacna gigas.*

*Project Title* : Development of Aquaculture and Fisheries Activities for Resettlement of Families from the Saguling and Cirata Reservoirs, Indonesia

*Cooperating institutions* : Institute of Ecology, Padjadjaran University (UNPAD); Perusahaan Umum Listrik Negara (PLN); with funding from the World Bank

*Duration* : Three years, to begin mid-1986

*Key Personnel* UNPAD : Drs. Otto Soemarwoto, Edy Brotoisworo
ICLARM : Drs. Ian R. Smith, Roger S.V. Pullin, John L. Munro. Resident consultant to be appointed.

*Objectives*

- To assist in the establishment of aquaculture and fisheries activities for the efficient implementation of resettlement of families from the Saguling and Cirata reservoir areas of Indonesia.
- To develop fisheries management plans for the two reservoirs for the involvement and benefit of the resettled families.

The Saguling and Cirata Resettlement Coordinating Board of Indonesia approved the resettlement of 1,500 families each for the "Aquaculture and Fisheries Option" of the Saguling and Cirata Hydroelectric Power Projects. These power projects involve the resettlement of many families following construction of the Saguling and Cirata reservoirs. The goal of this Option appears to be unique: it connects resettlement with aquaculture and capture fisheries development. There are no previous experiences anywhere involving resettlement of such a large number of persons through an aquaculture and capture fisheries development program.

PLN has requested the Institute of Ecology of Padjadjaran University in association with ICLARM to provide supporting services to the program including pilot demonstration aquaculture projects, training of farmers at these pilot aquaculture sites and the conduct of related economic, socio-economic, marketing, extension, fisheries and environmental research in support of the program objectives. It is the responsibility of ICLARM to

provide technical assistance in the area of fisheries management, economics and aquaculture. Also the Institute of Ecology, with assistance from ICLARM, will develop an aquaculture and fisheries management plan for the Saguling and the Cirata Hydroelectric Project.

On ICLARM's part, the project requires one scientist full-time and three part-time. ICLARM will also be providing information services for the project staff.

## RESOURCE ASSESSMENT AND MANAGEMENT PROGRAM

### Background

The emphasis of the Resource Assessment and Management Program through the early 1980s was directed to enhancing the ability of fishery scientists working in tropical developing countries to undertake stock assessment studies, mainly through the development and dissemination of appropriate methodologies, such as calculator software and the ELEFAN (Electronic Length Frequency Analysis) microcomputer programs.

Although very successful, this resources-oriented approach to deal with the realities of resource uses and allocation in tropical developing countries must be complemented in the coming years by an increased emphasis on interdisciplinary research including the social and economic aspects of resources management. For this reason, the former Traditional Fisheries Program and Resource Development and Management Program of ICLARM were merged during 1985 into a program whose new name—Resource Assessment and Management—is meant to reflect better the task at hand. During the year, the Program also began the planning of an expanded role for ICLARM in the area of integrated coastal resource research and management, thus taking the Program into areas beyond the fisheries themselves.

The Program has eight projects. Of these, three are continued from 1984, one was initiated in 1985 and four are new. The three continued projects briefly described below, have their emphasis on stock assessment research, but also involve extensive linkages with other institutions and have large training components. They are:

- The Tropical Fish Stock Assessment project, which provides the framework for a continuous series of in-house studies on various aspects of the population dynamics of tropical fish and invertebrates, along with methodologies for their study. These studies have had a demonstrably high impact on the research work conducted by other authors in the intertropical belt and elsewhere.
- The Network of Tropical Fisheries Scientists, initiated in April 1983, has now a global membership of 520 individuals in over 80 countries. The members receive a regular newsletter and free reprints and documents donated to the network by members and/or cooperating institutions. This approach, along with the question/answer service to members by the Project staff, significantly contributes to reducing the feeling of isolation of many researchers working on tropical fisheries.

- The Management-Oriented Fisheries Research Project consists of country-specific modules built around a group of network members in a given institution. Support from ICLARM is provided to conduct research on a given fishery or research; this support takes various forms, ranging from supplying a microcomputer and software (Indonesian, Zambian modules) to frequent visits in the frame of a larger series of studies (Peru).

The new project initiated in 1985 is an outgrowth of the Applied Research on Coastal Aquaculture project of the Thailand Department of Fisheries and ICLARM (see p. 33):

- Growth Studies on Cultured Marine Bivalves of Thailand is a field project, initiated in late 1985 and in which an attempt is made to age Thai commercial bivalves by means of daily shell increments, and to combine age and length-data such that optimal age and size at harvest and other information useful for management can be obtained.

Of the four upcoming projects of the Resource Assessment and Management Program, three have their emphasis on resources management and on the strengthening of research institutions involved with formulation of management options, while the fourth is stock assessment/training oriented. These projects are:

- The ASEAN-USAID Integrated Coastal Resources Management project, a major, long-term activity devoted to strengthening the capability of ASEAN (Association of Southeast Asian Nations) countries to exploit their renewable coastal resource systems (fish, invertebrates, mangroves, etc.) on a sustained basis.
- Management Options for Tropical Small-Scale Fisheries, a project, of which the key staff member will be a resource economist based at ICLARM who will identify and document the institutional arrangements that have resulted in successful management of small-scale fisheries in various parts of the world, assist cooperating agencies in planning and implementing appropriate management approaches, and further developing bioeconomic research methodologies.
- Assessment and Management of Small Pelagic Fisheries of the Philippines, the aim of which is to assist the Bureau of Fisheries and Aquatic Resources to formulate management options for the Philippine fisheries of scads, sardines, anchovies and mackerels, based on a thorough analysis of extant data.
- The "Compleat ELEFAN", which is a one-year project to produce well-tested, graphic-oriented versions of the ELEFAN stock assessment programs for use on widely available microcomputers (IBM PC, Apple II and their compatibles) and to prepare, publish and disseminate a comprehensive users' guide for these programs for research and teaching. This project represents ICLARM's first venture into the production of integrated microcomputer software.

These activities will contribute towards fulfilling the mandate of ICLARM's Resource Assessment and Management Program which is designed to: clarify management options for coastal resources; evaluate the likely impact

of alternative interventions on resource use, employment and equity; evaluate alternative institutional arrangements under which management might proceed; develop multidisciplinary research methodologies appropriate for providing the information needs of these management institutions; and offer training in the above areas to others.

## Progress of Work

The year 1985 was a year of both significant achievements and frustrating delays. Among the significant achievements, the ICLARM/KISR Conference on the Theory and Application of Length-Based Methods in Stock Assessment (held in February 1985 in Sicily) ranks first. It is expected that the proceedings of this conference, to be published by ICLARM in 1986 under the editorship of Dr. D. Pauly and Dr. G.R. Morgan (Kuwait Institute for Scientific Research), will have a major impact on fishery research throughout the world, and particularly in the tropics.

Expected impact is on fishery research planning because the feasibility of cost-effective, yet reliable stock assessments based predominantly on length data has been demonstrated, and on the research activity of individual researchers, because the detailed analysis of length-frequency data—whether available from previous sources, or newly collected—is an activity that can be pursued with even limited resources, yet can be performed up to any desired level of sophistication.

The delays experienced by the Program had four sources. First, ICLARM's uncertain funding situation throughout 1985 forced program staff to devote more time than anticipated to non-research activities, such as short-term consulting. Second, Dr. Munro was transferred from the Philippines to Australia in connection with the aquaculture program's International Giant Clam Project, which considerably affected the resource assessment and management program output. Third, Dr. Smith who had previously led ICLARM's Traditional Fisheries Program was promoted in early 1985 to Director General and his research output consequently much reduced. Finally, Dr. Pauly spent the second part of his six-month study leave at the University of Kiel, Germany, from April to July, thereby reducing his Manila-based activities. During his stay in Germany, Dr. Pauly lectured on tropical fish biology and fish population dynamics and wrote several contributions, notably a "Habilitationschrift", i.e., a postdoctoral "thesis", needed in Germany and some other European countries to have the right to supervise graduate students.

These factors delayed several projects, notably revised versions of the ELEFAN programs, the analysis of data from the Peru and Indonesian modules of the Management-Oriented Fisheries Research Project and continuation of in-house small-scale fisheries research. Much staff time during the year was spent on proposal preparation for the new projects listed above.

Nevertheless, the various presented papers and published contributions produced in 1985 (see below), the training activities and even the consultants' contracts have served to strengthen the role of the program activities among cooperating institutions and colleagues.

## Training

A series of workshops and lectures was held by Dr. J. Munro for participants of the ASEAN/Australian Institute of Marine Science/ADAB Coastal Areas Programme dealing with a systems approach to fish stock assessment and the use of the ELEFAN microcomputer programs for the analysis of length-frequency data.

Dr. Pauly's formal training activities in 1985 were numerous:

- Lectures in stock assessment at two institutions in Peru (February-March) (see advisory services)
- Weekly lectures on "Theory and practice of data analysis in fishery biology" and "Biology of tropical fishes" held at the Institute für Meereskunde, University of Kiel, Federal Republic of Germany (April-June)
- Regular lectures on fish population dynamics at the College of Fisheries, University of the Philippines (October-December) on behalf of the GTZ-funded Philippine-German Fishery Project
- Holding a four-day course on "Simple methods in stock assessment" in Sidi Fredj (Algeria) with the Algerian, French, Moroccan and Spanish participants of a Meeting of the General Council for the Fisheries of the Mediterranean (November)
- Supervision and guidance of M.S. and Ph.D. students at Kiel University and the University of the Philippines. One result of this training activity was a reanalysis of the data obtained in the ICLARM/CLSU integrated farming project (1979-1982) by Mr. Prein in the form of a thesis entitled "The influence of environmental factors on fish production in tropical ponds investigated with multiple regression and path analysis. Kiel University, 1985, 91 p."

Also, providing information to members of the Network of Tropical Fisheries Scientists, publishing the Network Newsletter *Fishbyte* and other informal educational activities consumed a considerable amount of program staff time.

## Advisory Services

Dr. Pauly performed a four-week consultancy for the GTZ-funded Programa de Cooperacion Peruano Aleman (PROCOPA) in Peru from 19 February to 14 March, to consult with staff of PROCOPA and the Instituto del Mar del Peru (IMARPE) on the progress of the Peruvian module of the Management-Oriented Fisheries Research Project (see p. 64). During his

stay in Peru, he also lectured on population dynamics at IMARPE and the University of Trujillo.

Advice was also provided to the staff of the Shrimp and Fish Management Project, Mariculture and Fisheries Department, Kuwait Institute for Scientific Research, which Dr. Pauly visited in April and December 1985.

In September-November, Ms. Emma Escover, Dr. Smith and Dr. Pauly assisted consultant Dr. P. Fox during field work in two provinces of the Philippines and in report preparation for a consultancy with Development Alternatives, Inc. (DAI) and the Ministry of Agriculture and Food to define the thrust and methodology of the fishery module of the USAID-funded "Rainfed" project, a major resources development and management project involving agriculture, forestry and coastal zone management in non-irrigated areas of the Philippines.

## Publications and Consultancy Reports


Fox, P., I.R. Smith, E.M. Escover and D. Pauly. 1985. Project plan for the fish stock assessment/pilot fishery management component of the rainfed resources development project. Consultancy Report for USAID and the Ministry of Agriculture and Food, Manila, 120 p. (mimeo)

Munro, J.L., J.D. Parrish and F.H. Talbot. 1985. The biological effects of intensive fishing upon coral reef communities. Chapter 3. *In* B. Salvat (ed.) Human activities causing damage to coral reefs. UNESCO/IUCN, Paris.

Munro, J.L. and J.J. Polovina. 1984. Artificial reef project, Thailand. Report of a consulting mission. 24 November-14 December 1984. Asian Development Bank. 98 p.

Munro, J.L. and I.R. Smith. 1985. Management strategies in multi-species complexes in artisanal fisheries. Proc. Gulf Caribb. Fish. Inst. 36: 127-141.

