FAO Aquaculture Newsletter

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Inland Water Resources and Aquaculture Service
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EDITORIAL

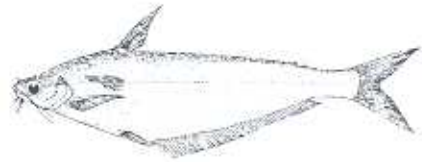
This is the first issue of the FAO Aquaculture Newsletter (FAN). Its antecedents are the FAO Aquaculture Bulletin, published from 1968 to 1977, and the "ADCP Aquaculture Minutes" (renamed "Aquaculture Minutes" for its last two issues), published from 1988 to 1990. Since 1977, the FAO Aquaculture Bulletin has been much mourned as a useful source of news, not only on FAO activities but also on aquaculture development generally. "ADCP Aquaculture Minutes" contained little news of FAO project activities but addressed general issues of relevance to decision makers. The "FAO Aquaculture Bulletin" was born in an era when there were few other newsletters and even fewer scientific journals or commercial magazines concentrating on aquaculture. Commercial aquaculture publications in many languages have now proliferated and several international peer-reviewed journals exist. Most major regional or international aquaculture projects and programmes produce their own newsletter.

Three significant information gaps remain, however. Commercial periodicals are still targeted principally at North America, Japan and Europe, where the major advertising and conference revenue originates. News of aquaculture development in the developing countries, where 76% of farmed products are grown, therefore receives scant attention. Secondly, though aquaculture development projects with funds totalling some US$56 million were executed by FAO from 1986 to 1990, there has been no medium to disseminate information on these

activities for over a decade. Finally, FAO's aquaculture-related activities at its Rome headquarters are not widely publicized.

Our new newsletter, FAN, hopes to address these deficiencies. Its primary purpose is to disseminate information on FAO's headquarters activities in aquaculture development. FAN will also bring you news and views on aquaculture research, training, and development issues generally. FAN will be published initially twice each year primarily in English although some articles in French and Spanish may also be accepted; funding limitations prohibit publishing FAN in all the FAO official languages. FAN is distributed free to a target audience which includes its own headquarters, regional, national and project staff, ministries of agriculture and departments of fisheries, universities, intergovernmental and non-governmental agencies, research and donor organizations, and the commercial aquaculture press. Articles and news, though primarily expected to originate from FAO staff, will also be sought from its target audience. Unsolicitated information and articles will also be considered for publication.

We hope you will find FAN interesting and informative reading. If FAN does not match up to your expectations, let us know; constructive criticism is always welcome.



AN OVERVIEW OF FAO 'S ROLE IN SUPPORT OF AQUACULTURE DEVELOPMENT

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The purpose of this article is to provide general information about the structure and activities of FAO in support of aquaculture development in its member countries and the evolution of its assistance to this sector. I also touch on our plans for the future, which will be discussed in more detail in future issues of FAN.

FAO has been involved in aquaculture development for several decades through three main programmes. The first is the core, or Regular Programme which has been implemented through the contributions of the member countries, basically since the inception of the FAO. The second is the Field Programme which started in the sixties and is almost entirely funded by extrabudgetary funds derived either from the United Nations Development Programme (UNDP) or from donor countries through trust fund arrangements. The third programme is that provided by the FAO Investment Centre (Development Department, DDC) in support of investment project preparation. Investment projects are eventually implemented by governments and financing agencies such as the World Bank, the International Fund for Agricultural Development (IFAD), and Regional Banks such as the African Development Bank, the Inter-American Development Bank or the Asian Development Bank.

Our Regular Programme supports activities which are mainly implemented at Headquarters through the staff of the Inland Water Resources and Aquaculture Service (FIRI), although all the Divisions and Services of the Fisheries Department (FI) play an active role in support of the sector (Figure 1). FAO also provides support to regular and Field Programmes from the Regional Offices located in Accra, Bangkok, Cairo and Santiago de Chile where designated Fisheries Officers are assigned.

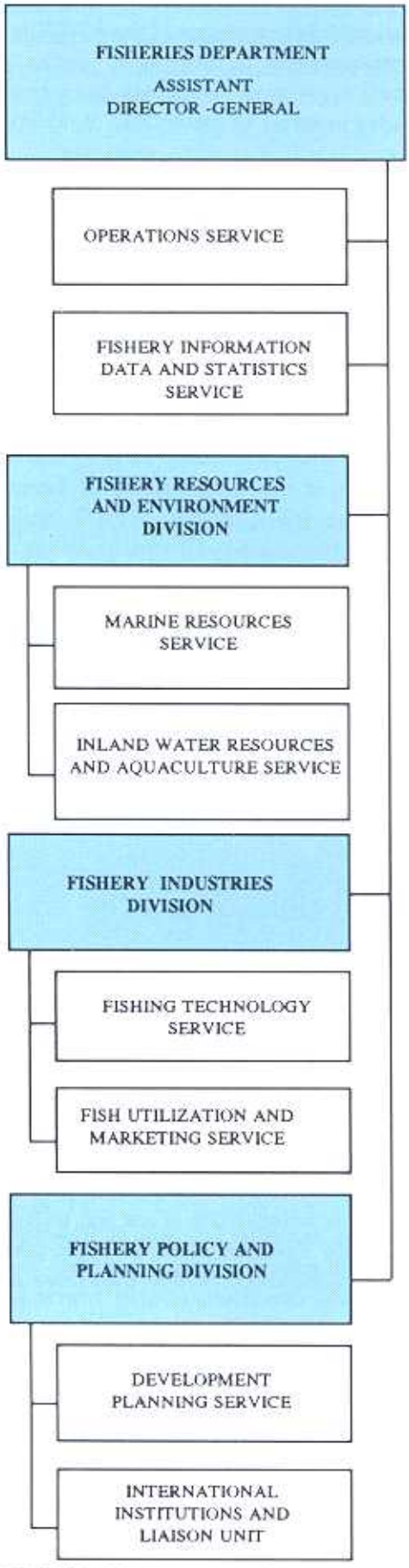

Figure 1. FAO Fisheries Department Organizational Chart

The main activities supported by the Regular Programme include:

-servicing the meetings of the various advisory bodies which provide guidance to the Regular and Field Programmes such as the FAO Committee on Fisheries (COFI), the General Fisheries Council for the Mediterranean (GFCM), the Indo-Pacific Fisheries Commision (IPFC), the European Inland Fisheries Advisory Commission (EIFAC), the Committee for Inland Fisheries of Africa (CIFA), and the Commission for Inland Fisheries for Latin America (COPESCAL);

-technical backstopping of field programme activities;

-direct assistance to member countries on requests for information;

-the preparation of statistical information on aquaculture production worldwide; and

-the preparation of technical publications.

From the sixties, activities in support of aquaculture development were strengthened by the creation of the Field Programme through which FAO has implemented a large number of aquaculture development projects, allowing us to gain a better insight of the development potentials and constraints in member countries. The administration and operation of these projects is ensured by FI's Operations Service (FIO).

Most of this assistance to field activities has been supported by UNDP although, in recent years, the proportion of projects financed through trust fund arrangements has increased. FAO has also allocated internal resources through its Technical Cooperation Programme (TCP) which are used for emergencies to finance studies to solve bottlenecks, to promote investment and to bridge important projects to ensure continuity of the development effort.

There has been a clear evolution in the assistance provided by FAO, as the Organization gained more experience and as the aquaculture sector became more mature enabling the consultative bodies to provide us with beter guidance. Internal and joint evaluations with other partners in development have

also played an important role in redirecting and focusing more clearly the work of the Organization.

