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*Cage culture of marine fish, Thailand*

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*The FAO Aquaculture Newsletter (FAN) is issued three times a year by the Inland Water Resources and Aquaculture Service, Fishery Resources Division, of FAO's Fisheries Department, Rome, Italy. It presents articles and views from the FAO aquaculture programme and discusses various aspects of aquaculture as seen from the perspective of both Headquarters and the field programme. Articles are contributed by FAO staff from within and outside the Fisheries Department, from FAO regional offices and field projects, by FAO consultants and, occasionally, by invitation from other sources. The FAN is distributed free of charge to various institutions, scientists, planners and managers in Member Countries and has a current circulation of about 3,000 copies. It is also available on the FAO internet Home Page: http://www.fao.org./waicent/fishery/newslet/newslet.htm*



# Editorial

## Importance of Aquaculture to Global Food Fish Supplies

*Although the total production of finfish and shellfish from capture fisheries amounted to 92 million metric tonnes (mmt) in 1995, only 61 mmt (live weight) or 66.3% was available for direct human consumption as 'food fish'. The remainder (31 mmt) was reduced into fishmeal and fish oil for use in animal feeding or for industrial purposes. Total food fish production from capture fisheries grew at an average compound growth rate of 1.5% per year between 1984 and 1995 or equivalent to the growth of the human population over the same period. By contrast, aquaculture has been the world's fastest growing food production system for the past decade with food fish production increasing from 6.69 to 20.94 mmt over the same period, with the sector growing at an average rate of 10.9% per year since 1984, as compared with a growth of 3.1% for terrestrial livestock meat production. On the basis of this rapid growth, it is perhaps not surprising that aquaculture's contribution toward total world food fish landings (i.e. 81.9 mmt in 1995; figure includes both food fish landings from capture fisheries and aquaculture) has increased more than two-fold from 11.5% in 1984 to 25.6% by weight in 1995. One in four food fish consumed by humans in 1995, from a total average per caput food fish supply of 14.4 kg, is now being provided by aquaculture. On a per caput food fish supply basis, aquaculture food fish production has increased by 163% since 1984 from 1.40 kg to 3.68 kg in 1995, at an average rate of 9.2% per year. By contrast, per caput food fish supply from capture fisheries has remained relatively static, decreasing from 10.8 kg in 1984 to 10.7 kg in 1995.*

*Of particular importance is the fact that over 85% of total aquaculture food fish production came from developing countries (as compared with 51% in the case of terrestrial animal meat production), and in particular from Low Income Food Defecit Countries or LIFDCs. The latter supplied over 76% of total food fish output from aquaculture (as compared with only 37% in the case of terrestrial meat production), with per capita aquaculture food fish production increasing nearly four-fold from 1.2 to 4.5 kg between 1984 and 1995, at an average rate of 12.3% (as compared with an average population growth rate of 2.1% over the same period). The main reason why food fish play such an important dietary role in these countries is its ready availability, and more importantly, its affordability (lower cost than most other conventional terrestrial animal protein sources). By contrast, the bulk of aquaculture food fish production within developed countries is generally restricted to the production of higher value (in marketing terms) food fish species for luxury or export markets. Clearly, if aquaculture food fish production is to contribute in a sustainable manner to food security within developing countries as a provider of an affordable source of much needed high quality animal protein, then it is essential that governments continue to encourage the further development of aquaculture production systems targeted toward the production of lower value herbivorous and/or omnivorous finfish and shellfish species feeding low on the aquatic food chain; these species being less demanding in terms of inputs and more efficient in terms of nutrient resource use (ie. by avoiding the use of finite 'food grade' animal feed inputs and maximising the use of locally available nutrient sources and agricultural waste streams), as well as keeping feed and input costs to a minimum and therefore within the economic grasp and capability of the both the resource-poor and resource-rich farmers and consumers*

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# INTERNATIONAL TRADE IN AQUACULTURE PRODUCTS

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International seafood exports reached US$ 52 billion in 1995, up from US$ 35.8 billion in 1990. The share of exports from developing countries has grown from 44 % in 1990 to 51 % in 1995 and their net receipts of foreign exchange rose from US$ 10.4 billion to US$ 18 billion in the same period. The rapid growth in aquaculture production has made the sector important to the economy of many developing countries and, in the case of some traded aquatic products, the sector has become either an important source of supply or the main supplier. In these cases, fluctuation in production of farmed products has significant impact on price trends. In general, however, aquaculture products have helped to stabilize supplies of traded products and to bring down prices over the years. This has made what was previously luxury products available at lower prices and helped expand markets.

The extent of regional and international trade in aquaculture products is difficult to analyze because trade in many aquaculture products is not yet well documented in the main producing countries, and since international trade statistics do not distinguish between wild and farmed origin. Thus, the exact breakdown in farmed and wild origin in international trade is open to interpretation. This situation will change gradually, as producers associations emerge in main producing countries and begin to keep records and in response to various trade regulations/pressures which distinguish between farmed and fished products.

The main traded products from aquaculture in 1995 were shrimp and prawns, salmon and molluscs. Other species showing strong growth in trade are tilapia, seabass and seabream.

**Crustaceans.** The most prominent product from aquaculture in international trade is **marine shrimp** and aquaculture has been the major force behind increased shrimp trading during the past 7-8 years. Shrimp is already the most traded seafood product internationally, and in 1996 about 25 % or 700,000 mt came from aquaculture (Rosenberry, 1996). Since the late 1980s, farmed shrimp has tended to act as a stabilizing factor for the shrimp industry. Therefore, the major crop failures in Asia and Latin America during the past few years have had an impact on overall supply, demand, prices and consumption trends. For example, shrimp consumption declined in the US in 1995 due to lower imports caused by declining supplies from Asian countries.