Pauly, D. 1985. A methodology for studying the recruitment into Kuwait's shrimp stocks, p. 32-44. *In* C.P. Mathews (ed.) Proceedings of the 1984 Shrimp and Fin Fisheries Management Workshops, Kuwait Institute for Scientific Research, Kuwait.

Pauly, D. 1985. Fisheries science: the view from Lowestoft. Reviews of three books by D.H. Cushing. J. Appl. Ichthyol. 1(2): 93-96.

Pauly, D. Report of a short term consultancy to PROCOPA/IMARPE (Callao, Peru), 14 February-19 March 1985. 19 p.

Pauly, D. 1985. The population dynamics of short-lived species, with emphasis on squids. NAFO Scientific Council Studies No. 9: 143-154.

Pauly, D. 1985. The ICLARM/KISR conference on the "Theory and Application of Length-Based Stock Assessment". Fishbyte 3(1): 5-12.

Pauly, D. 1985. Artisanal fishing and environmental conservation in Southeast Asian seas. Wallaceana (Kuala Lumpur) W41: 3-5.

Pauly, D. 1985. On improving operation and use of the ELEFAN programs. Part I: avoiding "drift" of K toward low values. Fishbyte 3(3): 13-14.

Pauly, D. 1985. Zur Fischereibiologie tropischer Nutztiere: eine Bestandsaufnahme von Konzepten und Methoden. (Habilitationschrift). Ber. Inst. f. Meereskunde an der Univ. Kiel. No. 147, 155 p.

Pauly, D. 1985. Consultant's report: Ecological Modelling and the Integration of Fishery Research by KISR/MFD. Report to the Kuwait Institute for Scientific Research/ Mariculture and Fisheries Department. ICLARM (mimeo), 11 p. + appendices.

Pauly, D. and J. Caddy. 1985. A modification of Bhatthacharya's method for the separation of normal distributions. FAO Fisheries Circular No. 781, 16 p. (+ Errata sheet)

Pauly, D. and G.R. Morgan. 1985. On using length-composition data in fishery research. Mar. Pol. 9(4): 245-246.

Pauly, D. and R.A. Neal. 1985. Shrimp *vs.* fish in Southeast Asian fisheries: the biological, technological and social problems, p. 487-510. *In* A. Yañez-Arrancibia (ed.) Recursos Pesqueros Potenciales de Mexico: la Pesca Acompañante del Camarón. Progr. Univ. de Alimentos, Inst. Cienc. del Mar. y Limnol., Inst. Nal de Pesca, UNAM, Mexico D.F. 748 p.

Smith, I.R. and D. Pauly. 1985. Book Review: D. Stevenson, R. Pollnac and P. Logan. A guide for the small-scale fishery administration from the harvest sector, Kingston, R.I. University of Rhode Island, Inter. Cent. Mar. Res. Dev., 1982. Mar. Res. Econ. 1(3): 313-319.

## Meetings Attended, Papers Presented

ICLARM/KISR Conference/Workshop on the Theory and Application of Length-Based Methods in Stock Assessment, Mazara del Vallo, Sicily, 10-15 February 1985. (D. Pauly, Technical Secretary)

Paper presented:

D. Pauly. A review of the ELEFAN system for analysis of length-frequency data in fish and aquatic invertebrates.

Advisory Committee on Marine Resources Research, FAO, Rome, May 1985.

Paper presented: *(in absentia)*

J.L. Munro. The Network of Tropical Fisheries Scientists: objectives and achievements.

Workshop on the Biology and Ecology of Snappers and Groupers, Honolulu Laboratory, Southwest Fisheries Center, National Marine Fisheries Service, Hawaii, USA, 20-22 May 1985. (J.L. Munro)

Paper presented:

J.L. Munro. Workshop synthesis and directions for future research.

American Fisheries Society, Honolulu Chapter, 23 May 1985. (J.L. Munro)

Guest lecture:

J.L. Munro. Management of coral reef fisheries.

Fifth International Coral Reef Congress, Papeete, Tahiti, French Polynesia, 25 May-2 June. (J.L. Munro)

Paper presented:

J.L. Munro and D. McB. Williams. Assessment and management of coral reef fisheries: biological, environmental and socio-economic aspects.

International Symposium on Age and Growth of Fishes—Present Trends and State-of-the-Art, Des Moines, USA, 9-11 June 1985. (D. Pauly, Keynote Speaker)

Paper presented:

D. Pauly. Applications to fishery management of information on the age and growth of fish (invited contribution).

4th Meeting of the General Council for the Fisheries of the Mediterranean (Western Division), Sidi Fredj, Algeria, 16-18 November 1985. (D. Pauly)

Paper presented:

D. Pauly. A brief review of the methods used by the participants of the GCFM workshop held in Sidi Fredj on simple analytic methods for stock assessment, 16-18 November 1985.

South Pacific Commission, Seventeenth Regional Technical Meeting on Fisheries, Noumea, New Caledonia, 5-9 August 1985. (J.L. Munro)

Course on the Fishery Potential of Mexico and the By-Catch of the Shrimp Fisheries, Universidad Nacional Autonoma de Mexico, and Secretaria de Pesca, Mexico, Mexico City, 12-16 August 1985. (D. Pauly)

Paper presented:

D. Pauly and R.A. Neal. Shrimp *vs.* fish in Southeast Asian fisheries: the biological, technological and social problems.

The Bibliometrics of the Third World's Contribution to Science, Philadelphia, USA, 10-14 July 1985. (D. Pauly)

Paper prepared for and distributed ahead of the meeting:

D. Pauly. Fishery science in tropical developing countries: some observation relevant to scientometry.

## Program Plans for 1986

The coming year will be a year of transition for the program. A number of projects or important components of projects are due to be completed during 1986, notably:

- All three modules (Indonesian, Zambian and Peruvian) of the Management-Oriented Fisheries Research Project with all related publications issued or in press. New modules will be identified in the course of 1986.
- The proceedings of the conference on the Theory and Application of Length-Based Methods in Stock Assessment will be published.
- New ELEFAN software will be made widely available, along with software for stock assessment using HP 41 calculators to be used with a manual jointly published by FAO and ICLARM.

On the other hand, a number of important new projects spanning several years will start in 1986, which will address broad social, economic and institutional issues. These are:

- The ASEAN-USAID Integrated Coastal Resources Management Project, a major four-year project involving four of the six ASEAN countries (Indonesia, the Philippines, Singapore and Thailand), in a number of site-specific research activities and information and training links with Malaysia and Brunei. The project will be coordinated by new staff members based at ICLARM headquarters.
- Management Options for Tropical Small-Scale Fisheries, a two-year project funded by the Ford Foundation to identify strategies for improving the incomes and livelihood of small-scale fishermen, predominantly in South Asia, and to further develop bioeconomic research methodologies.

These two projects, for which new staff have been hired, deal with activities previously covered by ICLARM's Traditional Fisheries Program and illustrate the Center's increased emphasis on the social, economic and institutional aspects of fisheries and resources management and on development of more comprehensive interdisciplinary approaches to analysis. The projects further represent an extension into a broader geographic and resource context of experience gained in the previous San Miguel Bay (Philippines) Project, which provided a significant part of the background to the conceptualization of these two new projects.

A number of other potential projects, covering the gamut of stock assessment to management to training, were still under negotiation at the end of 1985. When implemented, these projects will considerably strengthen ICLARM's activities in these areas. They include a stock assessment and coastal zone management project in the Philippines as well as a training project in tropical stock assessment and fisheries management.

Other activities by program staff will involve participation at several international conferences on resources management in fluctuating environments and continued work on the program's two major areas of emphasis, namely the identification, further development and testing of appropriate interdisciplinary methodologies for use in assessing and managing tropical fisheries and coastal zone resources; and dissemination of such methodologies through informal and formal networks, information and training schemes.

A new Program Assistant will be hired in 1986 whose main task will be to assist the Program Director in operating the program, and also to streamline the operation of the Network of Tropical Fisheries Scientists.

Despite the financial and staffing shortages during 1985, the Program ended the year on a note of promise, with several new professional staff members—Dr. Chua Thia-Eng, Mr. Random DuBois and Dr. Max Aguero—to be joining ICLARM in early 1986.

**Resource Assessment and Management**
**Project Summaries**

*Active*



*Upcoming*

*Project Title* : Tropical Fish Stock Assessment Project

*Cooperating Institutions* : Predominantly in-house studies, with informal linkages with various research institutions

*Duration* : Continuous from July 1979

*Key Personnel* ICLARM : Dr. Daniel Pauly
Dr. John L. Munro
Ms. Ma. Lourdes Palomares

*Objectives*

- To increase our understanding of 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.

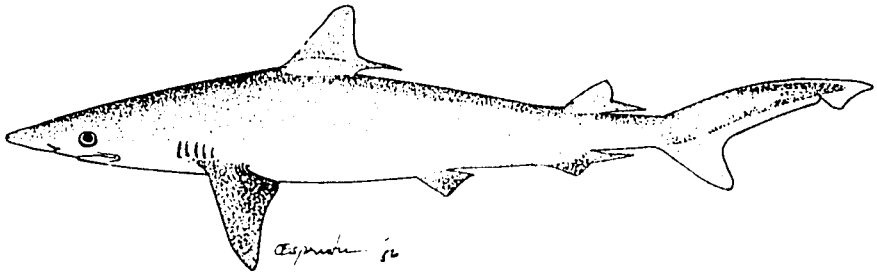
*Results*

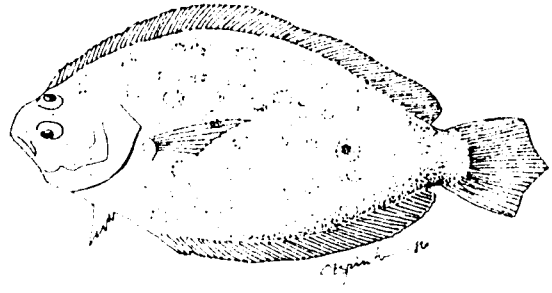
The international ICLARM/KISR Conference on the Theory and Application of Length-Based Methods in Stock Assessment, held in Mazara del Vallo, Italy, in February 1985, was a resounding success. The proceedings, to be published in 1986, will contribute to bringing approaches and methods developed in this project, notably the ELEFAN programs, into the mainstream of fishery science. This now allows for a refocusing of ICLARM's research effort away from methods for the analysis of length-frequency data towards other methods for studying and managing tropical multispecies stocks and fisheries.

A new method for estimating food consumption of natural fish populations based on laboratory and field growth data was developed. Its first application allowed the estimation of penaeid shrimp consumption by Kuwait fishes. It was found that the weight of shrimp consumed by fish was three times that of the fishery catches.

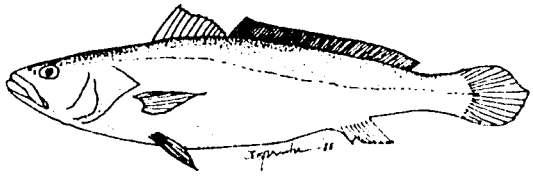
Another area of increased emphasis is the use of multivariate methods derived from fish population dynamics studies for the analysis of aquaculture experiments.

The list of contributions published in 1985 by program staff (see p. 54) further documents the research activities of the project.





Some of Kuwait's shrimp-eating fish. *Top:* requiem sharks (*Carcharinus* spp.), 14.5% of their diet is shrimp. *Right:* large-toothed flounder *(Pseudorhombus arsius)*, 23.8%. *Bottom:* the croaker *(Otolithes argenteus)*, 20.2%.



*Project Title* : Network of Tropical Fisheries Scientists

*Cooperating Institutions* : Fisheries Resources and Environment Division, Fisheries Department, FAO; FAO/DANIDA Training Course on Fish Stock Assessment in the Tropics

*Duration* : Continuous from April 1982

*Key Personnel* ICLARM : Dr. J.L. Munro (Fishbyte editor)
Dr. D. Pauly (other Network affairs)
Ms. F. Santos (Network Secretary)

*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.