In the sixties and seventies, FAO played a dominant role in aquaculture development because of its pioneering work in this sector. During this period a number of important technical meetings were organized to define the situation and to examine existing technologies and evaluate knowledge on the various species cultivated around the world. Milestones were the World Symposium on Warm Water Pond Fish Culture (Rome, 1966), the World Scientific Conference on the Biology and Culture of Shrimps and Prawns (Mexico City, 1967), the Symposium of Aquaculture in Latin America (Montevideo, 1974) and the Symposium on Aquaculture in Africa (Accra, 1975).

The preparation of a longer term strategy and programme to assist in developing aquaculture was initiated in the early seventies with the organization of a series of meetings in Asia, Africa, and Latin America on aquaculture development planning. These were organized through the Aquaculture Development and Coordination Programme (ADCP), a headquarters-based global programme financed by UNDP to reinforce the FAO's Regular Programme activities in aquaculture and designed to accelerate aquaculture development. These meetings led to the organization of the Technical Conference on Aquaculture, held in Kyoto in 1976, which prepared a development strategy (known as the Kyoto strategy) which assisted the work of the Organization until the mid eighties. This Conference also helped to spawn a number of important regional projects involved in training, research and information exchange, which have continued for a decade or more in Asia (NACA)[1], Africa (ARAC)[2], Latin America (AQUILA)[3], and the Mediterranean (MEDRAP)[4].

In the mid eighties the Thematic Evaluation of Aquaculture provided additional elements to guide the Organization in its work. The Thematic Evaluation, jointly conducted by the FAO, UNDP and the Government of Norway, reviewed over a hundred projects implemented by FAO, starting in the mid seventies. Its recommendations included broadening the approach to aquaculture development to give additional emphasis to social and economic considerations in addition to biotechnical ones. The findings of the Thematic Evaluation are still guiding the work of the Organization. However, a recent evolution has occurred, which coincides with the termination of the activities of the ADCP in 1989 and the incorporation of many of its duties in FAO's Regular Programme, which has been considerably expanded in terms of manpower capabilities.

At present we are trying to improve the integration of Regular Programme activities to accelerate aquaculture development, not only within the Fisheries Department but also through the contribution of other divisions in other Departments of the Organization possessing complementary experience and capabilities. This approach will supplement the technical capabilities of the core group dealing with aquaculture. Integration is the function of the Aquaculture Steering Committee in which staff of the Departments of Economic and Social Policy (ES), Agriculture (AG) and Forestry (FO), together with the Investment Centre of the Development Department (DD), participate.

This strategy of pooling the human resources available in the Organization is a response to the growing awareness, in FAO and amongst its member countries, that development activities require a broad, rather than a solely technical, approach to ensure the sustainability of our efforts in the third world. Poverty alleviation, the environmental sustainability of development efforts and conservation of biological resources are its three important guiding elements in the present FAO programme.

Problems faced by aquaculturally developed countries are becoming more complex. The level of assistance required from FAO needs to be simultaneously technically sharper and provide a broader perspective for improved planning and, eventually, to the design of investment programmes. This approach must redress situations which have failed due to anarchic development or ensure that the expansion of new aquaculture areas will be sustainable. Aquaculture developments must not create more problems in the long term than they solve in the short term.

It is also important for us to provide suitable guidance to countries which do not have a tradition in aquaculture. This may start with assistance in development planning, social analyses to investigate the chances of success of the introduction of aquaculture, and the selection of the most suitable areas. Further assistance may then be provided, in

collaboration with our Investment Centre and the financing institutions interested in aquaculture, to locate the necessary capital to ensure a correct and phased development.

The Inland Water Resources and Aquaculture Service of FAO intends to promote a more ecological approach to aquaculture development, which gives proper attention to the the high natural productivities characteristic of the tropics and favours the selection of optimum levels of production intensity. This approach must be in parallel with the necessary economic and social analyses to ensure the financial adequacy of the models proposed and their social acceptability.

This initial introductory article will be followed by others in which the themes introduced here will be developed, to provide further information to our readers on FAO strategies and plans to foster aquaculture development.

1 NACA - Network of Aquaculture Centres in Asia
2 ARAC - African Regional Aquaculture Centre
3 AQUILA - Regional Aquaculture Project for Latin America and the Caribbean
4 MEDRAP - Mediterranean Regional Aquaculture Project

PROBLEM IN THE APPLICATION OF THE FAO DEFINITION OF AQUACULTURE

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Systematic enquiries to ascertain world aquaculture production started in 1985, following two ad hoc surveys carried out by the Aquaculture Development and Coordination Programme (ADCP) in 1970 and in 1983. Comparing the 1983 data gathered by ADCP and that obtained by FAO's Information, Data and Statistics Service for 1984, it became apparent that respondents, often more than one government body in the same country, had problems in classifying certain types of activities into aquaculture or fisheries and with the inclusion or exclusion of their output in the production statistics.

In 1987, the FAO definition of aquaculture was refined through discussion within the Fisheries Department and with other agency members of the Coordinating Working Party on Atlantic Fisheries Statistics (CWP); this was first applied in the collection of aquaculture production data for the year 1986. The definition, which has since been supplied with all FISHSTAT AQ forms sent out to Member Governments, reads as follows: -

Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period

contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries.

The intention of this definition was to assist FAO and its member countries to separate aquaculture from capture fisheries data and, as a final target, to produce and publish two distinct sets of statistics, instead of the one consolidated in the Yearbook. Currently two questionnaires are sent out annually, one of which calls for returns on total fisheries production (including aquaculture) and one on aquaculture production, using the above definition. In theory, subtracting aquaculture data from total production should provide data on capture from wild stock but, in practice, it is proving difficult to apply. Educated estimates are feasible but little more.

PROBLEMS

In promulgating the definition, FAO knew that it would be impossible to satisfy everyone's ideas about which types of production do or do not fall into the aquaculture harvest. However, some standardization was, and is, necessary if national, regional and global trends are to be assessed for both the aquaculture sector and capture fisheries.

Some of the problems which have arisen in the application of the FAO definition of aquaculture to production data from 1984-1989 are recorded below.

In the 1986 survey, corrected freshwater aquaculture data for the years 1984 and 1985 indicated that a part of production previously thought of as inland capture fisheries by those bodies returning questionnaires had been redefined as aquaculture. While this action was in some cases correct, in others it was production from re-stocking activities in reservoirs and lakes that was now considered, incorrectly, as aquaculture. The result was that, if aquaculture data was subtracted from total catch, non-riverine inland fisheries production was falsely reduced.

This was not the intention of those who drafted the definition, who hoped that the concept of ownership would lead responding governments to allow the final production of most enhancement activities (culture-based fisheries) to remain in capture fisheries data. The intervention of aquacultural activities in the enhancement process is recorded by the collection of hatchery statistics, though these have not yet been published. Particular problems have been experienced with the returns from some Asian and Latin American countries. In an extreme case it was discovered that all inland fisheries production was being included as aquaculture because of a misuse of the actual word aquaculture. In some returns it is suspected that production data have been included as aquaculture to establish the national importance of aquaculture and/or to indicate the dynamism of its expansion.

Another important problem seems to be caused by local differences in the concept of ownership. Financial rewards may accrue to the public as well as the private sector. Thus some governments regard fish harvested as the result of re-stocking programmes to be owned (and thus counted as aquaculture) while others do not. Conversely the too strict application of a definition of ownership, as implying that only production which was privately owned was acceptable in aquaculture statistics, excludes the output of all enhancement and ranching activities, which is not acceptable to those involved in salmon ranching for example. In fact salmon ranching activities contribute both to the capture fishery (by extraction) and to aquaculture production. The FAO fishery statistics unit attempts to appropriately correct the data returned but is unable to identify all instances of incorrect allotment to production category.