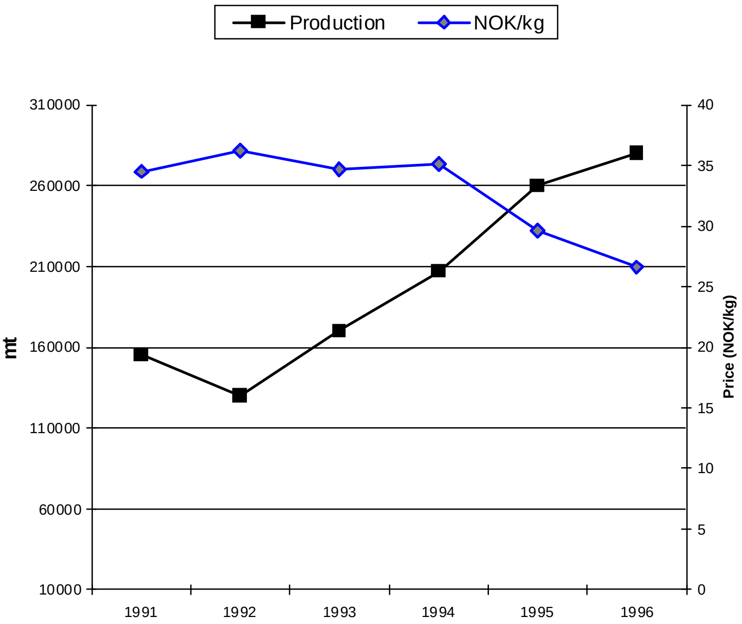
The major markets are Japan, the USA and, to a lesser extent, the European Union (EU), and the largest exporters of farmed shrimp (during the first nine months of 1996) are Thailand, Ecuador, Indonesia, India, Mexico, Bangladesh and Vietnam (Branstetter, 1997). The contribution of farmed shrimp to total domestic shrimp production in these exporting countries is shown in Table 1. Demand for shrimp and prawns is expected to increase in coming years. Asian markets such as China, Korea Rep., Thailand, Malaysia, will expand as local economies grow and consumers demand more seafood. This trend is already reducing the availability of shrimp to traditional importers and will eventually put upward pressure on prices if supplies do not expand. Increase in prices will encourage new entries into shrimp farming; if sustainable methods of production are practised that would help avoid production crashes, national curbs on production expansion, or trade embargoes.

Trade in **crab** species has increased with growing aquacultural production (1995: 98,000 mt ). Especially important have been the exports of China ( 21,000 mt in 1995) to Hong Kong and Japan.

**Finfish.** In terms of total aquaculture output, finfish production ranks first with 14.7 million mt produced in 1995, or about 53 % of the total production from aquaculture. The major part of this is carps (69% of total finfish production in 1995) which are consumed locally in the producing countries (mainly China and India).

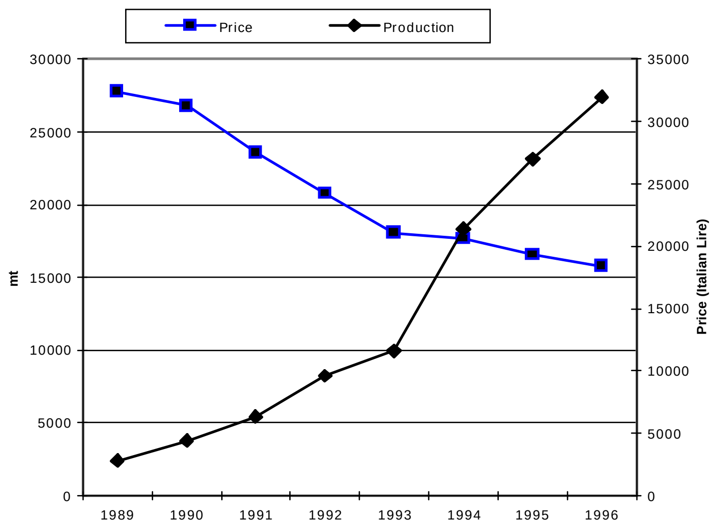
International trade in farmed **salmon** has increased from virtually zero to more than 500,000 mt (1996) in less than a decade. The traded species are mainly Atlantic salmon and, to a much lesser extent, coho salmon, which accounted for 87 and 11 % of production in 1995 respectively (FAO, 1997a). Growth in trade has followed the growth in salmon production, as the bulk of production is concentrated in a few countries with limited domestic markets — Norway, Chile and the UK. Norway is the main exporter of Atlantic salmon, and Chile is the main exporter of coho salmon and second largest exporter of Atlantic salmon. The EU is the main market for Norway (70% of exports) and Japan and the US are the main markets of Chile (60% and 30% of exports respectively). Norway has targeted Asia as the future growth market in addition to further penetration of the European markets, and more than US$ 7.25 million was spent in 1996 on promoting salmon and trout. Chilean producers foresee strong growth in the USA and Latin American markets and more emphasis in the industry on fillets and value-added products (FAO, 1996; Lem and Di Marzio, 1996).

With increased production volumes, costs and prices have been driven down, and at current levels (US$ 3.50-4/kg CIF) salmon has become a relatively medium priced product in international seafood markets (Figure 1).




Source : Seafood Export Council (EFF), Norway

Figure 1: Norwegian salmon production and export prices




Source: Wholesale prices,Fish market, Milan, Italy

Figure 2: Sea bream production and price development

International trade in **trout** is much less that in salmon, with exports reaching 55,000 mt in 1995 out of a total production of 384,000 mt. Consumption is concentrated in trout producing countries, but Norway and Chile have been able to farm particular qualities of large-sized heavy pigmented trout for the Japanese market (Japanese 1996 trout imports: 36,500 mt).

**Tilapia** is another species which has shown a tremendous growth in output (production of 660,000 mt in 1995). International trade is limited but growing, especially between Central America (Costa Rica, Ecuador and Colombia) and the USA, and between Asian producers (Taiwan PC, Indonesia and Thailand) and the USA and Japan. There is also modest trade between Jamaica and the UK. The biggest exporter, Taiwan PC, supplies Japan with high quality tilapia fillets for the sashimi market and ships frozen tilapia to the American market, with total exports of 16,000 mt in 1996. Taiwan PC exports about 35% of its domestic tilapia production and supplies 79% of the US tilapia imports (1996) (Table 2). Thailand and Indonesia export less than 5 % of their production (Dey & Eknath, 1997). Vietnam has also recently entered the world tilapia market and China exported the fresh weight equivalent of 122 mt to the USA in 1996.