*Results*

Network membership has grown to a total of 520 individuals from 80 different countries. The members receive at no cost to them issues of the Network newsletter "Fishbyte", of which eight issues have been distributed from its inception to December 1985. Use of the services offered by the Network, notably distribution of reprints and of FAO material, has grown considerably, attesting to the real need for the Network. However, its funding continued to be insufficient, and in the fall of 1985, it became necessary to inform the Network membership that the planned third issue of Fishbyte would not be produced, and other services discontinued, unless a special grant could be secured to fund these activities. As a result of this

appeal, FAO increased its 1985 contribution and will double its 1986 support of the Network. This, together with ICLARM contributions, will allow the Network to continue to provide its much appreciated services.

The table below gives details on five fishery scientists who spent training periods at ICLARM from mid-1984 to December 1985. A block grant to support the Visiting Scientist scheme could not be secured in 1985, and arrangements had to be made individually. It is hoped that this situation will change in the coming year.

Reports resulting from the project in 1985 are:

- G. Cardenas and J. Mendo. 1985. Preliminary length-based growth parameter estimates of Peruvian sardine *(Sardinops sagax sagax)*, Fishbyte 3(3): 10-11.
- Ng Fong-Oon. 1985. Length-frequency data based analysis on the growth and mortality of the Malaysian cockle (*Anadara granosa* L.) in five commercial culture plots. Report to the Bay of Bengal Programme, Madras, India, on a training stage at the International Center for Living Aquatic Resources Management, Manila, 1-25 October 1985.

Network members who spent training periods at ICLARM from mid-1984[a] to December 1985.

| Name | Main area of interest | Duration of stay at ICLARM | Originating institution | Funding agency |
|---|---|---|---|---|
| *Jacques Moreau | Length-based stock assessment methodology | July 1984 | Ecole Nationale Superieure Agronomique Toulouse, France | French Ministry of Foreign Affairs |
| M. Afzal | Management of a freshwater reservoir | 1 1/2 mos.– 18-Feb.-Mar. 1985 | Department of Fisheries, Pakistan Agricultural Research Council | German Agency for International Development (DSE) |
| Moshen Al-Hosseini | Stock assessment of penaeid shrimps | 2 weeks– 16-30 Mar. | Kuwait Institute for Scientific Research | Kuwait Institute for Scientific Research |
| Jaime Mendo | Population dynamics of pelagic fishes of the Peru upwelling system | 6 weeks– 15 Sept.-25 Oct. 1985 | Instituto del Mar del Peru, Callao, Peru | German Agency for Technical Cooperation (GTZ) |
| Ng Fong-Oon | Yield-per-recruit studies of cockle, *Anadara granosa* | 3 weeks– 1-25 Oct. 1985 | Fisheries Research Institute, Glugor, Penang, Malaysia | Bay of Bengal Programme; FAO/SIDA |

[a]The corresponding list in the 1984 Annual Report stopped in midyear.

Both of these reports result from application of improved graphics-oriented versions of the ELEFAN programs (see also p. 73) to size-frequency data. The former report confirmed previous estimates obtained by various authors working on otoliths of sardines sampled off Chile, Peru and Ecuador. The latter report showed, rather unequivocally that the present minimum legal harvest size for the cockle *Anadara granosa* in Malaysia is largely in excess of the size maximizing economic returns.

*Project Title* : Management-Oriented Fisheries Research Project

*Cooperating Institutions* : Marine Fisheries Research Institute (BPPL), Jakarta, Indonesia; Instituto del Mar del Peru (IMARPE); Programa Cooperativo Peruano-Aleman de Investigacion Pesquera (PROCOPA); Department of Fisheries, Zambia; Skaggs Foundation (Indonesian module)

*Duration* : Continuous from April 1982

*Key Personnel*
BPPL : Mr. A. Dwiponggo
IMARPE : Ms. I. Tsukayama
PROCOPA : Mr. Jaime Mendo
Zambia : Dr. S.P. Subramaniam and Mr. R. Matipa
ICLARM : Drs. Daniel Pauly and J.L. Munro

*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 in 1985.

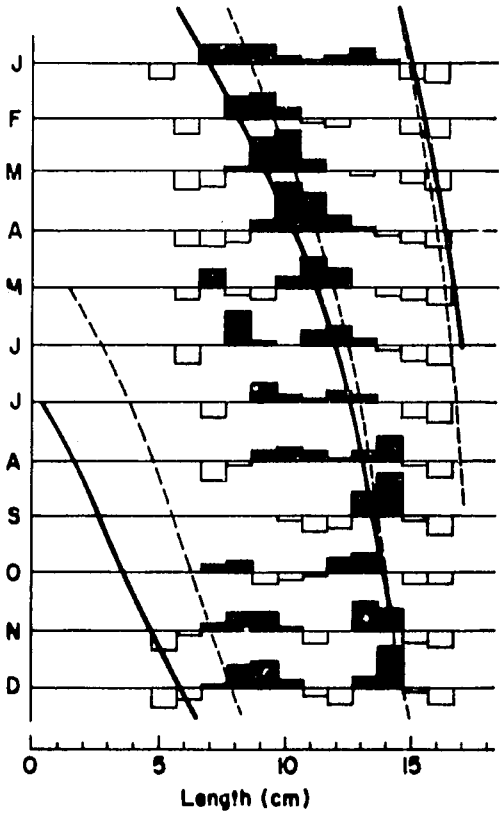
## Indonesian module

The TRS 80 (Model III) microcomputer and EPSON MX80 printer supplied by ICLARM to the Project were donated to BPPL in 1985. The finalization of the project's major output, an "Atlas of the growth, mortality and recruitment of Indonesian commercial fish and invertebrates" was considerably delayed by the absence of Dr. D. Pauly from Manila in the first half of 1985. The report will be published in 1986.

## Peruvian module

The acquisition, standardization and documentation of time-series data on the Peruvian ecosystem for the years 1953 to 1982 has continued through 1985. Dr. Pauly visited the project site from 19 February to 14 March 1985 and identified several additional IMARPE staff interested in contributing to the project. By December 1985, the following chapters were available for a planned book on the Peruvian anchoveta and its ecosystem (all cover the years 1953 to 1982 by month):

- numbers of fish-eating birds off Peru, by species;
- anchoveta consumption by fish-eating birds, based on a mathematical model taking account of prey density, water temperature and metabolic requirements and numbers of predators;
- numbers and anchoveta consumption of two species of seals, based on a mathematical model and metabolic requirements of the seal population, and field counts of their numbers;
- biomass and anchoveta consumption by the Peruvian "bonito", *(Sarda chiliensis)* based on previous food and feeding studies by Peruvian authors and a thorough study of the available data on the population dynamics of this species;




ELEFAN analysis of converted length-frequency data on Peruvian anchovy over one year showing the effect of correcting data for the impact of gear selection (broken line: uncorrected data).

- temperature, upwelling, turbulence and other oceanographic variables;
- corrections for unaccounted catches, based on interviews of former deckhands, captains, reduction plant operators and other persons formerly involved in the Peruvian anchoveta fishery.

A number of other contributions will be completed in the first half of 1986. They include virtual population estimates of anchoveta biomass, anchoveta egg production and standing stock, as well as detailed time-series analysis of certain variables.

An important early finding of the project is that much more high-quality, historic time-series information is available on the Peruvian ecosystem, at IMARPE, other Peruvian institutions, and in databases outside Peru, than was previously anticipated. It was decided that this project should access and include these important data, even if this should lead to delays in the preparation of the book in which all time series and analyses will be presented. Completion of the project is expected near the end of 1986, after a visit to IMARPE by Dr. Pauly during which the contributions will be reviewed by the Peruvian project participants.

## Zambian module

This module, equipped by ICLARM with a TRS 80 Model IV microcomputer, printer, software suite and two programmable calculators has been operational since July 1984. The first phase came to an end on 30 June 1985 and by mutual agreement was extended to the end of 1986.

Possession of the microcomputer has enabled the Department of Fisheries of Zambia to make estimates of fish production and fish catch rates from the artisanal fisheries of Lakes Bangweulu and Mweru-Luapula and from the Lusiwashi, Kafue and Upper and Lower Zambezi Rivers. Additionally catch rates for the artisanal and industrial fisheries of Lakes Tanganyika and Kariba have been analyzed. Length cohort analyses have been done for 1984 data sets for *Lates microlepis, L. stappersi, L. mariae, L. angustifrons, Limnothrissa miodon* and *Stolothrissa tanganicae* from Lake Tanganyika. Length-frequency analyses for *L. miodon* from Lake Kariba for 1982-1983 were also completed.

The programmable HP 47 calculators proved particularly useful when used in conjunction with Dr. Pauly's stock assessment manual and permitted a wide variety of assessment work to be undertaken.

*Project Title* : Growth Studies on Cultured Marine Bivalves of Thailand

*Cooperating Institutions* : Chulalongkorn University, Department of Marine Science

*Duration* : December 1985-May 1987

*Key Personnel* Thailand : To be identified
ICLARM : Mr. J.M. Vakily, Dr. D. Pauly

*Objectives*

- To develop and apply to as many important species as possible, methods for the age determination and growth parameter estimation of Thai bivalves, inclusive of methods based on daily shell rings.
- To train Thai marine scientists in microcomputer-based stock assessment methods, particularly for the analysis of size-frequency data.
- To analyze extant length-frequency data on Thai bivalves using the ELEFAN programs, and to derive management options for the stocks investigated.

*Results*

A microcomputer and appropriate software have been purchased and Mr. Vakily began his assignment at Chulalongkorn University in December 1985.

Spawning *Anadara granosa* females. Photo by Wong Tat-Meng.

*Project Title* : ASEAN Integrated Coastal Resources Management Project

*Cooperating Institutions* : Brunei—to be named. Indonesia—National Institute of Oceanology; Ministry for Population Affairs and Environment; Agency for Agricultural Research and Development (AARD); Ministry of Forestry; National Development Planning Agency. Malaysia—to be named. Philippines—Marine Science Institute, University of the Philippines; College of Fisheries, University of the Philippines in the Visayas; College of Fisheries, Don Mariano Marcos Memorial State University; Philippine Council for Agriculture and Resources Research and Development; National Science and Technology Authority. Singapore—Science Council of Singapore; National University of Singapore; Primary Production Department. Thailand—National Environment Board; Royal Forestry Department; Phuket Marine Biological Center; Thailand Tourism Authority; Kasetsart University; Chulalongkorn University; Department of Fisheries; Land Development Department; National Institute of Coastal Aquaculture

*Duration* : 4 years, beginning January 1986

*Key Personnel*

ASEAN countries : To be named

ICLARM : Dr. Chua Thia-Eng and Mr. Random DuBois

*Objectives*

The primary goal of the project is to strengthen the capability of ASEAN countries to develop their renewable coastal resources on a sustainable basis. This will help the long-term productivity of coastal fisheries, forestry and other renewable resources through coordinated, carefully planned coastal

resources management strategies. The immediate objective of the project is to help develop improved technical and institutional approaches for managing living coastal resource systems in the ASEAN countries. This purpose will be achieved by:

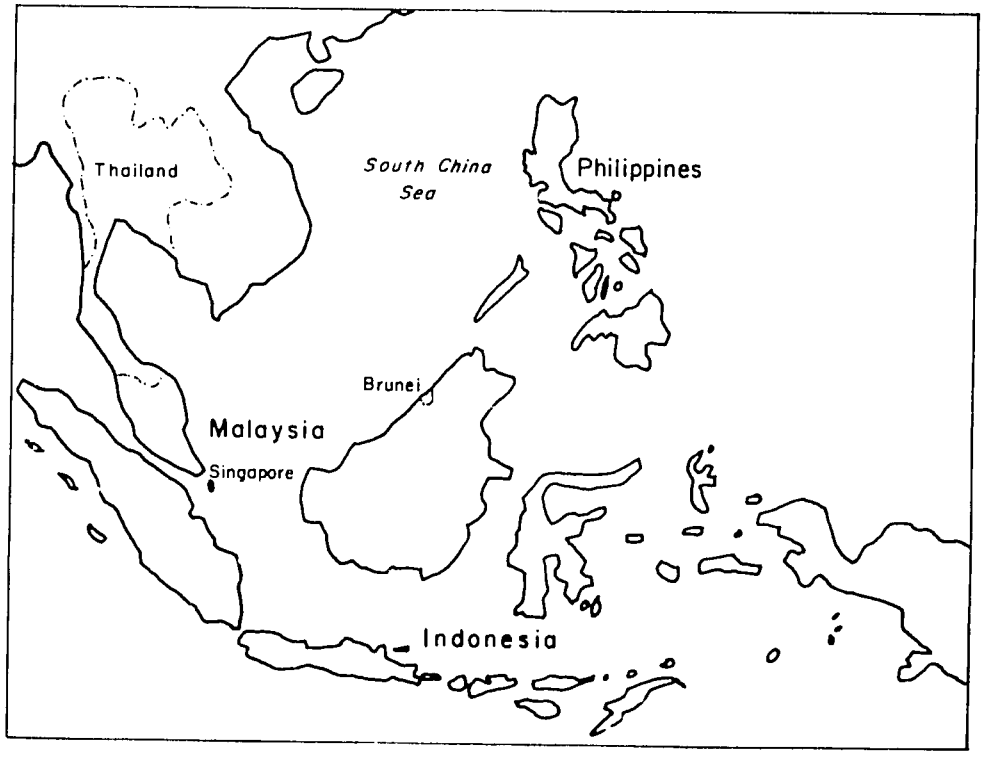
- Analyzing, documenting and disseminating information on trends in living coastal resources exploitation.
- Focusing attention on the importance of better resource management policies and identifying the critical information and manpower required to bring about improvements in management for sustainable development.
- Developing institutional arrangements that link applied environmental and socioeconomic research to coastal resources assessment, planning and management.
- Encouraging technical and institutional solutions to resource use conflicts and the loss of coastal development opportunities.