Other instances of the loose interpretation of our definition of aquaculture exist, for example, in some Mediterranean countries which regard all the catch from coastal lagoons as aquaculture. Others do not.

Some countries are reporting the aquaculture production of species that are not included in the catch data. The question remains whether they have been reported in the catch, though inaccurately identified (e.g. production of carps called "freshwater fishes" in the total production questionnaire) or whether they have been omitted. For species caught and farmed, subtraction of aquaculture from total catch figures may result in a zero or "negative" capture fisheries production for those species. This flags the probability of a much more serious problem, which is that some countries may not be including aquaculture production in their total catch returns as many omit inland capture data. This would result in artificially deflated figures for capture (especially inland) fisheries production. In other cases aquaculture

returns record data for certain species in a different category (freshwater, brackishwater, marine) than do the total catch returns.

A major problem is that the total catch statistics are frequently returned by a different government authority to that responding to the aquaculture questionnaire. Confusions, double counting, and/or omission of some data is then likely. To give one example only, in Italy total catch data originate from the Fisheries Branch of the Central Statistical Institute "ISTAT" while mariculture data come from ICRAP[1] and inland aquaculture data is provided by the Institute of Hydrobiology of the Ministry of Agriculture. Where possible, FAO attempts to verify data from conflicting sources through the use of information from trade associations but this is non-existent for most countries.

The division of non-freshwater aquaculture into brackishwater culture and mariculture (which were defined in the instructions for completion of FISHSTAT AQ) has also caused confusion. Dividing aquaculture simply into "inland" and "coastal" aquaculture has strong merits.

Broadly the FAO definition concurs with that of SEAFDEC[2]. The concepts of intervention by man and property ownership are accepted in both cases. Our definition is already implicitly accepted by ICES[3] and the EC[4] since both, as members of the CWP, accept our current FISHSTAT AQ questionnaire and receive copies of the returns which it generates. The Coordinating Working Party on Atlantic Fishery Statistics is the forum where these problems are discussed.

CONCLUSIONS

Clearly no perfect solution will be found to these problems exampled; a compromise position is therefore necessary. FAO statistical data (both for capture fisheries and aquaculture) is the prime source and it is important that it provides accurate and consistent information essential for the planning of aquaculture development. A number of actions are therefore being considered by FAO's Information, Data and Statistical Service as follows.

Firstly, two questionnaires would be sent out annually, one for capture fisheries and one for aquaculture. This would obviate the necessity to subtract aquaculture production data from total catch returns to obtain the production from capture fisheries. The request for total production data would be abandoned. Secondly, a number of improvements have been suggested to improve the clarity of the instruction sheets and the aquaculture questionnaire to make it easier for recipients to complete.

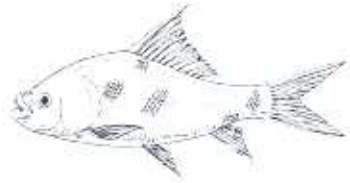
The existing definition of aquaculture would be retained; to change it at this stage would cause confusion. However, the instruction sheet should explain that FAO recognizes that opinions differ, from country to country and from individual to individual, of what forms the output of aquaculture and what is the product of capture fisheries. It should also note that FAO realizes that the completion of the form may necessitate allocation into a different category from that utilized when national statistical data are prepared. However, for standardization purposes and to enable accurate trend analyses, FAO will request its Member States to group each activity according to the definition. The instruction sheet will note that the definition is for statistical purposes and does not imply any attempt to demarcate a border between aquaculture and fisheries from a technical point of view. It would be further stressed that the designation of production as aquaculture is not dependent on the source of stock: both wild caught and hatchery reared stock can be used either for aquaculture or fisheries enhancement.

Improvements in clarity would include renaming "freshwater culture" as "inland aquaculture" and combining "brackishwater culture" with "mariculture" to form a category known as "coastal aquaculture". If the cultivation of the end product takes place in brackishwater or seawater (including production from off-shore activities, from coastal ponds and from on-shore tanks supplied with brackishwater or full-strength seawater), its harvest would be regarded as coastal aquaculture production. The earlier stages of the life cycle of some species may be spent in freshwater but, if harvested in brackishwater or seawater, production data should be recorded as coastal aquaculture.

Perhaps the most useful amendment to the instructions for completing the questionnaire would be an appendix that clearly places the most common practices into either aquaculture or capture fisheries for statistical purposes. This appendix would note that the production from hatcheries, ponds, cages, tanks, raceways, temporary barrages, permanent lakes and reservoirs where fish are harvested by their owners, anadromous fish returning to release sites, privately owned sport fisheries, brush parks and fish aggregating devices, molluscs from owned and managed grow-out sites, the harvest of planted and suspended seaweed, integrated aquaculture (e.g., rice-fish culture), and valliculture and private tidal pond culture (tambaks), should be recorded in the aquaculture return. Conversely, the harvest of fish and crustacea caught in open waters or in permanent lakes and reservoirs, whether enhanced or not, and of anadromous fish not caught by those who released the juveniles, together with fish caught around artificial reefs, molluscs subject to open harvest, enhanced marine fisheries, the harvest from natural seaweed beds and the result of coastal lagoon management, should not be recorded as aquaculture but be returned on the capture fisheries questionnaire.

It is hoped that these and other improvements into the questionnaire and its instructions sheets will be a significant step forward in our efforts to provide accurate information on global aquaculture production. Another milestone will be the recruitment (currently in progress) of a statistician specifically for the collection and analysis of aquaculture data. We hope that the publication of this article will help to explain our objectives and the inherent problems in separating aquaculture from capture fisheries data, whatever definition is employed.

[1] Central Institute for Scientific Research and Applied Technology for Marine Fisheries
[2] South East Asian Fisheries Development Centre
[3] International Council for the Exploration of the Sea
[4] European Communities



BIODIVERSITY AND GENETICS IN AQUACULTURE AND FISHERIES

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INTRODUCTION

The world we live in contains a tremendous wealth of plant and animal resources. The various forms of these organisms have contributed to the betterment of humankind by providing material for agriculture, forestry and fisheries, by providing natural and aesthetic refuges from our more industrialized and mechanized daily lives, and by providing spiritual experiences for a variety of human cultures. The term biological diversity has come to signify this organic variability at all levels of complexity, from molecular diversity to organismal, population, community, and finally to ecosystem diversity. However, underlying this hierarchical structure is the basis for the processes of biological change, adaptation and evolution, namely, genetic diversity. Thus, to ensure existence of biological diversity and its benefits to humankind, an understanding of the processes and organization of genetic diversity and genetic resources will be essential.

The conservation and utilization of genetic resources will be especially important in the fields of

aquaculture and fisheries. A technical consultation of the European Inland Fisheries Advisory Commission (EIFAC), recommended that principles of genetics "should be applied to all culture programmes, whether for conservation, stocking or human consumption". These "principles of genetics" encompass an extremely wide range of applications and technologies that vary in complexity from simple selective breeding programmes, where the "best looking" fish are selected, to genetic engineering programmes where the actual genes of organisms are manipulated to meet specific needs. Each application will involve specific principles and techniques depending on the objectives of the programme.

The purpose of this article is to examine some options for the sustained utilization and conservation of genetic resources in aquaculture and fisheries. It is not my intention to provide an exhaustive review of the applications of genetics to aquaculture and fisheries but rather to present an introduction to some principles and current applications.

GENERAL PRINCIPLES

Some very simple yet important principles apply to the conservation and utilization of genetic resources (Box 1). They basically state that genetic diversity

- is a valuable resource
- is a function of population size
- can be changed, lost or gained
- is not always obvious
- can be affected by anthropogenic (i.e., human) activities.