Tilapia is now the third most imported aquaculture product by weight in the USA (1996 imports of 19,000 mt), after shrimp and salmon. USA imports were up 21% by quantity in 1996, following an increase of 33% in 1995, and are forecast to increase further in 1997. Long term tilapia prices are expected to decrease and this should lead to greater exports to the USA as well as to Europe which presently is undeveloped as a market for tilapia.

In Europe, the **seabream/seabass** industry intends to copy the success of salmon growers. Production reached about 60,000 mt in 1996 of which nearly 90 % was exported, mainly to Italy and Spain (FAO, 1997a). The main exporter was Greece, with about 70 % of domestic production exported. Italy has been almost the exclusive market for Greek production. However, as a result of market development efforts, about 15% of Greek exports in 1995 went to new markets (UK, Germany, France, etc.) and the share of new markets is expected to grow (Stephanis, 1996). At the opposite end, trade in fingerlings was from Italy, Spain and France to farms in Greece, Malta and Croatia.

As output of seabass/seabream has grown, costs have been driven down, and market prices have almost been halved during 1990-1997, from US$ 16/kg to around US$ 8/kg. The rapid saturation of the market and the parallel rapid decline in prices (50 % in five years, compared to 50 % in ten years in the case of Atlantic salmon) is attributed

Table 1. Contribution of aquaculture to national shrimp production (1995)

| Country | % of total production |
|---|---|
| China | 13 |
| Ecuador | 90 |
| India | 32 |
| Indonesia | 43 |
| Mexico | 18 |
| Thailand | 69 |
| Viet Nam | 38 |

Source: FAO, 1997b,c

Table 2. U.S. tilapia imports by country in 1996 (quantities = fresh weight equivalent)

| Country | Quantity (metric tons) | Value (US$x 1,000) |
|---|---|---|
| Taiwan, PC | 15,032 | 24,822 |
| Costa Rica | 1,082 | 5,887 |
| Ecuador | 96 | 3,661 |
| Indonesia | 579 | 2,684 |
| Thailand | 284 | 1,489 |
| Jamaica | 246 | 1,399 |
| Colombia | 225 | 1,276 |
| Honduras | 21 | 914 |
| Belize | 153 | 226 |
| China | 122 | 267 |
| Other | 151 | 393 |
| Total | 19,044 | 43,018 |

Source: USDA, 1997

to the much smaller traditional market for these species (Southern Europe), compared to Atlantic salmon, lack of diversified products, inadequate market development, and absence of technological advances (e.g. genetic improvement; efficient feeds and feeding strategies, etc.) which could significantly improve productivity. The substantial drop in price of these species should help open new markets and expand existing ones, provided acceptable profit margins can be sustained at the production end through improvements in productivity and diversification of products.

**American catfish** is now the fifth most consumed fish in the USA (0.36 kg/capita edible weight in 1995). Exports are limited as the production is aimed at the domestic market, but producers have recently started exporting to Europe. The reason for the success of catfish is similar to that of tilapia: consumer demand for white, easy-to-prepare fillets.

**Seaweed.** Farmed seaweed production has been growing in the last decade (6.1 mmt in 1995) and is now 86 % of total seaweed supplies. Most of output is utilized domestically for food, but there is growing interna-tional trade. China, the major producer, has started exporting seaweed as food to Korea Rep. and Japan. Korea Rep. in turn exports some quantities of *Porphyra* (red seaweed) and *Undaria* (brown seaweed) to Japan (total Korea Rep. 1996 exports: 21,000 mt).

Significant quantities of *Eucheuma* (red seaweed), are exported by the Philippines, Tanzania and Indonesia (total Indo-nesian 1995 exports: 18,000 mt) to the USA, Denmark and Japan. Total EU imports of seaweed in 1995 amounted to 58,000 mt with the Philippines, Chile and Indonesia as the biggest suppliers.

**Molluscs.** International trade in molluscs is relatively limited compared to total output with less than 10 % of total output traded. Major importing markets are Japan, USA and France, and major exporters are China and Korea Rep. The contribution of farmed products to trade is uncertain.

Farmed mollusc production volumes are fairly evenly split between oysters, clams, mussels and scallops, but in international mollusc trade 70% of value is concentrated in scallops and clams (fresh and frozen). Total fresh and frozen **scallop** imports have grown from 28,000 mt in 1985 to 60,000 mt in 1995, reaching US$ 493 million. Clam imports have grown from 33,000 mt to 178,000 mt in the same period, valued at US$ 295 million. **Mussel** imports were showing a downward trend after a peak of 175.000 mt in 1992 but have now levelled out at 130.000 mt or US$ 188 million. **Oyster** imports have been growing steadily from below 10,000 mt in 1985 to 30,000 mt in 1994 and seem now to have stabilized at this level (1995: 27,000 mt, US$ 140 million.).

**Live Seafood.** Asia is rapidly increasing its consumption of live seafood as a result of cultural preferences and growing affluence. The live seafood market is largely restricted to the restaurant trade and to consumers with a relatively high disposable income. Major market expansion is anticipated due to good demand in China, but expansion is also expected in Malaysia, Singapore and Taiwan PC, as well as in parts of North America with large Chinese communities. The potential for aquaculture to supply the market is promising. The sector is already supplying large amounts of shellfish and limited quantities of grouper, crabs and other species. Technological developments in the culture of preferred livefood species will increase the contribution of aquaculture to supplies (Riepen, 1997).

**Seed supplies.** There appears to be significant regional and international trade in seed of cultured aquatic organisms, mainly from aquaculture sources, but this is poorly documented at present in most instances. Mention has been made above of regional trade in Mediterranean seabass and seabream, but there is also trade in glass eels ( e.g. recent large purchases of European eel elvers by China), post-larvae of various cultured shrimps, Indian and Chinese carps, and others. There is also limited trade (in terms of quantity) in broodstock. Documentation of trade in seed will improve gradually as in response to concerns about spread of diseases and the movement of genetic material.