The project is expected to produce the following results over four years:

- Increased awareness among decisionmakers of trends in renewable coastal resources depletion and greater attention to the importance of sound coastal resources management policy.
- Improved assessments of the capacity of living coastal resource systems to sustain intensive, multiple-use forms of development.
- Cooperative research on topics relevant to renewable coastal resources management, such as improved techniques for predicting demands for resources, and the identification and resolution of sociopolitical/legal problems of managing common property resources.
- The derivation of management concepts and procedures for allocating and developing coastal areas for sustainable use, including the application of economic analyses to alternative forms of coastal resource use, and the development of site-specific coastal resources management plans.
- Strengthening the ASEAN regional information dissemination channels on renewable coastal resources management, to include the publication of a regional newsletter and special activities such as the preparation of a coastal resource atlas, and the conduct of public awareness and education activities.
- Strengthening the ASEAN manpower base in renewable coastal resources assessment, research, planning and management through the provision of short- and medium-term (masters level) training.

The main activities will include area-specific resource assessment and planning, initially in Indonesia, Singapore, the Philippines and Thailand. Cooperative research will also be conducted to close the information gap for the formulation of an integrated coastal resources management plan. Training courses and workshops will be organized to upgrade technical and management capabilities in the ASEAN nations. Information gathered through research and resource assessment activities will be disseminated through the newsletter and media to create public awareness on the importance of coastal resource management.

The project is funded by the United States Agency for International Development (USAID) and executed by ICLARM. The project operates under the overall direction of a Steering Committee, membership of which was appointed by the respective ASEAN governments.




The ASEAN countries: Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand.

*Project Title* : Management Options for Tropical Small-Scale Fisheries

*Cooperating Institutions* : Bay of Bengal Programme (Sweden, FAO), Madras, India; USAID missions in selected Asian countries; Ford Foundation; other institutions to be identified

*Duration* : 2 years, starting March 1986

*Key Personnel* ICLARM : Dr. Max Aguero

*Objectives*

- To further develop suitable interdisciplinary research methodologies for analysis of management options capable of integrating the various determinant elements of tropical small-scale fisheries.
- To further develop quantitative as well as qualitative tools for the analysis of tropical small-scale fisheries and identification of basic cause-effect relationships.
- To identify and document the various institutional types that have resulted in successful management of small-scale fisheries and related activities in the coastal zones of tropical developing countries.
- To analyze the factors that have led to such success.
- To generalize where possible from these results and activities to tropical small-scale fisheries as a whole, to other small-scale fisheries of other areas and to other open access renewable resources such as swamplands, forest and uplands.
- To develop and disseminate widely a research manual based on the above interdisciplinary methodologies.
- To develop a training curriculum and course in use of these methodologies.
- To sponsor an international workshop on "Tropical Small-Scale Fisheries Management Options: Interventions and Institutions" where the main results of this research will be presented and discussed.

*Project Title* : Assessment and Management of Small Pelagic Stocks of the Philippines

*Cooperating Institutions* : Bureau of Fisheries and Aquatic Resources (BFAR), Manila; World Bank (Washington)

*Duration* : 18 months, starting early 1986

*Key Personnel* : To be named
ICLARM : Dr. Daniel Pauly

*Objectives*

- To collate, analyze and publish available information on gears, regional distribution of catch and catch-per-effort, size-frequency data and economic information on the fisheries for small pelagic fishes in the Philippines (scads, mackerels, sardines, anchovies).
- To formulate management options for these fisheries, with particular emphasis on options that would result in increased involvement of regional BFAR offices and fisheries groups.

*Project Title* : The Compleat ELEFAN

*Cooperating Institutions* : Philippine-German Fisheries Project [College of Fisheries, University of the Philippines in the Visayas, and German-Agency for Technical Cooperation (GTZ)]

*Duration* : January-December 1986

*Key Personnel* GTZ : Dr. J. Saeger
Mr. F. Gayanilo, Jr.
ICLARM : Dr. D. Pauly
Ms. Mina L. Soriano

*Objectives*

- To revise and expand all extant ELEFAN microcomputer programs, based on the recommendations of the participants of the ICLARM/KISR Conference on "The Theory and Application of Length-Based Methods in Stock Assessment" (Mazara del Vallo, Sicily, Italy, February 1985), and to incorporate the graphic routines facilitating their use.
- To implement the revised ELEFAN programs for use on IBM PC microcomputers and other systems (notably Apple II) if time allows.
- To prepare, print and distribute a detailed user's manual for both research and training.

## EDUCATION AND TRAINING

### Introduction

Education and training activities are important components in all ICLARM programs. They are listed in the program activities of all ICLARM annual reports. All ICLARM staff are involved and all recognize that training is a major personal responsibility and a major ICLARM responsibility. For financial reasons, ICLARM has not been able to staff the education and training program to consolidate and expand on the individual efforts of the professional staff. However, ICLARM continues to make a significant contribution to the training of fisheries and aquaculture scientists in the application of the results of its research programs and coordinates one major social science network which is now part of ICLARM's Education and Training Program.

## EDUCATION AND TRAINING ACTIVITIES OF INDIVIDUAL ICLARM STAFF: A SUMMARY

### Resource Assessment and Management Program

Dr. John Munro gave a series of workshops and lectures in Australia, dealing with a systems approach to fish stock assessment and the use of the ELEFAN microcomputer programs for the analysis of length-frequency data for participants of the ASEAN/Australian Institute of Marine Science/ADAB Coastal Areas Programme.

Dr. Daniel Pauly lectured on "The theory and practice of data analysis in fishery biology", and "The biology of tropical fishes" at the University of Kiel, Federal Republic of West Germany, and taught a regular course on "Fish population dynamics" at the College of Fisheries, University of the Philippines. At both universities he advised and supervised graduate students. Dr. Pauly gave a four-day course in Algeria on "Simple methods in stock assessment" for participants of a meeting of the General Council for the Fisheries of the Mediterranean and lectured on stock assessment at the Instituto del Mar del Peru and the University of Trujillo in Peru. Four interns

spent between two and six weeks at ICLARM during 1985, working on assessment of fish stocks in their countries—Kuwait, Malaysia, Pakistan and Peru (details are given on p. 62).

### Aquaculture Program

Dr. Roger Pullin lectured to the IDRC Fish Genetics Training Workshop in Singapore and to the Network of Aquaculture Centers in Asia (NACA) Training Course for Senior Aquaculturists in Asia and the Pacific Region at the NACA Regional Lead Centre, Iloilo, Philippines.

Mr. Jan Michael Vakily gave a training course in microcomputer techniques for bivalve age, growth and population analysis to personnel of the Department of Fisheries, Thailand.

Dr. John Colman continued to serve as a faculty member of the Asian Institute of Technology in Bangkok. During 1985 he supervised two graduate students and taught, with Dr. Kok Leong Wee, a course on "Analytical aquaculture techniques."

### Information Program

Miss Helen Chow, Assistant Librarian, University of the South Pacific, Fiji, was attached to the ICLARM library for training during September 1985 and in December 1985 an Office Practicum of 120 hours for six Secretarial Students of the Pamantasan ng Lungsod ng Maynila began. The Library staff also provided lecture-demonstrations of the capabilities and operation of online information retrieval systems for ten graduate students of the Institute of Library Science, University of the Philippines and the University of the East.

## ASIAN FISHERIES SOCIAL SCIENCE RESEARCH NETWORK

With the reorganization of ICLARM's research programs during 1985, the Asian Fisheries Social Science Research Network, which was initiated by ICLARM in 1983 and is coordinated and administered by ICLARM staff member Dr. Brian Lockwood, is now reported as a project of the Education and Training Program. (In the ICLARM Reports of 1983 and 1984 the Network was listed as a project of the Traditional Fisheries Program; the latter has now become part of the Resource Assessment and Management Program.) The Network receives financial support from IDRC and the Ford Foundation.

## Objectives

The Network aims to build national research capacity to address important social science issues in the development and management of the fishery resources of Southeast Asian countries. The Network assists participating countries attain this general objective in the following ways:

- By encouraging the development of national centers which specialize in training social scientists for research on problems of fishery development and management.
- By supporting the professional growth of a small number of social scientists in these centers through research grants, training opportunities and awards, and professional development activities.
- By developing and improving fisheries and aquacultural economics curricula for the training of social scientists who will work on Southeast Asian fisheries.
- By encouraging and supporting multidisciplinary research on fishery sector problems.
- By supporting graduate and undergraduate research within the national centers.
- By encouraging and strengthening professional linkages between teaching, research, development, and management in the fishery sectors.
- By developing and testing various methods of data collection and analysis to improve research on tropical multispecies, multigear fisheries and tropical aquaculture.
- By assisting in the presentation of research results to research clients and users.
- By facilitating cross-disciplinary, cross-institutional, cross-national professional exchanges through appropriate conferences, workshops and meetings.
- By encouraging the development of a professional association of Southeast Asian fisheries social scientists.

## Completion of Phase 1 (April 1983 to March 1985)

During its first development phase, April 1983 to March 1985, the Network consisted of three Southeast Asian universities:

1) Faculty of Resource Economics and Agribusiness
   Universiti Pertanian Malaysia (UPM)
   Serdang, Selangor, Malaysia;
2) College of Arts and Sciences
   University of the Philippines in the Visayas (UPV)
   Iloilo City, Philippines; and
3) Faculty of Economics and Business Management
   Kasetsart University (KU)
   Bangkok, Thailand.

In addition, the Network provided staff training awards in 1983 and 1984 to the Faculty of Economics, Diponegoro University (UNDIP), Semarang, Indonesia, to help it prepare for Network membership in 1985.

During its first phase the Network concentrated on three important research capacity building activities: (1) the formal academic training of research staff, (2) the development and funding of fisheries-related socio-economic research by teams of researchers at UPM, UPV and KU, and (3) the development of academic teaching programs and course curricula in fisheries management economics and aquacultural economics at UPM, UPV and KU.