Genetic resources are affected and used by both the natural processes of evolution and the anthropogenic processes associated with development, fishing, farming and human population growth. The environment and natural selection have caused organisms to come and go for about 4 billion years. These changes have occurred slowly over geological time. However, anthropogenic effects, such as pollution and over-fishing, can occur more quickly on a time scale of a few generations.

Traditional hatchery practices may affect genetic resources through a number of factors. Hatchery broodstock are often founded from a very few individuals that may not be indigenous to the area. This reduction in the number of fish may promote inbreeding (the mating of closely related individuals) which may reduce the viability and vitality of the hatchery's product. The selection pressures in the hatchery environment are different from those in the wild. Thus, the genetic resources of the hatchery population may be only a fraction of, or be very different from, those found in the wild. Improved husbandry and the natural high fecundity of aquatic organisms has made it extremely easy to produce large quantities of organisms that may interact with the surrounding ecosystem either through intentional releases or inadvertent escapes. Fisheries may affect genetic resources by the selective removal of one part of a population, as well as by reducing overall population size to the point where inbreeding and loss of genetic variation become problematic.

AREAS OF GENETICS

When discussing the applications of genetics, it will be important to have a common vocabulary to facilitate exchange of information and ideas. For the present paper, I address two broad areas: 1) quantitative genetics, and 2) population genetics. Non-geneticists should not be discouraged by this terminology. Quantitative genetics deal basically with how several genes act together with the environment to influence continuous traits, such as growth rate, age of maturity or number of eggs per spawn. Population genetics is the transmission or movement, through time (generations) and space, of genes in either natural or cultured populations. Here the genes can be thought of as markers or tags that can assess migration, identify unique groups or detect changes in levels of variability. (A third area, genetic engineering, is progressing rapidly, has potential benefits and pitfalls for aquaculture and can be extremely controversial. However, this topic will be deferred to future issues of FAN.)

Quantitative Genetics

Increased production of farmed plants and animals has been possible through genetic selection programmes, as well as a combination of better nutrition, disease prevention and hygiene and improved knowledge of environmental requirements. Because genetic selection is only one tool with which to increase production, it is important to understand the relative influence of a fish's genotype (array of genes within an organism) on its phenotype

(expression of the genotype in a certain environment). Toward this end, heritability estimates for specific traits can be derived from simple equations and performance records; these estimates represent the genetic component involved in determining the trait. Heritabilities range from 0 to 1; those near 0 indicate a strong environmental component and little genetic influence, whereas estimates near 1 indicate a strong genetic component. Geneticists and fish breeders use these estimates to evaluate which production traits can be improved by selection programmes and also to predict the amount of improvement.

Breeding centres have been developed in Scandinavia, and are being planned in Asia, which incorporate principles of quantitative genetics to assist aquaculturists. One such programme is the International Center for Living Aquatic Resources Management (ICLARM) Genetic Improvement of Farmed tilapia (GIFT) programme which followed the example of the Institute of Aquaculture Research of Norway. The Norwegian project had initial goals to collect several strains of Atlantic salmon to create a diverse genetic base population, to estimate genetic parameters such as heritabilities, and develop breeding programmes. ICLARM's project collected different strains of tilapia and evaluated them for growth characteristics in several different environments. Both heritability estimates and selection programmes are environment specific so the project was designed to find specific strains that would be optimum for specific culture conditions. Some results of the first several years of the GIFT project were that significant differences in growth characters existed among the strains, but that the relative performance (or rankings) of the strains was nearly the same for all tested environments. In addition, the strain that performed best in all environments was not the strain most widely cultured in the Philippines. This project is ongoing and should promote increased production of tilapia in Asia.

Population Genetics

In the sixties geneticists developed the capability to examine the proteins that are made by an organism's genes. The theory is that differences in the forms of these proteins, called isozymes, reflect differences in the genes. Scientists were somewhat surprised to discover a tremendous amount of variation in isozymes, thereby implying substantial genetic variation in natural populations. Some of this variation is the raw material that allows an organism to evolve and adapt to its environment and which selective breeding programmes utilize for improvement of farmed fish. Fishery scientists and aquaculturists are now utilizing this variability and the ease with which it can be visualized in the conservation and management of genetic resources.

Because the phenotype of an organism is determined by both its genes and the environment, external appearances may not provide much information on the population, race, or even species from which a fish is derived. Therefore, the proper identification of valuable strains, endangered species, or specific populations of fish may be difficult without an examination of the fish's genotype. For example, the cui-ui, an endangered fish historically utilized by native Americans in Nevada (USA), was thought to be threatened by hybridization with another local species. Fish with mouth and head morphologies intermediate between the two species were recently observed. The selective removal of these "hybrids" was planned. Fortunately, genetic analysis of isozymes revealed that the presumed "hybrids" were in fact pure cui-ui before any fish were destroyed. In another stream in Nevada, cut-throat trout thought to be an extinct subspecies became the object of a multi-agency recovery programme; this programme suffered greatly when isozyme analysis revealed that these fish were in fact not pure species, but hybrids between cut-throat and rainbow trout.

Another recent application of population genetics is in fisheries management and stock identification. Resource managers in the Pacific Northwest (North America) are utilizing differences in isozymes among populations of Pacific salmon from different rivers to evaluate their abundance in mixed ocean fisheries and then set fishing regulations accordingly. It has been demonstrated by the University of California, Washington Department of Fisheries, and the National Marine Fisheries Service (USA) that this genetic stock identification is more accurate, more efficient, and cheaper than conventional stock identification methods. Furthermore, the contributions of fishery enhancement programmes can be determined by genetically marking the output of a hatchery and then monitoring the marker in the target or enhanced population.

Although much of the application of population genetics in fisheries has been in temperate fishes

BOX 1. Genetic Principles in Aquaculture and Fisheries.

Principle	Situation	Result	Recommendations
I. Genetic variability is a valuable resource.	**1.** Natural levels of genetic variability.	**1a.** Diverse, resilient world; resources for farming, fishing, and recreation.	**1b.** Conserve and utilize genetic resources.
II. Genetic variation dependent on population size, numbers of adults used in spawning.	**1.** Low number of individuals in hatchery brood stock or founding population.	**1a.** Loss of genetic resources, inbreeding, and decreased production; reduced ability for genetic improvement through selection programmes.	**1b.** Maximize number of broodstock in hatcheries; develop breeding programmes to avoid in-breeding. Infuse genes from natural populations. Preserve natural gene pools as a source of this infusion.
	2. Habitat degradation and/or loss.	**2a.** Same as II.1a. plus loss of vulnerable forms, populations, races or species; reduced ability for organisms to adapt to environmental changes.	**2b.** Monitor and preserve aquatic habitat; conduct species surveys to document genetic resources.
III. Genetic resources are changeable.	**1.** Hatchery environment; selection programmes.	**1a.**Domesticated animals, improved breeds, inadvertent changes in hatchery product.	**1b.** Define goals of hatchery programme and set breeding programmes, culture conditions accordingly.
	2. Fishing Pressures.	**2a.** Change in life history characters (spawning time, age of maturity, growth etc.), loss of variation, reduction in population size, then as in II.1a.	**2b.** Cease over-fishing, establish and enforce fishing regulations. Define stock structure of fisheries.
	3.Introductions, transfers, or escapes of animals used for fishery enhancement or culture programmes.	**3a.** Change in community structure, hybridization of native and non-native fish, increased (?) or decreased (?) production.	**3b.** Establish code of conduct for introductions and use of exotic organisms. Improve aquaculture holding facilities. Assess efficacy of fish transfers.
IV. Genotype and environment determines organism's phenotype.	**1.** Hatchery selection programmes.	**1a.** Traits of some strains may be improved in some environments, but not in others.	**1b.** Breeding programmes, strain evaluations.
	2. Cryptic species or morphologically similar populations.	**2a.** Unique forms may go undetected and unutilized.	**2b.** Genetically survey aquatic species to document genetic differences.