## Issues Affecting Future Trade in Aquaculture Products

**Externalities.** Environmental and social concerns have already influenced farmed shrimp exports to North America and Europe in 1997. The importance of sustainable aquaculture with no or limited externalities will force many exporting countries to adopt more sustainable production practices. The introduction of eco-labeling schemes will further increase this trend.

**Quality.** With growing concern about food safety, increasing efforts have been undertaken to improve the quality of aquaculture products. International codex standards cover aquaculture products, and the introduction of mandatory HACCP requirements for exports to the USA and the European Union in 1997 will heavily impact trade in aquaculture products in the near future. Some countries have developed comprehensive HACCP plans for selected aquaculture products; for example, the USA has now plans for catfish, crawfish and molluscan shellfish. In other countries, individual aquaculture producers undertake voluntary certification (ISO 9000) for control as well as marketing purposes.

**Tariffs.** Despite steady reductions in tariffs on fish and aquaculture products in recent years, tariffs as well as import licenses continue to represent barriers to trade in many countries. This is especially the case in many fast growing economies in Asia, but important markets such as Japan, the European Union as well as the USA all give competitive advantages to domestic producers of many species, especially in the case of processed products. Average tariffs on imports from developing countries are now estimated at 4.8 %, a cut of 27 % from previous levels (FAO,1995). The long term trend, with growing membership in the World Trade Organization will lead to further reductions in tariffs.

**Food security.** As the major part of total output from aquaculture is consumed internally by producing nations, aquaculture is an important source of seafood. Aquaculture has also become a significant source of foreign currency to many developing nations as the products exported usually are the more valuable ones and destined for markets in the developed world. These revenues allow the countries to import other less costly protein, and as such, aquaculture can be considered important to food security even when the output is exported.

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Hybridization is the mating of genetically differentiated individuals or groups and may involve crossing individuals within a species (also known as line crossing or strain crossing) or crossing individuals between separate species. This breeding technique is used by aquaculturists in the hope of producing aquatic organisms with desired traits. Commonly, the desired goal is to produce offspring that perform better than both parental species (hybrid vigor or positive heterosis). Hybridization may also be used to transfer other desirable characteristics from one group or species to another, to combine valuable traits from two species into a single group, and to produce sterile individuals. This article focuses on the hybridization between different species, i.e. inter-specific hybridization, and we will limit the coverage to species of finfish.

# The use of inter-species hybrids in aquaculture and their reporting to FAO

*D. M. Bartley, K. Rana and A. J. Immink*

Much of the early work on finfish hybridization in aquaculture was conducted on salmonids, but, in general, these species did not produce hybrids of commercial advantage because of insufficient growth improvement and lower survival. As a result, there was or perhaps still is, an impression that hybrids do not hold much attraction for aquaculturists. With the expansion of the sector and the increased number of species being bred and farmed, there are hybrids that now account for a substantial proportion of aquaculture production, and other hybrids may be emerging through further development. The increased use of induced spawning techniques such as hypophysation (the use of pituitary gland extract to induce ovulation) and synthetic hormones, in-vitro fertilisation technologies and increased knowledge of reproductive biology will enable the aquaculturist to overcome many of the behavioural, biological and geographical reproductive isolating mechanisms that prevent fish from hybridizing in nature.

The purpose of this article is to point out some of the hybrids used in aquaculture to draw attention to their growing contribution to aquaculture production. We also wish to point out the problem that hybrids presently cause with regard to their inclusion in FAO databases.

## The use of hybrid finfish in aquaculture

Hybridization is widely used to increase growth rate, manipulate sex ratios, produce sterile animals, improve flesh quality, increase disease resistance, and improve environmental tolerance (Table 1). Hybridization between some species of tilapias such as *Oreochromis niloticus* x *O. aureus* results in the production of predominantly male offspring and reduces unwanted natural reproduction in growout ponds (Rosenstein and Hulata, 1993). Most of the tilapia production in Israel is based on this hybrid and reported by FAO as *Oreochromis spp*. The African x Thai catfish hybrid (*Clarias gariepinus* x *C. macrocephalus*) is preferred to the Thai catfish because it has the desired flesh quality of the Thai catfish and the fast growth of the African. The Thai National Inland Fisheries Institute indicated that nearly 80% of the Thai catfish aquaculture is based on this hybrid, however this is not reflected in official statistics which simply lists production as "*Clarias spp*.". In the USA the striped bass, *Morone saxatilis*, x white bass, *M. chrysops*, hybrid is the sixth most cultured "fish species". It accounts for 1.4% of the production and has only recently been included in FAO statistics. The production of *Colossoma macropomum* in Venezuela accounts for 29% of total aquaculture according to official information provided to FAO, but government aquaculture experts now believe that most of this production is of the hybrid between *C. macropomum* and *Piaractus brachypoma* (Photo 1). Other popular hybrids that are not found in government reports to FAO include the "bester" a sturgeon cross between the Beluga, *Huso huso* and the sterlet, *Acipenser ruthenus*, and the blue, *Ictalurus furcatus*, x channel, *I. punctatus*, catfish.

Hybrids may be used to exploit degraded aquatic environments. Lakes affected by acid rain may not be suitable for native salmonids, yet they are suitable for splake, a hybrid between lake trout, *Salvelinus namaycush*, x brook trout, *S. fontinalis*, that can tolerate low pH levels (Snucins, 1993).

Chromosome-set manipulation (eg Polyploidization) can be combined with hybridization to increase the viability of fishes and provide increased developmental stability during early life history stages. Polyploid hybrid salmon appear to be better suited for culture than either polyploid or hybrid salmon are on their own. Although many diploid salmonid hybrids are not used for culture, triploidization of the hybrids may confer increased viability on the hybrids (viability refers to the ability of the hybrid to survive and grow, but does not infer that the hybrid is fertile or capable of reproducing) (Gray et al., 1993). Hybridization and polyploidization utilized in tandem have improved developmental stability in salmonid x hybrids, for example triploidization of Atlantic salmon, *Salmo salar*, x European (brown) trout, *S. trutta*, hybrids crossed to produce sterile salmon, increased their survival and growth rate to a level comparable to diploid Atlantic salmon (Galbreath and Thorgaard, 1997). Triploid

*Hybrid between Colossoma macropomum and Piaractus brachypomus, Papelón Station, Venezuela*

*Inadvertant hybrid (top), between farmed Nile tilapia O. niloticus (bottom) and an unidentified tilapia (possibly O. mossambicus or O. andersonii), that invaded farm ponds, Chizzizira Hatchery, Mozambique*

Pacific salmon hybrids have earlier seawater acclimation times (Seeb et al., 1993). General disease resistance was improved by producing rainbow trout, *Oncorhynchus mykiss*, x char, *Salvelinus spp*., triploids and rainbow trout x coho salmon, *O. kisutch*, triploid hybrids had increased resistance to infectious hematopoetic necrosis virus (IHN), but these hybrids grew more slowly (Dorson et al., 1991).