The following mimeograph Research Reports based on phase 1 projects were released during 1985:

a. AFSSRN Team, Faculty of Resource Economics & Agribusiness, Universiti Pertanian Malaysia
   1) *Fish Marketing in Peninsular Malaysia* by Mond. Ariff Hussein, Fatimah Mohd. Arshad, Nik Mustapha Raja Abdullah, Tai Shzee Yew, K. Kuperan, Abu Hassan Md. Isa, and E.T. Gibbons (October 1985)
   2) *A Bivariate Time Series Analysis of Wholesale Fish Price and Quantity* by Mohd. Ariff Hussein and Sam Strong (published in Malaysian Journal of Agricultural Economics, Vol. 1, No. 1, December 1984)
   3) *Some Aspects of the Short Run Prospects for Malaysia's Fish Exports* by Nik Mustapha Raja Abdullah and Roslan Abd. Ghaffar, presented at the conference of Malaysian Agricultural Economics Association (PETA), Kuala Lumpur (14-15 May 1985)
   4) *Some Socioeconomic Determinants of Fish Consumption in a Multiracial Society* by Nik Mustapha Raja Abdullah and Roslan Abd. Ghaffar (October 1985)
   5) *Factors Affecting the Success of Freshwater Fishfarming in the Segamat District* by Mohd. Ghazali Mohayidin and Gan Kim Lan (June 1985)

b. AFSSRN Team, Faculty of Economics and Business Administration, Kasetsart University
   1) *Marketing System of Shellfish Products* by Ruangrai Tokrisna, Somkit Tugsinavisuitti, Sanit Kao-ian and Piti Kantangkul
   2) *Marketing System of Fresh Cephalopod in Thailand* by Ruangrai Tokrisna, Somkit Tugsinavisuitti, Marut Muangkoe and Sanit Kao-ian
   3) *Economics of Giant African Snail, Short Necked Clam, Green Mussel, and Cockle Processing in Thailand* by Sarun Wattanutchariya, Banlu Puthigorn and Wunwiboon Garnjanagoonchorn

c. AFSSRN Team, College of Arts and Sciences, University of the Philippines in the Visayas.
   1) *Fish Consumption in Iloilo: a consumer profile and behavior study* by Benjamin C. Posadas, Ebonia B. Seraspe and Nida R. Ty
   2) *Selected Psychological Characteristics of Fishing Communities* by Nuria B. Catells and Cynthia Ticao
   3) *Socioeconomics of Marketing Practice of Small-Scale Fisheries* by Ma. Luisa E. Mabunay and Antonina Baldevia

d. M.Sc. (Resource Economics) theses in Fisheries Economics, Universiti Pertanian Malaysia submitted by AFSSRN Fellows:
   1) *An Economic Analysis of the Milkfish Marketing System in Semarang Regency, Central Java, Indonesia* by Mudiantono (Diponegoro University)
   2) *An Economic Analysis of the Export Market for Thai Squid* by Ratana Sungsitthisawad (Kasetsart University)
   3) *Effects of Fishery Regulations on the Trawler Industry: a case study of trash fish production in Thailand* by Penporn Janekarnkij (Kasetsart University)

## The AFSSRN Phase 2 (April 1985 to March 1988)

In April 1985 the AFSSRN entered its second phase with grants from IDRC, the Ford Foundation and ICLARM totalling approximately $740,000 for the three years to March 1988. With this increased level of funding the Network was able to expand to eight member institutions, to continue funding research and to develop a program of workshops and short-term training courses to support the research and teaching activities of its member institutions. The five new member institutions are:

| | | |
|---|---|---|
| Indonesia | : | Faculty of Economics<br>Diponegoro University (UNDP)<br>Semarang, Indonesia |
| | | Center for Agro Economic Research (CAER)<br>Bogor, Indonesia |
| Thailand | : | Fisheries Economics Section<br>Department of Fisheries (DOF)<br>Ministry of Agriculture and Cooperatives<br>Bangkok, Thailand |
| Philippines | : | Aquaculture Department<br>Southeast Asian Fisheries Development Center (SEAFDEC)<br>Iloilo, Philippines |
| | | Center for Policy and Development Studies<br>University of the Philippines at Los Baños (UPLB)<br>College, Laguna, Philippines |

## Network Development, Coordination and Administration

While the Network is formally an association of institutions it is also, within each member institution, a voluntary association or team of individuals with professional interest in the socioeconomic aspects of fisheries and aquaculture. Each team has an elected leader who shoulders the responsibility of coordinating the program of research and other professional development activities within the framework of the Network. Each Team Leader

receives a small annual grant from the Network to defray the costs associated with this responsibility.

In April 1985 the Team Leaders and the Network Coordinator met for the first time as a Committee at the ICLARM headquarters in Manila. Discussions ranged over a broad spectrum of Network related matters including the future role and responsibilities of the Committee itself. One of the most important responsibilities the Committee agreed to assume was that of reviewing all research proposals submitted for Network funding and to

AFSSRN Team Leaders and friends at the first Team Leaders Committee Meeting, April 1985, ICLARM, Manila. *Left to right:* Ian Smith (Director General, ICLARM), Wilfrido Cruz (CPDS-UPLB), Brian Lockwood (AFSSRN Coordinator), Ma. Luisa Mabunay (UPV), Christopher MacCormac (IDRC), Ruangrai Tokrisna (KU), Wiratno (UNDIP), Pongpat Boonchuwong (FES-DOF Thailand), Nik Mustapha Raja Abdullah (UPM), Elwood Pye (IDRC) and Danilo Israel (AQD-SEAFDEC).

give formal approval to those considered appropriate and adequate for Network support. The Committee met for a second time in June at the IDRC Regional Office in Singapore where its main task was to review the first batch of seventeen research proposals received from Network Teams for AFSSRN grants. Ten were approved as submitted and seven were returned for revision. The Committee has set up a "second review" procedure for revised proposals. The ten approved projects are shown in Table 1.

## The UPM Postgraduate Degree and Module Programs

In 1983, the Faculty of Resource Economics and Agribusiness, Universiti Pertanian Malaysia (UPM), introduced the first postgraduate training program in fisheries and aquacultural economics in Asia. It requires candidates to take the core courses of the M.Sc. (Resource Economics), three special courses in fisheries and aquacultural economics, and undertake thesis research on a fisheries/aquacultural economics problem. On completion of the program the candidate is awarded the degree of Master of Science (Resource Economics).

Table 1. Approved AFSSRN projects.

| Institution | Project | Project Leader(s) | Duration (months) | Budget ($) |
|---|---|---|---|---|
| KU | An economic analysis of cockle *(Anadara granosa)* culture in Thailand: selected areas | Dr. Ruangrai Tokrisna | 12 | 8,000 |
| KU | An economic evaluation of sea bass *(Lates calcarifer)* culture in selected coastal areas of Thailand | Dr. Marut Muangkoe | 12 | 7,800 |
| KU | An economic analysis of green mussel culture systems in Thailand | Mr. Sanit Kao-ian | 12 | 7,300 |
| KU | An economic analysis of various cultural practices of oyster (*Crassostrea* sp.) farming in Thailand | Mr. Somkit Tugsinavisuitti | 12 | 7,500 |
| UNDIP | Economics of aquaculture: the case of shrimp cultivation in Central Java Province, Indonesia | Drs. Mudiantono<br>Ir. Yohanes Hutabarat | 8 | 6,000 |
| UNDIP | Analysis of catfish production and marketing in Central Java Province, Indonesia | Drs. Basuki Suwardo<br>Ir. Subiyanto | 6 | 6,000 |
| UPLB | An assessment of the credit and financial programs for the fishing sector, Philippines | Dr. Generoso G. Octavio | 6 | 5,400 |
| AQD | Comparative economic analysis of different prawn *(Penaeus monodon)* nursery production systems in the Philippines | Mr. Danilo Israel | 9 | 2,300 |
| AQD | Economics of prawn *(P. monodon)* hatchery and integrated hatchery-floating nursery operations in the Philippines: comparative analysis | Mr. Danilo Israel | 8 | 2,300 |
| DOF | Cost and returns analysis of demersal and pelagic fishing gears | Mr. Pongpat | 10 | 8,500 |

In addition, the Faculty offers the three special courses, plus an optional course in economics or fisheries science as a one-semester non-degree module for economists or fisheries scientists who require such training. The teaching is in English and non-Malaysian students are eligible for admission.

With these professional training programs UPM has become the core training institution for the Network and each affiliated university, including UPM itself, has enrolled staff and/or future staff members in one or other of the two programs.

## Workshops and Training

### a) *Aquacultural economics research methods*

The Faculty of Economics and Business Management, Kasetsart University, hosted and organized the first Network research methods workshop at the Ambassador Hotel, Bangkok, 6-10 May 1985. This workshop brought together researchers from each Team that planned to carry out projects of research in the general field of the socioeconomics of aquaculture. The following special papers were prepared for the workshop:

Christopher MacCormac, IDRC, Aquaculture economics research for Southeast Asia: needs, status, development priorities and implementation

Sarun Wattanutchariya, KU, Aquacultural production economics

Theodore Panayotou, KU, Social welfare economics of aquaculture

Ruangrai Tokrisna, KU, Marketing research: with special reference to aquaculture

Michael M. Vakily, ICLARM, Bioeconomics of aquaculture: how economists and biologists can work together. The need for multidisciplinary research in aquatic resources management

Pairoj Brohmanonda, Department of Fisheries, Thailand, Information needs for effective aquacultural planning

K. Kuperan, UPM, Production under risk

The Workshop compiled advisory panels of members with special expertise in various aspects of aquacultural economics research to assist project leaders where problems in research design, analysis and interpretation are experienced. A followup workshop on the same general subject matter is planned for 1987 after the completion of a number of aquaculture research projects.

### b. *Aquaculture production course for social scientists*

A five-week practical course for social scientists on aquaculture production was organized for the AFSSRN by the Aquaculture Department of SEAFDEC at its Tigbauan, Iloilo, Philippines, research station in November and December 1985. Participants came from the Network Teams and graduate students at UPM, KU, DOF Thailand and UNDIP. This course will be repeated in 1986.

**Workshops and Training Courses Planned for 1986**

a. Training Course of Microcomputer Applications to Fisheries Social Science Research, 13 January to 7 February, Center for Policy and Development Studies, University of the Philippines at Los Baños, Philippines.
b. Workshop on Southeast Asian Training Programs in Fisheries and Aquacultural Economics, 12-16 March, Diponegoro University, Semarang, Indonesia.
c. Aquaculture Production Course for Social Scientists, November-December, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines.

## INFORMATION PROGRAM

### Background

Over the eight years of its existence, ICLARM's Information Service has increased the scope of its activities from an in-house service to the Center's scientists to a specialized service for fisheries researchers in developing countries. The resulting wide interaction with other information-oriented organizations and the numerous requests for research information have enabled ICLARM to form a comprehensive picture of tropical fisheries information.

Equally importantly, ICLARM learned something of the deficiencies of the present information database. Missing are various basic parameters of the developing-country literature and its users. For instance, how many fisheries scientists are there in these countries? How much literature does each produce on average and who makes use of it? These and a number of other questions need to be addressed if meaningful information activities in developing countries are to be formulated in the future.

Against this background, ICLARM's Information Service was upgraded at the Center's Board of Trustees meeting in June 1985 to become a research and information program.

Within the Information Program a broad spectrum of research activities is planned to provide a full understanding of developing-country fisheries information. Most of the activities will be bibliometric, summarizing the "raw" data available in computer databases and other sources. Later, analyses of the summaries and their implications will be made. Such analyses may lead to recommendations for a variety of different activities such as preparation of textbooks, curricula development and new information services.

### Progress of Work

#### *Research*

The funding crisis in which ICLARM was still enmeshed at the end of 1985 prevented the implementation of any research plans. One major project to investigate the characteristics of Asian fisheries literature was submitted

to a donor late in 1985. This research would be carried out on behalf of the Asian Fisheries Society and would use the *curricula vitae* submitted by applicants to the Society as its primary data. Two minor in-house studies have begun: an investigation of the reading behavior of users of the ICLARM library, and citation analysis of ICLARM's publications. The former will provide an indication of which journals are read (and which are not read) as well as how carefully they are read. The citation analysis will let us know who has been making use of ICLARM publications and research results published in various journals.