Box 2. Suggested References on Utilization and Conservation of Aquatic Gene Resources

Electrophoretic and isoelectric focusing techniques in fisheries management. CRC Press, Boca Raton FL (USA). D.H. Whitmore (ed.). 1990. *Includes technical information on means to visualize genetic variation and analyze data.*

Population genetics and fishery management. University of Washington Press, Seattle, WA, USA. N. Ryman and F. Utter (eds.). 1987. *Reviews, concerns and principles associated with conservation and management of genetic resources; heavily biased toward salmonids.*

Genetics for fish hatchery managers. Argent Chemical Laboratories, Redmond, WA, USA. D. Tave. 1986. *A very readable book which discusses a broad range of genetic topics of interest to aquaculturists; includes simple formulae and heritability estimates for important traits.*

Introduction to quantitative genetics. John Wiley & Sons, Inc. New York, NY, USA. D.S. Falconer. 1989. *The classic text for quantitative geneticists; includes formulae for determining quantitative genetic information such as heritabilities, response to selection.*

Genetic basis of fish selection. Springer-Verlag Berlin Heidelberg New York. V.S. Kirpichnikov. 1981. *Reviews a wide range of genetic topics from the structure of chromosomes, genetics of aquarium fishes, to isozymes. Somewhat outdated, but very informative.*

Tilapia genetic resources for aquaculture. ICLARM, Manila, Philippines. R.S.V. Pullin (ed.). 1988. *Contains the proceedings of a workshop on tilapia genetic resources; the information and discussion provided by the international experts attending the workshop is extremely useful.*

Genetics in aquaculture. Vols I-III (IV in press). Aquaculture Journal and Elsevier Science Publishers, Amsterdam and New York. Various Editors. 1982, 1985, 1988, in press, respectively. *These volumes are the proceedings of The International Symposium on Genetics in Aquaculture and contain scholarly contributions by international experts on a wide variety of subjects*

such as salmonids, these same principles apply to tropical species as well. Currently, in Lake Malawi a mixed fishery exists for tilapia species. It is unclear exactly what species are being harvested and what the patterns of migration and population structure are. Genetic analysis may provide such answers and help insure that a particular species is not overfished and that critical juvenile habitat is preserved. The GIFT project is using both external and genetic descriptors to categorize the strains of tilapia used in their breeding trials.

CONCLUSIONS

An important aspect of utilizing genetic principles in aquaculture and fisheries is to have a clear idea of what type of culture programme is planned and what types of need are going to be addressed. It is, therefore, critical to define the objectives of culture or fisheries programmes so that the correct genetic tools can be applied to facilitate success. For example, a culture programme designed to enhance or create a natural fishery would want to utilize local populations and minimize the amount of artificial selection imposed on the fish by the hatchery environment, whereas a programme designed for production would incorporate specific selection regimes and fish to meet market demands. Stocking of exotic or hybrid fish in isolated artificial lakes or reservoirs may be acceptable, but this practice would be ill-advised in or near natural bodies of water where native fish fauna may be affected.

This short introduction to genetic applications in aquaculture and fisheries has hopefully provided some useful information and ideas. When formulating projects, evaluating existing projects, or advising member countries, incorporation of genetic principles will promote long-term productivity and conservation. Selected references are included in Box 2 and interested individuals are encouraged to request more detailed information and references from the author.

COASTAL AQUACULTURE AND THE BAY OF BENGAL PROGRAMME

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Small-Scale Fisherfolk Communities in the Bay of Bengal Project
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Examples of small scale aquaculture can be found in most Southeast Asian countries. Seaweeds, mussels, oysters, cockles and finfish are widely cultured by fisherfolk. But there must be a blending of market demand, suitable environment, adaptable fisherfolk and a host of other factors for such small-scale enterprises to flourish. It may not always be possible to transfer successful technologies from one country to another, or indeed, from one site to another. When transfer is tried, years may be required to adapt and develop the system. In the real world, of course, all projects are time bound. There is no guarantee that a pioneering effort can be carried on long enough to resolve all the issues confronting its successful conclusion.

It was inevitable that the Bay of Bengal Programme (BOBP) would be drawn into shrimp culture in one way or another, given the strong interest of its member countries. In Bangladesh, the productivity of shrimp farms was, and still is, very low compared to the potential. Acid sulfate soils in Malaysia resulted in low yields and severe economic problems. Over-exploitation of shallow water resources by a growing population of fisherfolk on the east coast of India is leading to declining standards of living. Perhaps some way could be found for them to participate in the shrimp culture bonanza.

BOBP responded by initiating sub-projects designed to address each government's concerns. A demonstration of semi-intensive shrimp culture was attempted in western Bangladesh, its main shrimp producing region. Pond construction began in 1982, with the sub-project winding up in 1986. A similar sub-project was taken up with the State Fisheries Department at Polekurru, Andhra Pradesh on the east coast of India between 1982 and 1985. Techniques for management of acid sulfate soils were demonstrated at Ban Marbok, Malaysia from 1979 to 1983.

The problem of landlessness blocks the entry of fisherfolk into shrimp farming. Pen culture in protected lagoons seemed to be a technology which could overcome this constraint. These open waters are a common property resource traditionally shared by the fisherfolk living on their shores. Thus the Programme undertook field trials in one of the backwaters of Tamil Nadu on the east coast of India. Field work began in 1983 and was terminated in 1988. Similar pilot tests were conducted in Chilaw Lagoon, Sri Lanka from 1986 through 1988.

Shrimp and prawn seed supply are major constraints in India and Bangladesh. Both countries have been slow to adopt the advances made in Southeast Asian countries, but are now trying to catch up. The Governments of India and Bangladesh have undertaken large hatchery projects whose function is to augment natural seed supply, as well as demonstrate technology. However, the hatchery industry in Southeast Asia developed on the basis of small hatcheries operated by the private sector.

Consequently, fisheries departments in several member countries sought the assistance of BOBP to accelerate the spread of hatchery technology to the private sector. This support has been in the form of funds for the construction of model small-scale hatcheries in West Bengal, India and Chittagong, Bangladesh. Operations began in 1991 in Bangladesh and this year in West Bengal.

There are tens of thousands of shrimp and prawn seed collectors in India and Bangladesh. Their income is subject to seasonal availability of the fry, as well as widely fluctuating prices during the season.

There is considerable wastage of the limited fry resources due to bad handling and transportation methods. Nursery cageculture trials are a response to those problems. The trials began in 1989 and are continuing. Seed collectors can hold their fry in the floating cages to await better prices. Shrimp farmers will pay more for older post larvae and early juveniles. Dramatically improved fry survival is a significant benefit of the technology. It also enables us to link our target group to hatchery production.

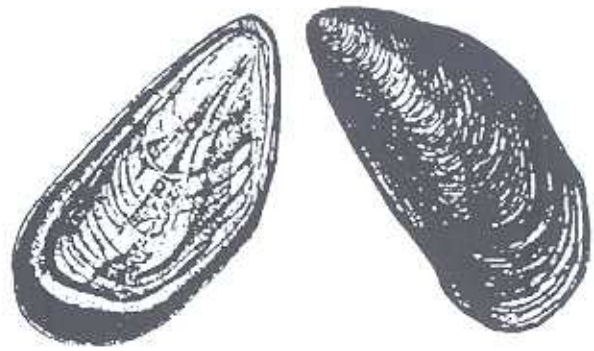
Overfishing in Thai and Malaysian coastal waters led to declining catch values and lower income for fishermen. A variety of small-scale aquaculture technologies were tested in fisherfolk communities in these countries. Sea bass cage culture was introduced into Phang Nga Bay in southern Thailand in 1979 and concluded during 1985. Oyster culture methods were developed and field tested in the states of Kedah and Perak on Malaysia's west coast. Development of Technology began in 1988 and by 1991 participants began regularly marketing their products. Oyster farming was also part of BOBP's extension project in Ranong, Thailand, started in 1987.