As the domestication of fish species increases, the possibilities to increase production through appropriate hybridization will also increase. New hybrids will need to be tested as to their performance, viability (their abilty to grow), and fertility (their ability to reproduce). The Kuwait Institute of Scientific Research has produced a hybrid bream, *Acanthopagus latus* (Sheim) *x Sparidentex hasta* (sobiaty), that is currently being investigated. It has good growth and body quality and appears to be fertile (Khaled Al-Abdul-Elah, Kuwait Institute of Scientific Research, pers. comm.).

Although many aquaculturists purposefully produce inter-specfic hybrids, some hybrids are produced inadvertently through mixed spawning of different species in a hatchery, misidentification of species by hatchery personnel, or by contamination of the aquaculture facility with wild fish (Photo 2). To produce Indian major carp seed, different species are often induced to spawn in a common spawning pond thus providing the opportunity for unintentional hybridization (Padhi and Mandal 1997). Hybridization with wild fish is especially prevalent in tilapia ponds connected to natural water bodies that contain indigenous or feral tilapia populations. Such uncontrolled and unintentional hybridization could undermine the performance of cultured stocks and make future use of the contaminated stocks as broodstock questionable.

## Reporting Hybrid Production to FAO

To collect data on aquaculture production from countries, FIDI (Fisheries Information, Data and Statistics Unit) sends out two questionnaires to each reporting country: a fisheries questionnaire and an aquaculture questionnaire. Total aquaculture production is included in the fisheries questionnaire and a breakdown of aquaculture production is requested in the aquaculture questionnaire. From this information FIDI annually produces the Fisheries Circular No. 815 - Aquaculture Production Statistics. Users of this publication will be aware that the data are available in various forms, but are all based around species or groupings of production from each country.

The incorporation of production information on hybrids is not easily reflected in the FAO database since the taxanomic classification code adopted by FAO cannot accommodate the hybrid nomenclature. The taxomomic code descriptors, as listed in FAO's Aquatic Sciences and Fishereis Information System, for e.g. 1,70(59)051,01 *Oreochromis mossambicus* are as follows:

| | |
|---|---|
| main grouping | 1 |
| order or sub-order | 70 |
| family | (59) |
| genus | 051 |
| species | 01 |

As can be seen, there is no provision for hybrids in this coding system. Moreover, the FAO questionnaire on aquaculture requests that respondents report species and consequently hybrids may often be reported to the taxonomic level of genera only, e.g. *Clarias* spp. or grouped as ‘nei’ (not elsewhere included). The increased tonnage of incompletely identified species reported by FAO reduces the usefulness of the data for monitoring the utilisation of aquatic biodiversity for aquaculture. This problem is not specfic to FAO, most international monitoring organisations require more clarity in the data they are provided with.

As well as information on production, the value of production is also included in the FAO database. Hybrids may command a premium price where their quality, e.g. flesh colour or texture, is superior, requiring that this difference in price be recorded separately. For example hybrid striped bass x white bass in the USA currently sell for $3/lb ($6.6/kg) and freshwater white bass have a market price of $2.44/lb (adapted from USA fishery production statistics).

Within the FAO aquaculture questionnaire, there is provision for each country to supply production data for every species it produces and any “other production”, including hybrids. Some countries do report hybrid production, for example tilapia in Israel, but in many cases this reporting is inconsistent. The lack of constant reporting could be the result of limited interest in a hybrid. If the hybrid is well known, it could be reported as such for a short time, after which it is reported in the other groupings, such as family/genus or even as pure species. Tilapia hybrids in Israel were originally reported as the full cross (*Oreochromis niloticus* x *O. aureus*), but after two years this reverted to ‘tilapia hybrids’ and eventually to ‘tilapia nei’ (*Oreochromis* spp.) in 1995.

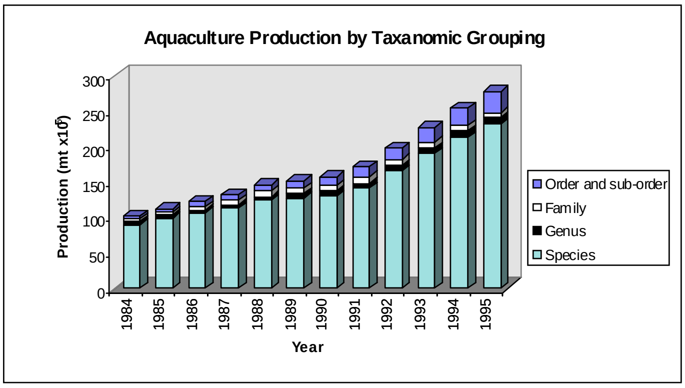


Figure 1. Breakdown by taxonomic level of total aquaculture production (including aquatic plants) reported to FAO.