*Publications*

ICLARM produced 16 items in its technical series in 1985. A major publication was "Philippine tilapia economics" edited by Drs. I.R. Smith, E.B. Torres and E.O. Tan, which contains the full proceedings of a workshop held on 10-13 August 1983 at Los Baños, Laguna, Philippines. Another major production was a "A hatchery manual for the common, Chinese and Indian major carps," which was the result of a joint consultancy for the Asian Development Bank by Dr. V.G. Jhingran of India and ICLARM's Dr. Roger Pullin to carp hatcheries in six Asian countries; the discussions and papers from an ADB Regional Workshop on Carp Hatchery and Nursery Technology held in Manila, February 1984; and the experiences of the authors in different aspects of carp culture.

A new series, the *ICLARM Newsbriefs,* was started in November 1985. It is an occasional, informal news medium for staff, colleagues and donors interested in the Center's activities. Circulation is about 300 copies.

*Distribution.* In 1985, ICLARM appointed another distributor for its publications, Verlag Josef Margraf, Eichendorffstrasse 9, 8074 Gaimersheim, Federal Republic of Germany.

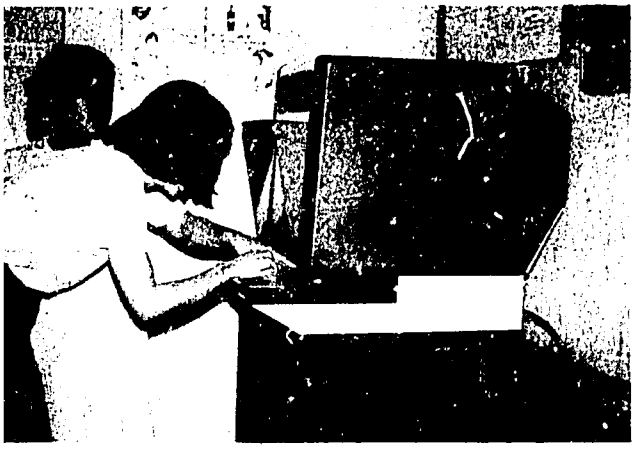
From sales, library exchange and free issue, the total number of books in ICLARM's five technical series distributed since the first publication early in 1980 is over 55,000.

Distribution of quarterly ICLARM Newsletters from the first issue in July 1978 now exceeds 100,000. Present distribution is 3,600 of each issue.

*Exhibitions.* ICLARM books have been exhibited at the following displays: Philippine Federation of Aquaculturists Convention, 18-19 April 1985; Hunan Books and Learning Aids Expo '85, Changsha, China, 10-24 May 1985; International Book Festival, Philippines, 2-16 June 1985; Third Zimbabwe International Book Fair and Exhibition, 30 July-3 August 1985; Frankfurt Book Fair, Germany, 9-14 October 1985.

*Library*

The library now holds over 6,000 books and monographs related to tropical aquaculture and fisheries. The number of different serials received



Assistant Librarian Erlinda Gonzalez and library user at the microfiche reader/printer.

increased slightly in 1985 to 592 titles. A microfiche reader/printer is now available; about 50 microfiche documents have been collected to date.

The number of external users of the library during 1985 was over 1,200. Growth in library use is a continuing phenomenon.

The library also received an IBM XT personal computer towards the end of the year and the long-awaited computerization of holdings is beginning. Previously a terminal was acquired for library use but appropriate software was not available.

*Contribution Series*

ICLARM's contribution series is a record of all articles by ICLARM staff and commissioned external authors. The number of articles published or in press as of December 1985 was 275. The full list is provided on p. 105. Many of these contributions are available free.

*Selective Fisheries Information Service*

The Selective Fisheries Information Service is primarily a question/answer service to researchers in tropical developing countries who are working in subject areas in which ICLARM has special expertise—finfish and mollusc aquaculture, integrated farming, small-scale fisheries and resource management.

This free Service is funded by the International Development Research Centre (IDRC) of Canada. IDRC has agreed to extend the project from its initial two years to three years, ending March 1987. This funding has provided for extra staff to run the Service as well as a microfiche reader/printer and IBM XT microcomputer for library use.

Response to the Service, first advertised in the April 1984 Newsletter, has been good. The number of enquiries during the first year to March 1985 was 170. Another 204 were received up to the end of 1985.

The Service is able to respond to trends in enquiries through preparation and publication of bibliographies and even commissioned reviews on important subjects (see p. 88). Many computer-generated bibliographies have been produced for individual requests.

The response of users is almost universally enthusiastic according to returned postcard questionnaires.

Records are kept of the various enquiries, such that ICLARM can identify trends and important research areas. By far the most required subject is tilapia, while integrated farming and socioeconomic aspects are clearly becoming important topics.

*Asian Fisheries Society*

ICLARM's assistance to the young Asian Fisheries Society continued during 1985. Dr. Richard Neal, former ICLARM Director General, was the Society's Secretary until he left the Center in March 1985. Jay Maclean, Information Director, was appointed to this post at the Society's second council meeting in September 1985.

The major activity of the Society is the First Asian Fisheries Forum in May 1986. Planning for this meeting and the publication of the proceedings is a time-consuming task.

## Meetings, Courses Attended, Papers Presented

The SAFIS Seminar on Fisheries Extension Literature, Bangkok, Thailand, 5-8 February 1985. (J.L. Maclean)

Seminar on Indonesian Fisheries Information System (INFIS), Cisarua, Bogor, Indonesia, 23-26 April 1985. (R.M. Temprosa)

Paper presented:

R.M. Temprosa. ICLARM's Selective Fisheries Information Service.

Conference on Planning and Implementing a National Scientific and Technological Information Policy, Manila, Philippines, 2-9 April 1985. (J.L. Maclean)

Paper presented:

J.L. Maclean. International issues and the Philippines national science and technology information policy.

VIIth World Congress of International Association of Agricultural Librarians and Documentalists (IAALD), Ottawa, Canada, 2-6 June 1985. (R.M. Temprosa)

Third International Conference on Toxic Dinoflagellates, New Brunswick, Canada, 8-12 June 1985. (J.L. Maclean)

Paper presented:

J.L. Maclean and A.W. White. Toxic dinoflagellate blooms in Asia: a growing concern.

Training Attachment at the Marine Biological Association of the United Kingdom, Plymouth, England, 17 June-12 July 1985. (R.M. Temprosa)

Workshop of IDRC-Supported Fisheries Information Projects in Southeast Asia, Singapore, 28-30 August 1985. (N.I. Jhocson and J.L. Maclean)

Second Council Meeting of the Asian Fisheries Society, Tungkang, Taiwan, 24-26 September 1985. (J.L. Maclean)

Aquatic Sciences and Fisheries Information System (ASFIS) Training Workshop, SEAFDEC, Tigbauan, Iloilo, Philippines, 30 September-11 October 1985. (N.I. Jhocson)

11th Annual Conference of the International Association of Marine Science Libraries and Information Centers (IAMSLIC), Williamsburg and Gloucester Point, Virginia, USA, 14-18 October 1985. (R.M. Temprosa)
Paper presented:
R.M. Temprosa. Development of a library-based tropical fisheries information system: the ICLARM experience.

Workshop on Marine Information Management at Regional and National Levels, Washington, D.C., USA, 21 October-1 November 1985. (R.M. Temprosa)

Seminar-Workshop on the Use of Computers in Information Storage and Retrieval in Libraries, University of the Philippines at Los Baños, College, Laguna, 20-22 November 1985. (E.B. Gonzalez)

Manila Life Sciences Editorial Workshop, ICLARM, Manila, Philippines, 8 October 1985. (J.L. Maclean, L.B. Dizon, M.S. Sadorra)

## Program Plans for 1986

It is expected that the information research program will continue to evolve over the next 12 months as results of the early projects point to new directions.

The Selective Fisheries Information Service will continue to March 1987. It is expected that additional bibliographies and reviews on subjects of importance will be commissioned and published.

The library will expand over the next few years as ICLARM becomes more involved in information research and broader coastal zone issues, such as the ASEAN-USAID Integrated Coastal Resources Management Project (see p. 68). New reference works and new journals will be required to support the research in these areas.

ICLARM's indicative publication schedule for 1986 and beyond will strain the existing staff and equipment to the limit. It is planned to upgrade the Center's word processing and typesetting equipment to ease the burden on both typing and editing staff.

| | | |
|---|---|---|
| *Project Title* | : | Selective Fisheries Information Service |
| *Cooperating Institution* | : | International Development Research Centre (IDRC), Canada |
| *Duration* | : | 3 years beginning March 1984 |
| *Key Personnel* ICLARM | : | Mr. Jay L. Maclean<br>Mrs. Rosalinda M. Temprosa<br>Mrs. Norma I. Thocson |

*Major Objective*

To extend the capabilities of the existing ICLARM Information Program to users in tropical developing countries.

*Specific Objectives*

- To assist in an advisory capacity in strengthening the information capability of fisheries institutions in developing countries.
- To provide answers to specific questions to researchers working in subject areas in which ICLARM has special expertise—finfish and mollusc aquaculture, integrated farming, small-scale fisheries and resource management.
- To produce bibliographies and reviews on important topics as identified by trends in enquiries.

*Results*

The Selective Fisheries Information Service (SFIS) was first announced in the April 1984 ICLARM Newsletter. Since then, the service has been promoted through a regional press release, publications in newspapers and international newsletters, personal contacts and brief "talks" in local and foreign conferences/meetings. In addition, a brochure was produced to facilitate publicity.

SFIS is enhanced by the expertise of the Center's scientific staff, the full resources of the library and use of online searching of bibliographic databases. To enable the service to increase its productivity two additional staff, Miss Marie Sol Sadorra, editorial assistant and Mrs. Erlinda Gonzalez, assistant librarian were hired.

During the period April 1984 to December 1985, the number of enquiries totalled 374 as shown in Fig. 1.

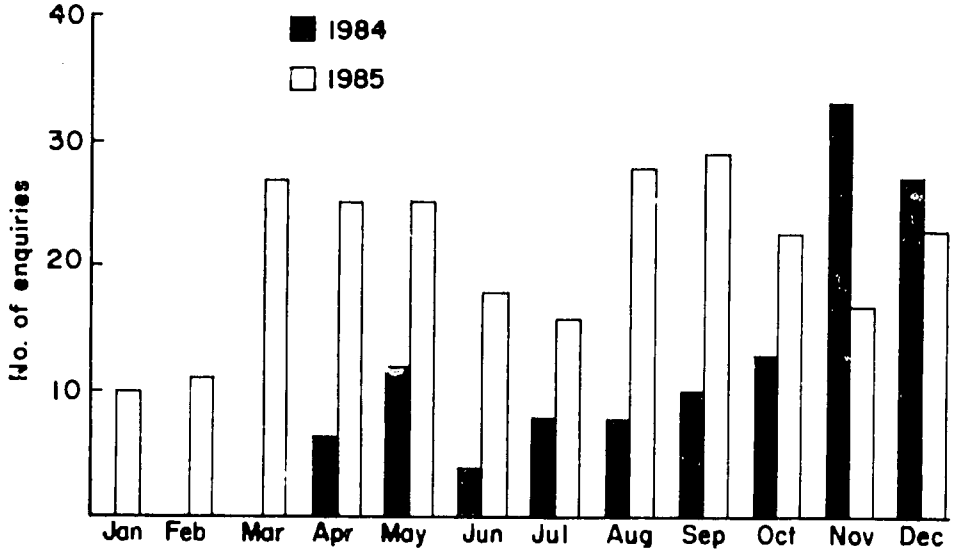



Fig. 1.

An average of 18 enquiries is received each month. From ICLARM's point of view the response has been ideal. The number of requests handled is still manageable.

Fig. 2 shows the geographical pattern of enquiries received. Most of the requests come from all parts of Asia, with the biggest number from Southeast Asia.

A detailed record of each enquiry is kept as a means of identifying trends to define subject matter for bibliographies, reviews, directories and important research areas. Tilapia is the most requested subject of enquiry while integrated farming and socioeconomic aspects are distant second and third topics, respectively, in order of numbers of requests.