Controversy developed over cockle harvest regulations in Malaysia in the mid eighties. The cockle is Malaysia's premier aquaculture crop in quantity so the Department of Fisheries requested BOBP's assistance to conduct an in-depth study of seed supply, basic cockle biology and production systems. This work started in 1984 and was completed during 1986.

There has been interest in agarophyte production in India and Sri Lanka for a number of years. Research by national institutions indicated that commercial production might be possible. There is a substantial domestic market for agar in Malaysia, all of which is supplied by imports. Over-exploitation of natural stocks of Gracilaria, particularly in India, heightened interest in its culture. Consequently, BOBP undertook experimental and pilot field trials of Gracilaria farming in Malaysia in 1983 and 1984. We attempted to transfer this technology to Sri Lanka and India between 1988 and 1990.

What has been the Impact?

Sea bass cage culture in Thailand was a clear success. Fishermen who took up the activity significantly increased their income. Production in the former project area is now worth several million dollars annually. Cage culture has spread throughout Phang Nga Bay and beyond. Many operations have changed to grouper as fish farmers respond to changing market conditions, but the technology remains economically viable.



Oyster culture is on the verge of commercial development on the west coast of Peninsular Malaysia. Economic studies of the pilot project indicate very good profitability. However, the investment cost for the technology is relatively high. The difficulty of financing aquaculture through existing credit institutions could hinder expansion. Cultured oyster production could expand rapidly if the entrepreneurial sector gets involved. Unfortunately, such a development would be unlikely to benefit our target group. In Ranong Province of southern Thailand oyster farming is slowly developing as a result of our extension project. Seed supply continues to be the main constraint to rapid expansion.

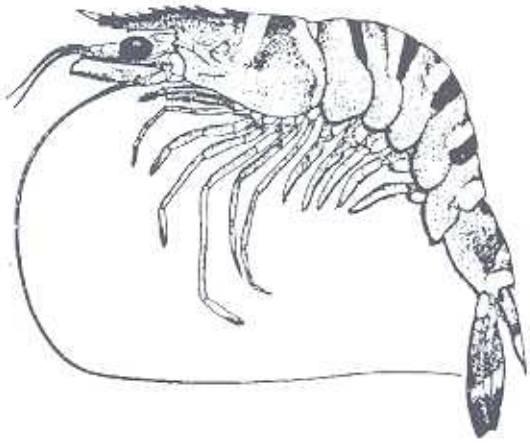
Cockle management studies in Malaysia furthered the biological knowledge of the species and led to changes in implementing harvest regulations. After the completion of the BOBP sub-project, the Department of Fisheries began the introduction of cockle culture to new areas in the country.

Experimental spore setting and grow-out trials with Gracilaria in Malaysia were promising. At that time, the results did not give a clear indication that the technology could be economically viable and the sub-project was terminated at the request of the Department of Fisheries. It is interesting to note that work has resumed as the value of agar has risen.

Gracilaria grow-out trials in both India and Sri Lanka were total failures. Grazing and poor growth

were the culprits. The results were so discouraging that BOBP terminated its support in 1990. Spore setting techniques were successful on an experimental scale in Sri Lanka and work is continuing with funds from other sources. Several more years of research will be required. Many more sites have to be tested before suitable grow-out conditions can be found.

Our involvement in shrimp culture has had mixed results. Trained staff may be the most tangible impact of pond culture trials at Satkhira, Bangladesh and Andhra Pradesh in India. The impact on existing shrimp culture practices was small. A few technical innovations were adopted by farmers in Bangladesh. Existing land ownership patterns and lack of capital and technical inputs were major constraints to the spread of the technology. In spite of six years of effort in pen culture, economic success could not be achieved. Perhaps the most significant result will be to caution others who might be tempted to try this technology. Besides the problems of pest control, harvesting and feed development (now overcome in most countries), serious social issues were raised. On top of these difficulties, unpredictable climatic changes wreaked havoc with management protocols. More time will be needed to assess the impact of nursery cage culture. Our target group was involved right from the beginning. Fisherfolk readily took up the technology. Indications are that nursery cage culture can be profitable, but the selection of motivated, interested participants will be crucial to its future success. Marketing requires a degree of sophistication that will take some time to develop amongst the fisherfolk. It is clear that Non-Governmental Organizations (NGOs) can be very effective in implementing such technical trials; BOBP's current time span may be too short for this work. However, we are optimistic that the NGOs will be able to come up with alternative funding if necessary.



It is too early to assess the impact of our support for small-scale shrimp and prawn hatchery development. We know that interest among the private sector in India is strong. A training course targeted specifically at small-scale entrepreneurs will be held about the middle of this year. Our attempt to adapt Thai technology for inland prawn hatcheries to Bangladesh shows promise, but our model hatchery has not yet reached a profitable level of production. Until it does, private sector participation will have to wait.

We have learned some general lessons through the years. While obvious, they bear restating. Aquaculture technology can be transferred to fisherfolk but it may require a longer timeframe than is possible within the BOBP project period. Technologies may be very site specific and hence not replicable on a regional basis. The complex social and economic milieu within which development takes place has to be considered both at the planning and implementation stage. The needs of fisherfolk go far beyond increased income. Aquaculture should be a part of an integrated approach to community development. For this reason, we have relied heavily on NGOs because of their ability to address a wider range of issues than would be possible through a technical agency.

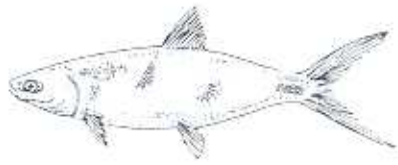
Apart from technical constraints, user conflicts are a persistent obstacle to small-scale aquaculture development. This is particularly the case in the very crowded inshore waters of South Asia.

This concludes on overview of the role of the Bay of Bengal Programme in coastal aquaculture development and its major sub-projects in the field. The Programme's activities have spanned a period of 13 years, beginning in 1979. It has played an important part in aquaculture technology transfer, information sharing and dissemination among its member countries. We hope that BOBP has made a lasting contribution to fisherfolk community development through these activities. Detailed description of sub-projects may be found in the working papers, reports and the quarterly Bay of Bengal News published by the Programme (Bay of Bengal News, Post Bag 1054, Madras 600 018, India).

FAO NEWS ITEMS

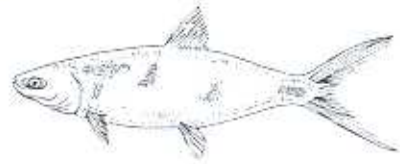
NACA, the Network of Aquaculture Centres in Asia, an independent intergovernmental organization which evolved from an UNDP/FAO regional project of the same name, is striding ahead. Ten governments - **Bangladesh, China, Hong Kong, Korea (DPR), Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka and Viet Nam** are already official members. Cabinet approval has been given for **Thailand's** membership and **India, Indonesia, Korea (Rep.) and the Philippines** are various stages towards accession to the agreement. NACA is now seeking support for a large regional programme from a consortium of donors. Topics to be covered by projects in this programme will cover aquaculture and the environment, health and the environment, seaweed research and development, planning and development of cage farming industries and regional training on aquaculture nutrition and feeding.