Unclassified groupings, i.e. the production that is not reported as species, accounted for approximately 16 percent of annual global aquaculture production over the last seven years (in 1995 this was 4,669,000 tonnes). Of this unclassified production, the greatest percentage originates from production recorded to the taxonomic level of Order. Hybrids may have been reported in any category, but because most hybrids in Table 1 are of the same Genus, most, but not all, hybrids would probably be reported to Genus, which accounted for 3.6% of total aquaculture production in 1995. An unknown proportion of this production is likely to be hybrids, for example, *Clarias* spp reported by Thailand. It is assumed that the lack of reporting may be due, on one hand, to the difficulty of assessing parental origins of inter-specific hybrids and, on the other, because of the aggregation of small levels of production. It is also expected that some of the production given as species will include some hybrids. For example, tilapia production in Indonesia is given as *Oreochromis niloticus* and *O. mossambicus*, but it is known that a percentage of the production is of *Oreochromis* hybrids. This is important, not only for assessing aquaculture production in each country and of each species or hybrid, but also to allow for a better understanding of biodiversity. If the levels of production for hybrids are not known, countries could add an attachment to their returned questionnaires suggesting the probable percentages of the production resulting from the culture of each hybrid. Possible means of dealing with these shortcomings are summarized in Table 2.

In concluding, we wish to point out that it is not our intention to promote hybridization as the only method of genetic improvement, but simply as *one* method of improvement that has potential for some immediate gains. Desirable traits can usually be passed to the hybrid in one generation but it should be appreciated that hybridization can be a hit and miss proposition. In the case of some fertile hybrids, it may be desirable to backcross to either parental line or to breed the hybrids together and then select the best animals, thus combining hybridization and selective breeding. Although hybridization may not require the data management that a long term selective breeding programme would require, proper broodstock management, including the documentation and maintenance of the correct parental lines, avoidance of inbreeding, and the appropriate choice of sex for the matings, will be necessary. Documentation of the use of hybrids will be necessary to evaluate correctly the utility of this technique.

The reporting of hybrid production to FAO is strongly encouraged. It is of paramount importance to ensure that the correct information is being collected, collated and disseminated so that any decisions made using FAO statistics are done so on the correct knowledge base.

Readers are encouraged to provide additional information on the use of hybrids in aquaculture to the authors.

| Table 1. Hybrid animals in aquaculture | | |
|---|---|---|
| **Species Hybridized** | **Effect/advantage and comments** | **Reference** |
| **Cyprinids** | | |
| Grass x bighead carp (*Ctenopharyngodon idella x Aristichthys nobilis*) | Sterile; natural triploids | (Allen and Wattendorf 1987) |
| Mud loach x cyprinid loach (*Misgurnus mizolepis x M. anguillicaudatus*) | High hatch and survival, probably fertile | (Kim et al. 1995) |
| Silver x Bighead carp (*Hypophthalmichthys molitrix x Aristichthys nobilis*) | Fertile, with positive heterosis for growth rate. Pure lines may be lost due to fertility of hybrids. Food and feeding strategy is intermediate to parents. | (Krasnai 1987) |
| Common carp x rohu (*Cyprinus carpius x Labeo rohita*) | Sterile, good growth in monoculture and survival and good seinability. Good subsititute for fertile common carp. Common carp (natural tetraploid) mated with diploid cyprinids yielded sterile triploids. Many deformities and high juvenil and larval mortality | (Khan et al. 1990) |
| Common carp x mrigal (*C. Carpio x Cirrhinus mrigala)* | As above | |
| Common carp x catla (*C. Carpio x Catla catla*) | As above | |
| **Trout and salmon** | | |
| Brown x brook trout (*Salmo trutta x Salvelinus fontinalis*) | Sterile,common name is Tiger trout. | (Scheerer and Thorgaard 1983) |
| Atlantic salmon x brown trout (*Salmo salar x S. trutta)* | Triploidization of this hybrid increased survival and growth rate to a comparable level to Atlantic salmon, but offspring would be sterile. | Galbreath and Thorgaard 1997) |
| Lake trout x brook trout (*Salvelinus namaycush x S. fontinalis*) | Fertile, fast growing, tolerant of acid water. Common name is Splake. | (Snucins 1993) |
| Chum salmon x chinook salmon (*O. keta x O. tshawytsha*) | These triploid hybrids had early sea-water tolerance. | (Seeb et al. 1993) |
| Rainbow trout x char *(O. mykiss x Salvelinus sp.* ) | General disease resistance to salmonid viriuses were improved in several crosses. | Dorson et al. 1991 |
| Pacific salmon crosses (*Oncorhynchus spp.)* | Most diploid hybrids not useful in culture or fisheries, but have potential for disease resistance, sterility, and early seawater tolerance when the diploid hybrids are made triploid. Also useful for all female production using denatured sperm and rediploidization of egg. | (Scheerer and T horgaard 1983, Grey et al. 1993) |
| **Tilapia (most if not all tilapia hybrids appear to be fertile)** | | |
| Nile x blue tilapia (*O. niloticus x O. aureus*) | All male offspring in some strains; Superior growth of males; fertile hybrids, increased cold and salinity tolerance. Reciprocal cross gives 50% males and females. | (Lahav and Lahav 1990, Wohlfarth 1994) |
| *O. niloticus x O.hornorum* | Predominately male offspring. | (Wohlfarth 1994) |
| *O. niloticus x O. macrochir* | Predominately male offspring, but strain of Nile tilapia important for good fry production. | |
| *O.mossambicus x O. hornorum* | Predominately male offspring, fertile hybrids; however slow growth and dark color | (Krasnai 1987, Wohlfarth 1994) |
| *O. urolepis hornorum x O. mossambicus* | Red tilapia with salinity tolerance | (Head et al. 1994) |
| Mossambique x Nile tilapia *(Oreochromis mossambicus x O. niloticus)* | Red tilapia with salintiy tolerance Taiwan red tilapia, progeny of these give range of colors. | (Lim et al. 1993) |