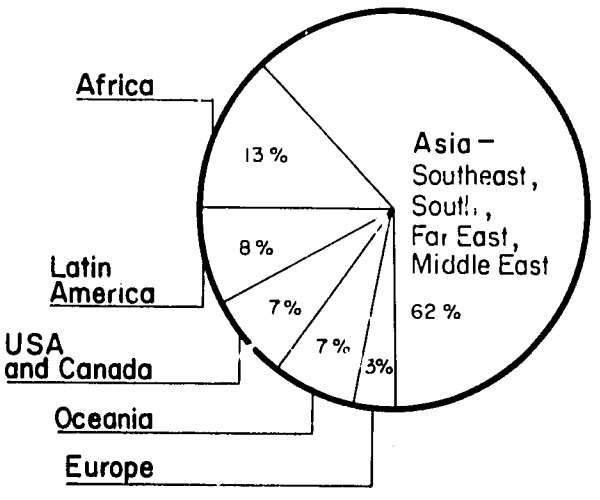



Fig. 2.

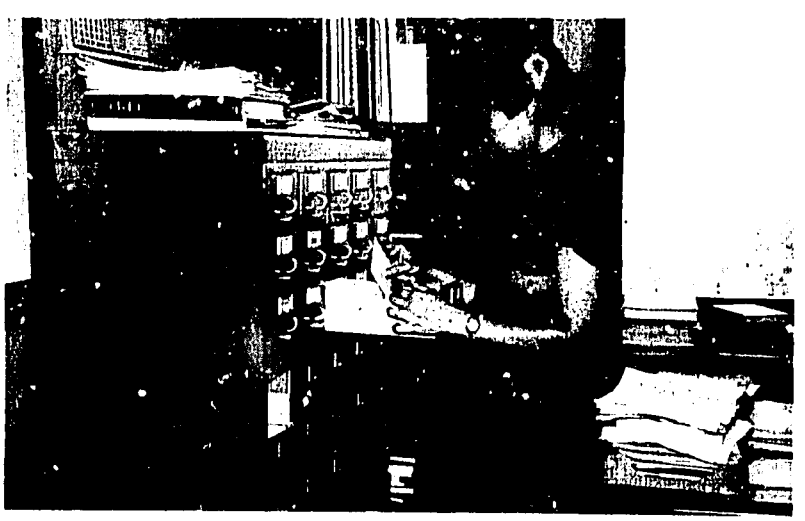
Each requester is sent a questionnaire postcard along with the information package to obtain feedback as to the usefulness of the service and its products. Of the 374 forms sent, 96 or 25.7% have been returned so far. In the opinion of the majority of the respondents, the quality of the information was "very useful," the quantity was "most of what was needed," and the information either "improved the project quality," or "led to new research ideas/projects." Most of the respondents indicated that the information helped them locate or communicate with other researchers in their field. In general, the responses were very encouraging. Nevertheless, there were a few negative responses, such as information was "inadequate." Others complained about the extreme vagaries of the postal system.

Assistance in information use and handling has been provided through attendance and papers presented at various workshops in Indonesia, Malaysia, the Philippines, Singapore, Thailand and the USA. Short-term training in fisheries librarianship, online searching and non-technical library activities were also conducted to various groups from the Philippines and visiting groups from overseas.

Cooperative information activities have been established or strengthened with different institutions like the Agricultural Information Bank for Asia and the University of the Philippines, Institute of Library Science.

In addition to answering specific requests, a current awareness service is offered. In July 1984, at the request of IDRC, the Information Department section of the ICLARM Newsletter was expanded in subject scope to cover the full fisheries spectrum. An Acquisitions List of all newly received materials in the ICLARM library is also widely distributed as part of the project.

To carry out the functions of the project efficiently, ICLARM's database in its subject areas has been strengthened through the acquisition of library materials and equipment. Back issues of relevant journals and some titles not currently received have been acquired; a microfiche reader/printer has been installed; and an IBM-PC XT computer has been recently acquired.



Librarian Ms. Norma Jhocson checking ICLARM library holdings for Selective Information Service enquiry.

The need to automate bibliographic handling procedures and retrieval had become self-evident to enable the Service to respond faster and more completely to SFIS requests for current information.

The following publications have resulted from the project:

Boonyubol, M. and S. Pramokchutima. 1982. Trawl fisheries in the Gulf of Thailand. ICLARM Translations 4, 12 p. Thirapan Bhukaswan, translator. 1984.

Broom, M.J. 1985. The biology and culture of marine bivalve molluscs of the genus *Anadara*. ICLARM Studies and Reviews 12, 37 p.

Brouard, F., R. Grandperrin, M. Kulbicki and J. Rivaton. 1984. Note on observations of daily rings on otoliths of deepwater snappers. ICLARM Translations 3, 8 p.

Dioury, F. 1985. Insights on the developmental aspect and future importance of artisanal fisheries. ICLARM Newsl. 8(3): 1-17. Translated from French by Ramona O. Buencamino.

Jhocson, N.I. and I.R. Smith, compilers. 1985. Bibliography on socio-cultural, economic and institutional aspects of tropical aquaculture and small-scale fisheries, p. 105-125. *In* R.N. Roy (ed.) Consultation on social feasibility of coastal aquaculture, Madras, India, 26 November-1 December 1984. Fishery Development Series No. 16; BOBP/MIS/2. 125 p. National Swedish Board of Fisheries, Sweden and the Bay of Bengal Programme, FAO, Madras, India.

Schoenen, P. 1984. A bibliography of important tilapias (Pisces: Cichlidae) for aquaculture. *Oreochromis macrochir, O. aureus, O. hornorum, O. mossambicus, O. niloticus, Sarotherodon galilaeus, Tilapia rendalli* and *T. zillii*. ICLARM Bibliographies 3, Supplement 1, 191 p.

Schoenen, P. 1985. A bibliography of important tilapias (Pisces: Cichlidae) for aquaculture. *Oreochromis variabilis, O. andersonii, O. esculentus, O. leucostictus, O. mortimeri, O. spilurus niger, Sarotherodon melanotheron* and *Tilapia sparmanii*. ICLARM Bibliographies 6, 99 p.

Tookwinas, S. 1985. Commercial cockle farming in southern Thailand. ICLARM Translations 7, 13 p. Translated from Thai and edited by Edward W. McCoy.

*Training Conducted*

Training Attachment of Miss Helen Chow, Assistant Librarian, University of the South Pacific, Suva, Fiji, 11-23 September 1985.

Lecture-Demonstration of the Capabilities and Actual Operation of an Online Information Retrieval System for Graduate Students of the Institute of Library Science, University of the Philippines and the University of the East, 30 October 1985. (10 graduate students)

Office Practicum for Secretarial Students of the Pamantasan ng Lungsod ng Maynila for a total of 120 hours starting 1 December 1985. (6 student trainees)

## SOUTH PACIFIC OFFICE

ICLARM's South Pacific Office commenced in October 1985 with the endorsement by the Board of Trustees of Dr. John Munro as Director, South Pacific. Dr. Munro had been based at James Cook University of North Queensland (JCUNQ), Australia, since mid-1984 to facilitate his work in the International Giant Clam Mariculture Project. At that time Dr. Munro was also Director of the Resource Assessment and Management Program. His new posting has freed him from the duties of the latter post but he continued to be involved in aspects of ICLARM's stock assessment work during 1985, especially as Editor of *Fishbyte*.

For the Resource Assessment and Management Program, Dr. Munro prepared papers for and attended the Fifth International Coral Reef Congress in Tahiti; managed the affairs of the Network of Tropical Fisheries Scientists for most of the year and gave a series of lectures in Townsville on stock assessment. Details are given on p. 53, 55 and 61.

The majority of Dr. Munro's time in 1985 was spent on activities related to the International Giant Clam Mariculture Project, in preparation of proposals for funding support, in attending project-related meetings, negotiations for development of a clam hatchery in the Solomon Islands, and analysis of growth data on giant clams. A survey of giant clam stocks in Kiribati was undertaken and discussion papers prepared for future research activities. Details are given on p. 46.

Apart from these activities, the South Pacific Office will enable ICLARM to plan and coordinate cooperative research projects with the South Pacific Forum member states more efficiently. The development of a Coastal Aquaculture Center is one example. Support from various agencies has been provided to establish a long-term regional aquaculture facility in the Solomon Islands. The clam hatchery will be one module of this facility.

The present address of ICLARM's South Pacific Office is:

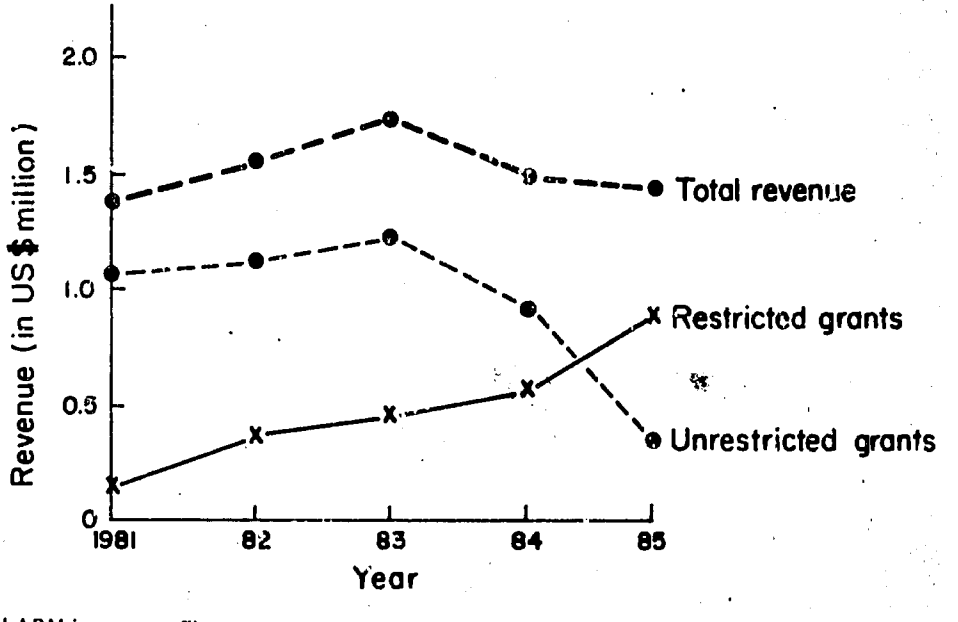
P.O. Box 1531
Townsville, Queensland 4810
Australia
Tel. : (077) 814-122
Telex : Attn: J. Munro
AA 47009 BIOLSCI

## ADMINISTRATION AND FINANCE

In past ICLARM Reports, data on administrative activities were not published. This year, given the changing circumstances of the Center, seemed a particularly appropriate time to begin recording such activities.

In 1985, ICLARM's revenue profile changed significantly. As the Rockefeller Foundation shifted its program focus away from Asia and concluded its core support for ICLARM at the end of 1984, the annual level of unrestricted grants to the Center declined by 57%. For the first time in ICLARM's history, the level of restricted or project-specific grants in 1985 exceeded that of unrestricted grants. Total revenue, however, remained the same at close to US$1.4 million.

The substantial reduction in unrestricted support, which includes funding for headquarters scientific and information staff and facilities, forced ICLARM to contract its research program activities. The 1985 financial strategy adopted by ICLARM was to conserve whatever resources were available in order to keep key headquarter staff positions filled for as long as possible. Thus, ICLARM cancelled or indefinitely deferred several in-house projects, publications and other program activities for which restricted




ICLARM income profile.

funding could not be found and from which staff time had to be diverted. A significant portion of staff time was channeled, by necessity, into income-generating consultancies, the preparation of project proposals and involvement in funded projects.

Severe cost-cutting measures were also implemented. In August, ICLARM headquarters moved to realize savings from lower rental rates. Aside from implementing additional controls on expenses for utilities, supplies and communications, major purchases and capital investments were deferred. In addition, all salary adjustments were deferred not only for promotion and merit but also for increases to compensate for the rise in cost of living indices. The final outcome of these steps was total 1985 core expenditures of US$726,416 versus an original 1985 core budget of US$1.06 million.