[NACA, Bangkok]



Funded by **UNDP** (US$ 300 000), with a duration of 2.5 years, a project titled Promotion and Development of Aquaculture and Mariculture in **Mexico** completed its activities in June 1991. Within its objectives, it emphasized the development of the shrimp culture industry. The project focused on a study of the sector in the State of Sinaloa, the centre of this development, including economic and financial analysis as well as social aspects. Methods for technical assistance and monitoring developed. Two training centres working on trout and tilapia culture were rehabilitated and 24 courses were given for producers, extensionists, technicians, investors and government officers. Fifteen workshops were also organized with the same multidisciplinary participation as well as national meetings on post-larval production and financing. Six professionals were trained in other countries and a number of extension manuals produced. Financial and economic aspects of shrimp culture development received priority attention: investment models for extensive, semi-intensive and intensive culture, the setting up of several data banks, and direct assistance to investors have accelerated the development of the sector towards its significant potential.

[FAO Fisheries Department, Rome, (MEX/87/018)]



1991 was the first year of operation of the second phase of the Mediterranean Regional Aquaculture Project **(MEDRAP II)**, funded by the Arab and European Bureaus of **UNDP**. The project's regional headquarters are located at the Ministry of Agriculture in **Tunis**, but the project also has four sub-regional centres in **Algiers** (covering **Algeria, Morocco, Portugal and Tunisia**), **Tripoli** (covering **Libya, Egypt and Malta**), **Nicosia** (for **Cyprus, Lebanon and Syria**) and **Dubrovnik** (for **Yugoslavia, Albania, Bulgaria and Turkey**).

In the first part of 1991, MEDRAP II held four sub-regional meetings in Tunis to define priorities for work in the various sub-networks which compose the project and to define a programme which was approved at the first Steering Committee (April 1991). The project organized workshops on species diversification (**Malta**) and the use of coastal lagoons (Nador, **Morocco**), and a course on disease diagnosis and prevention (Bodrum, **Turkey**). It also held three seminars to discuss and organize the training (Meze, **France**), research (Nicosia, **Cyprus**) and information (Cairo, **Egypt**) networks. The project is led by Mr H. Akrout.

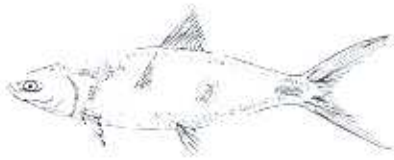
[FAO Fisheries Department, Rome, (MEDRAP II: RAB/89/005-RER/88/009)]

The following press report has appeared concerning the South Pacific Aquaculture Development Project:

"Until about five years ago fish farming was little known in the islands of **Fiji** but the launch of a new project, the Regional South Pacific Aquaculture Development Project (GCP/RAS/116/JPN, executed by FAO and funded by Japan) has resulted in Fiji aquaculture becoming one of the fastest growing in the world. The project has helped to set up over 500 fish farming ponds in Inland villages in less than five years. Some have also been dug with the assistance of US Peace Corps volunteers. Annual yield is 600-1,200 kg per hectare per year of tilapia. Some are using Chinese-style methods of integrating ponds with poultry. A college running courses for orphaned teenagers which has integrated chicken and ducks with tilapia produces over 32 tonnes of fish each year, mostly for consumption at the college. Noting that the project covers all the **South Pacific islands**, its project manager, Mr. M. Tanaka, reports an increasing interest in fish farming particularly in the outer islands. Apart from subsistence aquaculture, commercial fish farming could become profitable in some countries due to increases in purchasing power and fish prices in urban areas."

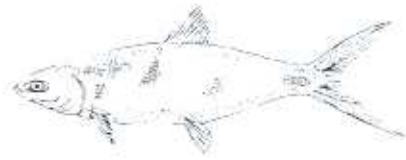
The technologies diffused included artificial spawning of fish and shellfish, seeding and seaweed culture. Recently an evaluation team recommended that the project be followed by a second phase - expected to start in 1993. In the course of the second phase, new aquaculture techniques, harmonized to the environment of the region, should be introduced.

[Financial Times, London, and
FAO Fisheries Department, Rome
(GCP/RAS/116/JPN]



The **Global** Fish Disease Diagnosis and Information Exchange Systems Project became operational in 1991; its objectives are: (i) information exchange, (ii) training, through national and international training courses on fish disease diagnosis, and (iii) the establishment of national/regional fish disease diagnostic centres. With reference to (i), a network of laboratories has been created for the purpose of accessing and exchanging information on fish diseases. As for (ii), in 1991 one international and three national training courses were held respectively in **Czechoslovakia, China, Viet Nam** and **Thailand**, with a total participation of 130 trainees. The diagnostic service centres (iii) will be established at four institutes, i.e. the Research Institute of Fish Culture and Hydrobiology, Vodany, Czechoslovakia; the East China Sea Fisheries Research Institute, Shanghai, China; the Aquaculture Research Institute No.3, Nha Trang, Viet Nam, and the Samutsakorn Fisheries Station, Samutsakorn, Thailand. The project is coordinated by **FAO**, which in this exercise cooperates with regional bodies and international/intergovernmental organizations such as **COPESCAL**, the **Codex Alimentarius Commission**, the Office International des Epizooties **(OIE), ICLARM and NACA.** The first phase of the project will terminate in 1993.

[FAO Fisheries Department, Rome
(GCP/INT/526/JPN)]

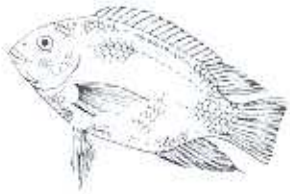


Dr. James Kapetsky, of FAO's Inland Water Resources and Aquaculture Service (FIRI), was recently in the **Republic of Korea** on behalf of the FAO/UNDP Seafarming Development and Demonstration Project (RAS/90/002) to design a regional project to establish national information bases for mariculture management and development. To facilitate his work, his host, Dr. Byung-Ha Park, Director of the Aquaculture Department of the National Fisheries and Development Agency (NFRDA), kindly arranged a two-day familiarization tour of NFRDA laboratories and commercial mariculture installations along the South East coast of the ROK.

Jim reports: " As the ROK is one of the world leaders in mariculture production, perhaps I should not have been surprised at the density and intensity of mariculture as I sped along by commercial hydrofoil. .In many places the styrofoam floats, supporting oysters, mussels and sea squirts, are so close together and extend so far into the distance that one has the impression of ice-covered Antarctic bays and coves.

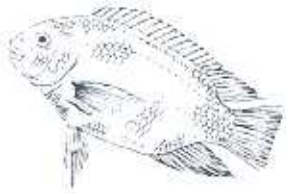
Close up, I was impressed by the mechanized oyster harvesting, but fascinated by the wet-suited divers, all women, all free diving, not for oysters, but for the many organisms of commercial value associated with the oyster strings."

[FAOFisheries Department,Rome]



After nearly two years of interruption, the activities of the **AQUILA** (Aquaculture in Latin America) project were resumed in February 1992. The new **headquarters is in Mexico City** at the National Fisheries Institute (INP). This second phase has a duration of two years and is funded by the **Italian Government**. The number of countries which will be assisted through AQUILA 2 has increased to 33, covering also anglophone islands of the **Caribbean**. The preliminary programme of work for 1992 includes, amongst other activities, one session of a basic course on planning and management in aquaculture, a revision of the sub-sectorial analysis carried out by AQUILA 1, a similar exercise for the Caribbean countries, assistance for the establishment of SIPAL (an information system to assist aquaculture planning), and liaison with bilateral and multilateral agencies for identification and preparation of new projects. Assistance in the identification of aquaculture research priorities will also be provided as a follow-up of the meeting of the fisheries donor communities held last October in Paris to discuss the Study of the International Fisheries Research (**SIFR**).