| Species Hybridized | Effect/advantage and comments | Reference |
|---|---|---|
| **Miscellaneous freshwater fish** | | |
| Black x white crappie (*Pomoxis nigromaculatus x P. annularis)* | Heterosis for growth; F1's are fertile. Limited F2 recruitment for unknown reasons<br>Recommended for stocking small impoundments | (Hooe et al. 1994) |
| *Colossoma macropomum x Piaractus brachypoma* | Good growth rate and probably fertile | FAO unpublished report |
| Tambaqui x pacu (*Colossoma macropomum x Piaractus mesopotamicus*) | Good early survival, no information on fertility of hybrids, probably fertile | (Senhorini et al. 1988) |
| *Esox masquinongy x E. lucius* | Cost effective and suitable for intensive culture;sterile<br>Tiger muskellunge | (Brecka et al. 1995) |
| Walleye x sauger (*Stizostedion vitreum x S. canadense)* | Intensive culture alternative to catfish; fertile. | (Hearn 1986) |
| Green sunfish x bluegill (*Lepomis cyanellus x L. macrochirus*) | Good culture characters, growth, low oxygen tolerance. Fertile, but producing skewed sex ratios<br>Other Lepomis hybrids similar. | (Tidwell et al. 1992, Will et al. 1994) |
| **Miscellaneous marine and diadromous fish** | | |
| Black drum x red drum (*Pogonias cromis x Sciaenops ocellatus)* | Faster growth rate to 9months., slightly lower survival; Sterility unknown<br>Reciprocal cross yielded 0% fertilization | (Henderson-Arzapalo and Maciorowski 1994) |
| Beluga x sterlet sturgeon *(Huso huso x Acipenser ruthenus)* | Fully fertile offspring with good culture characters, does not need to be anadromous as Beluga.The Bester is most desirable and the reciprocal cross not as good. | (Steffens et al. 1990) |
| Beluga x Russian sturgeon (*H.huso x A. güldenstäti)* | Being tested in the former USSR and appears to have tolerance to both fresh and seawater; fertility is unknown | (Gorshkova et al. 1996) |
| White bass x striped bass *(Morone chrysops x M. saxatilis*) | Good culture characteristics, Sterile, but fertile in some crosses. Sunshine bass; Cool water hybrid (Reciprocal cross, Palmetto bass, not as desirable) | (Smith 1988) |
| Gilthead seabream x red seabream (*Sparus auratus x Pagrus major*) | Produced sterile hybrids | Hulata 1995 |
| Sheim x sobiaty (*Acanthopagus latus x Sparidentex hasta)* | Recently produced in Kuwait, appears to have good growth and fertility | (Khaled Al-Abdul-Elah, Kuwait Institute of Scientific Research pers. comm.) |
| **Catfish** | | |
| African x Thai catfish (*Clarias gariepinus x C. macrocephalus)* | Superior flesh and growth characters<br>Artificial fertilization and spawning induction required | (Suresh 1991) |
| African catfish x Vimba catfish (*C. gariepinus x Heterobranchus longifilis)* | Fertile F1 and F2 hybrids and backcrosses | (Nwadukwe 1995) |
| *C. gariepinus x H. bidorsalis* | Positive heterosis for growth rate and size. | (Salami et al. 1993) |
| Numerous catfish species are being hybridized in Venezuela | Testing underway on useful hybrids for aquaculture and aquarium industry | FAO unpublished report |
| Channel x blue catfish (*Ictaluras punctatus x I. furcatus*) | Superior growth in ponds and high density culture; also disease resistence, low Oxygen tolerance, dressing percentage and ease of fishing and seining. | (Dunham 1987, Dunham et al. 1990) |

**Table 2. Suggestions for reporting data on inter-species hybrids**

| | |
|---|---|
| Reporting data on hybrid production should be standardized and consistent | Problems may arise because parental origins of the hybrid may not be clear, leading to inconsistent annual reporting. If the exact cross is known the female should be given first. Where the cross is random the order should be given consistently, but the sex of the parents should be given in parentheses. |
| Countries need to establish that a hybrid is going to be part of the long-term production system. | Currently, FAO adds any short-term production of a hybrid to the 'nei' (not elsewhere included) grouping of the appropriate genus. For a hybrid to become included as a separate entry in the record it needs to be reported consistently over a period of years, even where the levels of production are low. Therefore, countries should report data on hybrids in production, as with all data, consistently, year after year. |
| As much information as possible should be made available. | Regional and national bodies sending data to FAO and other interested organizations should try to avoid aggregation of the data, as this reduces the clarity of the data when assessing production requirements and biodiversity. |
| It is important that the correct training is given to data collectors. | Data collectors within each country should be made aware of technological developments which would allow them to collect as much appropriate information as possible about the production, especially where the organism is a hybrid. |

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# Introductions of Aquatic Organisms in Africa

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## Introduction

Introductions and transfers (briefly introductions[1]) of aquatic organisms into and out of Africa are an old practice. Compared to other continents, the phenomenon is recent, approximately 150 years old. This time factor may, however, be a reflection of the absence of records. There are few major rivers and lakes in Africa which have not been subjected to deliberate or inadvertent introductions.

In the early 1980's FAO started a database on international introductions of inland aquatic fishes (Welcomme, 1988). Recently, this database has been expanded, through an internationally distributed questionnaire and a literature search, to include marine organisms and other aquatic taxa, such as molluscs and crustaceans (Bartley and Subasinghe, 1996). Coverage in the database is still uneven, probably being most complete for freshwater fish and least complete for aquatic plants. Although some introductions that have resulted from ballast water and fouling organisms are included in the database, no effort has been made to consider these inadvertent introductions in this article.

The information presented in this article is derived from the FAO database. The data base indicates that over 2,800 introductions have been made world-wide. Of these, 430 introductions were made into Africa; about 30 out of Africa and about 140 among African countries.

These introductions reflect prevailing attitudes and values by the public and private sectors in which the primary concern is socio-economic benefit. There is very little evidence that conservation, protection and long term sustainable use of biodiversity by humans were central considerations.

[1] *Introduced species (includes both non-indigenous and exotic species): Any species intentionally or uccidentally transported and released by humans into an environment outside its present range.*
*Transferred species (includes transplanted species): Any species intentionally or accidentally transported and released within its present range.*

## Species Introductions

One hundred and thirty-nine (139) species from 87 genera and from 46 families have been introduced into 42 African countries. The majority (79%) of the introduced organisms are finfish, with relatively few molluscs (7%) and crustaceans (9%). The five most often introduced species were common carp (28 records), rainbow trout (19), large mouth bass (19), Nile tilapia (17) and grass carp (15). Thus, about 4 % of the species account for 23% of the introductions. By family, the most often introduced were Cichlidae (116 records), Cyprinidae (81), Centrarchidae (50) and Salmonidae (40). About 9% of the families account for 67% of the introductions. The large and varied number of species from tropical to temperate environments implies efforts to exploit almost all the aquacultural zones of the continent.