## Personnel

There were two major changes in senior staff at ICLARM Headquarters during 1985. ICLARM Director General Richard A. Neal resigned in March 1985 and in June, Ian R. Smith was named by the Board to succeed him. Previous Administrative Director Mr. Angelito O. del Mundo left ICLARM in August 1985 and the position was filled by Mr. Basilio M. Rodriguez, Jr. as ICLARM's new Manager, Administration and Finance.

The credit for ICLARM's survival through 1985 should be given to all members of the ICLARM staff—both support and professional. At the height of 1985's uncertainty, retrenchments seemed inevitable. Despite the uncertain tenure of many staff positions and the continuing erosion of incomes of peso-paid staff due to increasing domestic inflation in the Philippines, all staff members continued their high level of performance. This performance was coupled with an amazing display of confidence and a continued willingness to assume additional responsibilities, to share in the total burden of work and, in the process, to work longer hours. It was with some relief that ICLARM welcomed the end of the year with most staff positions still intact.

## Board of Trustees

The annual meeting of ICLARM's Board of Trustees was held in Manila on 3, 6 and 7 June 1985. The Board decided to hold its meeting much earlier in the year than it had done in the past in order to discuss ICLARM's future at a time of considerable financial uncertainty.

Among the measures undertaken by the Board to conserve funds was the abolition of the Program Advisory Committee (PAC), on the condition that it be reconstituted when funding permitted. During the subsequent meeting of the Executive Committee in late October, the PAC was reconstituted for 1986 in a different form. Instead of having a formal committee, the Executive Committee agreed to form a Program Advisory Panel, on an ad

hoc basis, to give ICLARM advice regarding program development. The members of this panel, as determined by the Director General and Program Leaders, would be assembled from time to time on the basis of fields of expertise and at the most cost-effective locations.

In 1985, ICLARM's Board of Trustees also announced the retirements of former Board Chairman, Dr. James E. Johnston of the Rockefeller Foundation and Minister Manuel S. Alba of the Philippines, both of whom served as trustees since ICLARM was established in 1977. Khun Prida Karnasut (Thailand) also retired from the Board this year. The Board regretted the retirements of Dr. Johnston, Minister Alba and Khun Prida, but it was nevertheless very pleased to announce the following new trustees:

- Ms. Hannah R. King from The Gambia and currently Fisheries Adviser, Commonwealth Secretariat, London, UK
- Dr. Keishi Amano, Professor Emeritus, Tokyo University of Fisheries, Japan
- Dr. Gunnar Saetersdal, former Director, Institute of Marine Research, Bergen, Norway.

At its 1985 annual meeting, Mr. Roy Jackson was re-elected Chairman of the Board for another year.

## Plans for 1986

Among the plans expected to be implemented in 1986 are the following:

(1) *Computerization of the ICLARM Accounting and Financial Reporting System:* With the help of a programmer-consultant, Administration staff have begun working on a computerized system which, when implemented in June or July 1986, will result in significant time savings and benefit ICLARM in the form of timely and relevant reports, improved cash management techniques, and the ability to administer additional and more complex projects without the need for additional staff.

(2) *Accounting Policies:* ICLARM will also amend its accounting policies on revenue recognition and recording of liabilities in order for financial reports to present a better picture of ICLARM's finances.

(3) *Budget.* Budget procedures to be implemented in 1986 will be designed to make the ICLARM budget more accurately reflect the true costs of implementing its research program activities and present a more comprehensive picture of ICLARM's operations.

(4) *Personnel and Salary Administration:* In 1986, ICLARM will implement more effective performance evaluation procedures which should help in providing staff members with a clearer idea of what is expected from them. ICLARM is also reviewing its merit review procedures in order to develop a system that would be more responsive as far as rewarding staff for good performance is concerned.

## 1985 SOURCES OF SUPPORT

### 1. Unrestricted Support

The United States Agency for International Development (USAID) and the Australian Development Assistance Bureau (ADAB) provided, in 1985, about half of the unrestricted program support needed by ICLARM to pursue its research program activities.

### 2. Restricted Support

| Activity | Sources of 1985 Support |
|---|---|
| a. Giant Clam Project | Australian Development Assistance Bureau (ADAB)<br>New Zealand |
| b. Asian Fisheries Social Science Research Network | Ford Foundation<br>International Development Research Centre (IDRC) of Canada |
| c. Management Options for Small-Scale Fisheries | Ford Foundation |
| d. Applied Research on Coastal Aquaculture Project, Phase 3 | German Agency for Technical Cooperation (GTZ) |
| e. KISR Tilapia Project | Kuwait Institute for Scientific Research |
| f. International Conference on Detrital Systems for Aquaculture, Bellagio, Italy | German Agency for Technical Cooperation (GTZ) |

| | |
|---|---|
| g. Selective Fisheries Information Service | International Development Researc Centre (IDRC) of Canada |
| h. Tilapia Genetics/Economics (Philippines) | International Development Researcl Centre (IDRC) of Canada |
| i. ICLARM Fund-Raising Program | The Rockefeller Foundation |
| j. Assistance for Research Exploitation and Utilization of Aquatic Resources | San Miguel Corporation |
| k. Publication on the Economics of Tilapia Production in the Philippines | Planters Products, Inc. |
| l. Network of Tropical Fisheries Scientists | Food and Agriculture Organizatior (FAO)/Danish International Development Agency (DANIDA) |

# STATEMENT OF REVENUES AND EXPENSES
# (US $)[1]

| | 1985 | 1984 |
|---|---|---|
| **REVENUE** | | |
| Grants: – 1. Unrestricted | | |
| United States Agency for International Development (USAID) | 300,000 | – |
| Australian Development Assistance Bureau (ADAB) | 46,350 | 83,257 |
| Planters Products Inc. | 1,047 | – |
| San Miguel Corporation | 1,047 | – |
| Rockefeller Foundation | – | 720,000 |
| | 348,444 | 803,257 |
| 2. Restricted | | |
| German Agency for Technical Cooperation (GTZ) | 292,366 | 191,588 |
| International Development Research Centre (IDRC) | 225,906 | 200,754 |
| Ford Foundation | 165,138 | – |
| Australian Development Assistance Bureau | 53,397 | – |
| Rockefeller Foundation | 50,000 | 50,000 |
| Kuwait Institute for Scientific Research | 30,883 | 67,721 |
| New Zealand Embassy | 12,582 | – |
| Skaggs Foundation | – | 7,500 |
| San Miguel Corporation | – | 714 |
| | 830,272 | 518,277 |
| | 1,178,716 | 1,321,534 |
| Miscellaneous (Consultancies, Overheads, Publication Sales) | 141,135 | 149,020 |
| | 1,319,851 | 1,470,554 |
| **EXPENSES** | | |
| Programs, research and development: | | |
| Aquaculture | 519,127 | 567,866 |
| Traditional Fisheries | 253,957 | 239,408 |
| Resource Development and Management | 175,577 | 207,842 |
| Program Development | 10,412 | 16,611 |
| Advisory Committee | 614 | 1,478 |
| | 959,687 | 1,033,205 |
| Administrative | 309,617 | 339,300 |
| Information Services | 210,122 | 197,264 |
| Depreciation | 29,310 | 36,316 |
| | 1,508,736 | 1,606,085 |
| Excess (deficiency) of revenues over expenses | (188,885) | (135,531) |
| FUND BALANCE, BEGINNING OF YEAR[2] | 557,266 | 692,797 |
| FUND BALANCE, END OF YEAR | 368,381 | 557,266 |

[1] As audited by Sycip, Gorres & Velayo & Co.

[2] The term "FUND BALANCE" as used in this statement refers to ICLARM's net worth or remaining balance after deducting total year-end liabilities from year-end assets. Year-end liabilities would include accrued expenses, payables and ICLARM's commitments on projects for which funding was received in advance. Total assets include cash, depreciated property and equipment and advances to projects. Previous years' presentations used the term "FUND BALANCE" less accurately to refer to cash balances only.

## ICLARM STAFF

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Richard A. Neal, Ph.D.
(resigned March 1985)

Ian R. Smith, Ph.D.
(appointed June 1985)

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AQUACULTURE PROGRAM

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|---|---|
| Roger S.V. Pullin, Ph.D. | Director, Aquaculture Program |
| James C-M. Kuo, Ph.D. | Senior Scientist[1, 10] |
| Kevin D. Hopkins, Ph.D. | Senior Research Fellow[2, 10] |
| Edward D. McCoy, Ph.D. | Team Leader and Economist, Thailand Project[2] |
| John L. Munro, Ph.D. | Director, South Pacific[3] |
| John A. Colman, Ph.D. | Postdoctoral Fellow[2, 10] |
| Jan Michael Vakily, M.Sc. | Associate Scientist[4] |
| Ms. Emma Escover, B.S. | Junior Research Fellow[2] |
| Mr. Orestes Salon, B.S. | Research Assistant[2] |
| Ms. Josephine Capili, B.S. | Research Assistant[5] |
| Ms. Felicidad Estrada, B.S. | Secretary, Aquaculture Program |

RESOURCE ASSESSMENT AND MANAGEMENT PROGRAM

| | |
|---|---|
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| Ms. Ma. Lourdes Palomares, B.S. | Research Assistant[5] |
| Ms. Ferdinandina Santos, B.S. | Network Secretary, Network of Tropical Fisheries Scientists[2] |
| Ms. Nenita Jimenez, B.S. | Secretary, Resource Assessment and Management Program |
| Ms. Erlinda Miralles, B.S. | Secretary, Resource Development and Management Program[1] |

## Education and Training Program

| | |
|---|---|
| Brian A. Lockwood, Ph.D. | Economist, Coordinator, Asian Fisheries Social Science Research Network[5] |

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| Ms. Marie Sol Sadorra, B.S. | Editorial Assistant[5] |
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| Mr. Ovidio Espiritu, Jr., B.S. | Draftsman |
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| Ms. Leni-Lou Estudillo, B.S. | Secretary, Information Program |

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| Basilio M. Rodriguez, Jr., M.B.A. | Manager, Administration and Finance[7] |
| Ms. Marieta Veneracion | Administrative Assistant[8] |
| Ms. Remedios Apostol, B.S. | Chief Accountant |
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| Ms. Ma. Concesa Calderon, B.S. | Receptionist[5] |
| Mr. Benjamin Bayron | Driver |
| Mr. Edwin Sebastian | Driver[3] |

## Affiliate Scientist

| | |
|---|---|
| Wade O. Watanabe, Ph.D. | Aquaculture |

[1] Resigned
[2] Fixed-term appointment ended
[3] Effective October 1985
[4] Effective December 1985
[5] Fixed-term appointment
[6] Effective June 1985
[7] Commenced 15 August 1985
[8] Effective 16 July 1985
[9] Effective 27 November 1985
[10] Now ICLARM Affiliate Scientist

# ICLARM Staff

R.A. Neal

I.R. Smith

B.A. Lockwood

E. Escover

D. Pauly

R.S.V. Pullin

A.O. del Mundo

J. Capili

B.M. Rodriguez, Jr.

Information staff *(seated left to right):* L. Estudillo; J.L. Maclean, Director, Information Program; L. Dizon. *(Standing left to right):* P. Calalang; N. Jhocson; R. Temprosa; O. Espiritu, Jr.; E. Espiritu; E. Gonzalez; M.S. Sadorra; and R. Estarez.

Some of the staff at ICLARM's 8th anniversary celebration, March 1985. *Front row:* E. Sebastian, N. Urmeneta, M.S. Sadorra, M. Querubin, M. Veneracion, B. Bayron, R. Estarez. *Standing (first row):* H. de Castro, G. Calderon, N. Danetares, E. Ramos, J. Capili, E. Gonzalez, P. Calalang, A. Balane, N. Jhocson, R. Temprosa, A.O. del Mundo, E. Miralles, F. Santos, N. Jimenez, M.L. Palomares, L. Estudillo. *Back row:* Visitor, R. Damalerio, J.L. Maclean, O. Salon, visitor, D. Pauly, R.S.V. Pullin, E. Escover, F. Estrada and I.R. Smith (Director General).

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