[FAO Fisheries Department, Rome, (AQUILA 2: GCP/RLA/102/ITA)]



ALCOM, a sub-regional project, covering the Southern African Development Coordination Conference (SADCC) countries of **Southern Africa**, is financed by the Swedish Government and has its headquarters in Harare, **Zimbabwe**. It is led by A. Andreasson and, after a preliminary period which started in 1987, is now in its main phase which will last until 1995. In 1991, ALCOM activities centred on general studies on aquaculture and farming systems, aquaculture and integrated rural development in Luapula Province, **Zambia**, rehabilitation of homestead ponds in **Swaziland**, and the use of carps for pond culture and stocking of small water bodies. ALCOM also assessed the potential of small water bodies and their use in **Botswana, Lesotho, Malawi, Zambia,and Zimbabwe**, the enhancement of fish production from reservoirs, extension and training methods, gender analysis in aquaculture, aquaculture and human nutrition. Surveys of fish farmers were carried out and preparation of projects in support of development and material for information prepared. In February 1992, the project held the second meeting of its Steering Committee in **Malawi.**

[FAO Fisheries Department, Rome, (ALCOM:GCP/INT/436/SWE)]

MEETINGS

As one of the final activities of an UNDP/FAO project on pond fish production in Poland, a workshop is being provisionally scheduled for 1992 on **"Aquaculture in the Countries re-entering the Market Economy"**. The workshop will concentrate on environmental, technical and business issues and will be held in Milicz. [Further details from Dr. Zygmunt J. Okoniewski, Inland Fisheries Institute in Olsztyn, 05-500 Piaseczno, **Poland**. Telex: 825216; telephone: [(48) 22 56 20 44, 56 20 88, 56 74 86]

PUBLICATIONS

Four useful lists of publications on aquaculture were updated in 1990 and 1991 by Dr. André Coche, recently retired from FAO Fisheries Department in Rome. They are:

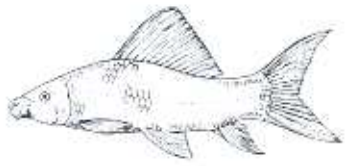
1.**Aquaculture in marine waters**: a list of selected reference books and monographs, 1961-1991. FAO Fisheries Circular No. 723 Revision 4. 1991. 56 p.

2.**Aquaculture in fresh waters** : a list of selected reference books and monographs, 1951 - 1991. FAO Fisheries Circular No. 724 Revision 4. 1991 60 p.

3.**A list of selected FAO publications related to aquaculture,** 1966-1989. FAO Fisheries Cricular No. 744 Revision 2. 1990. 60 p.

4.**Selected aquaculture publications** : serials, newsletters, meeting proceedings, and bibliographies/ directories/glossaries. FAO Fisheries Circular No. 808 Revision 1. 1991. 133 p.

Copies of these lists may be obtained by writing to the **Inland Water Resources and Aquaculture Service (FIRI), FAO, 00100 Rome, Italy.**



Dr. A. Coche and various collaborators have also prepared **a series of practical aquaculture training manuals**. Those published so far are:

1.Simple methods for aquaculture: **WATER** for freshwater fish culture. FAO Training Series No. 4. 1981. 111 p.

2.Simple methods for aquaculture: **SOIL** and freshwater fish culture. FAO Training Series No. 6. 1985. 174 p.

3.Simple methods for aquaculture: **TOPOGRAPHY** for freshwater fish culture; topographical **tools.** FAO Training Series No. 16/1. 1988. 330 p.

4.Simple methods for aquaculture: **TOPOGRAPHY** for freshwater fish culture; topographical **surveys.** FAO Training Series No. 16/2. 1989. 262 p.

Four more manuals in this series are in press, two each on **Construction and Management**.

All four existing manuals are available in English; No. 4 and No.16/1 are also available in French and No.6 in Arabic. Copies may be purchased from your local FAO Sales Agent or through the office of your FAO Representative or through **Distribution and Sales Section, FAO, 00100 Rome, Italy**.

Also popular have been the **aquaculture manuals in the FAO Better Farming Series** which are designed as hand books for intermediate-level agricultural education and training. They are illustrated by simple line drawings; available in English, French and Spanish, the text leads itself to adaptation in other languages. Those currently in press, which all relate to freshwater aquaculture, are :

1.Freshwater fish-farming: **how to begin**. FAO Better Farming Series No. 27. 1979. 43 p.

2.Water: **where water comes from**. FAO Better Farming Series No. 28. 1981. 31 p.

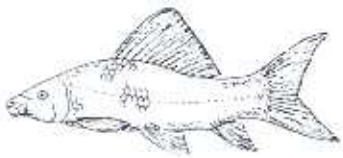
3.Freshwater fish-farming: **the pond.** FAO Better Farming Series No. 29. 1984. 44 p.

4.Freshwater fish-farming: **the fish.** FAO Better Farming Series No. 30. 1981. 48 p.

5.Freshwater fish-farming: **further improvement.** FAO Better Farming Series No. 35. 1986. 61 p.

6.Freshwater fishfarming: **raising fish in pens and cages.** FAO Better Farming Series No. 38. 1990. 83 p.

These manuals can be obtained from the **Distribution and Sales Section, FAO, 00100 Rome, Italy.**

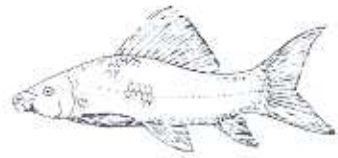


A recent edition of **"CERES : the FAO Review"** contains 21 pages featuring aquaculture, including integrated development, the Asian shrimp farming boom and progress in Africa and Latin America. CERES, the premier magazine of development, is published in Arabic, English, French and Spanish and costs US$24 per year for six issues. The subscription fee is waived for some readers in the developing countries who meet the required criteria. Write to The Editor, CERES, **Distribution and Sales Section, FAO, 00100 Rome, Italy.**

The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), co-sponsored by 8 United Nations agencies, recently prepared a report entitled: **"Reducing Environmental Impacts of Coastal Aquaculture"**. The report first analyses the ecological impact of coastal aquaculture developments and also considers implications for human health as well as related socio-economic aspects. In the second part, it provides guidelines for the development of environmentally acceptable coastal aquaculture.

This document suggests specific actions which include the formulation of coastal aquaculture development and management plans, application of environmental impact assessment to project proposals, establishment of guidelines governing the use of mangrove wetland, bioactive compounds, transfers and introductions of species, and improvement of siting and operation of fish farms. Emphasis is also given to monitoring of ecological change and to the application of regulatory measures promoting sound environmental management of coastal zones.

The report [Rep. Stud. GESAMP, (47): 35p. 1991], can be obtained by writing to the **Inland Water Resources and Aquaculture Service, (FIRI), FAO, 00100 Rome, Italy.**



Between 1984 and 1990, FAO prepared twenty-eight **National Reviews for Aquaculture Development in Africa.** Those published in 1990 were for Burundi, Nigeria, Rwanda and Zaire. Containing information on fishery and aquaculture status and development, together with background information on geography, climate, hydrology, demography, land and water use, fish marketing, infrastructure, national food policy, etc., these reviews are essential reading for those contemplating aquaculture development in Africa. Copies are obtainable from the **Inland Water Resources and Aquaculture Service (FIRI), FAO, 00100 Rome, Italy.**

An essential publication for those interested in **aquaculture statistics** is published annually, based on returns from FAO's member states. Information is provided on aquaculture production by species groups, by country and by environment, as well as the value of aquaculture production by country. The latest version, published in 1991, covers aquaculture production up to the year 1989. An updated version, covering 1990, is expected to be available by July 1992. The current issue is called Aquaculture Production (1986-1989), (FAO Fisheries Circular No. 815 Revision 3, Rome, FAO. 1991. 141 p.) and is obtainable from the **Fishery Information, Data and Statistics Service (FIDI), FAO, 00100 Rome, Italy.**