Three main waves of introductions are identified: before 1949 (93 records); 1950-1989 (226) and after 1990 (22 records). There are also 77 introductions of unknown dates. Figure 1 shows introductions by decade. The relatively high number of introductions between 1950-1959 (78) and 1960-69 (60) is a reflection of the search for the "appropriate" species for aquaculture development, for the stocking of

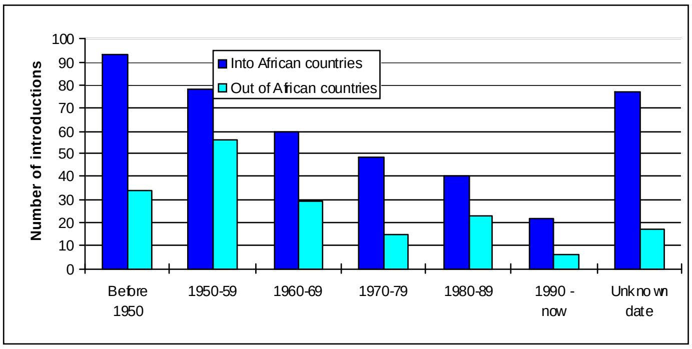


Figure 1. Chronology of introductions - Africa
*(Note that introductions out of African countries could be into other African countries; introductions into African countries could be from other African countries as well.)*

man-made lakes and for the control of disease vectors and weeds. The subsequent reduction per decade after 1980 is apparently related to the growing awareness of the possible negative effects of species introductions and to legislation, particularly in developed countries prohibiting such introductions.

Africa has received introductions from all continents except Oceania and Antarctica. The source of parent stock seems to have been linked to "colonial affinities". At the same time, Africa has also given to the other continents. The most remarkable of these exports was the Nile tilapia (Oreochromis niloticus) from four countries (Ghana, Egypt, Kenya and Senegal) to the Philippines. This parent material has been improved genetically by ICLARM researchers under the Genetic Improvement of Farmed Tilapia (GIFT) Project, to become what is known as the "super tilapia" (Eknath *et al.*, 1993).

There have also been about 140 intra-African introductions of species. The intensities of introductions, that is, the number of introductions into and out of a country, for the ten countries that have had the most introductions is summarized in Table 1.

Table 1. Intensities of introductions for 10 principal countries

| Country | No. introductions | Imported from Africa | Imported from Other | Exported to Africa | Exported to Other |
|---|---|---|---|---|---|
| South Africa | 41 | 2 | 30 | 42 | 2 |
| Morocco | 37 | 1 | 34 | 2 | 1 |
| Kenya | 26 | 14 | 7 | 14 | 3 |
| Zambia | 26 | 18 | 6 | 5 | 0 |
| Zimbabwe | 25 | 18 | 2 | 5 | 0 |
| Madagascar | 24 | 9 | 13 | 3 | 0 |
| Mauritius | 23 | 7 | 14 | 1 | 0 |
| Congo | 20 | 15 | 4 | 10 | 1 |
| Egypt | 16 | 5 | 8 | 1 | 7 |
| Tunisia | 15 | 3 | 10 | 0 | 0 |

## Reasons for the Introductions

In many developed countries, species are often introduced to freshwater bodies to create sport fisheries. In most African countries, introductions have been made to produce high quality fish protein, alleviate poverty and hunger, as well as provide employment, control disease vectors and weeds. In the FAO data base, these different purposes have been grouped into three main classes: Aquaculture development, biological control and capture and sports fisheries. Figure 2 presents a classification of introductions into Africa according to purpose of introduction. Besides the purpose categories mentioned above, there were five reported cases of accidents, 10 cases of natural migration to the wild and eight introductions to fill so called " vacant niches". There were also 71 introductions with unknown motivation.

## Status and Impact of the Introductions

The impacts of these introductions are summarized in Table 2. The objectives of some introductions could not be met and several species (34%) have become widespread in both rivers and lakes. In a few cases, succes has followed the introductions of species as a foundation for capture fisheries. This has been the case with the introduction of the voracious Nile perch (*Lates niloticus*) into Lake Victoria. This predatory species is reported to have contributed to the elimination of over 300 species of haplochromine cichlids and changed the primarily small-scale artisanal fishery on the lake into a multi-million dollar commercial fishery that supports industrialized processing and export ventures (Pitcher and Bundy 1996; Mann, 1970; Ogutu Ohwayo 1990).

Another example is the introduction of the pelagic clupeid *Limnothrissa Miodon* into Lakes Kivu and Kariba and its accidental diffusion downstream to Lake Cahora Bassa, leading to the establishment of substantial stocks of fish that have formed the basis of important Kapenta/Sardine fisheries in these lakes and reservoir. The sardines have, however, altered the zooplankton composition and possibly other elements of the ecosystem (Marshall 1991; Mayabe 1987; Jackson 1960). Yet a third important fishery that has been established through introductions is the *Heterotis niloticus* fishery on the Nyong River in Cameroon (Depiere and Vivien, 1977).

In the three cases cited, the current fishery has increased fish supplies two to three fold and helped maintain a high per capita fish consumption in the face of significant increases in human population. However, these changes have also introduced a series of socio-economic problems from deforestation to provide fuelwood for processing to a shift in the rural economy of the locality (Depiere and Vivien, 1977; Reynold and Greboval, 1989).

With regard to aquaculture species, *Cyprinus carpio* has be come well established in many countries but the *Oreochromis spp.* remain the principal aquaculture species. It is reported (Lazard, 1990 ) that the introduction of *Oreochromis niloticus* into Côte d'Ivoire has led to a significant development of fish culture in the country. It is really a paradox, that while Africa was/is scouting for a suitable fish species to be introduced for aquaculture, the potential of *Oreochromis niloticus* was recognized and acted upon outside the continent. China and other Asian countries now dominate a rapidly increasing global production through aquaculture, while the first major genetic improvement of the species was first reported in the Philippines.

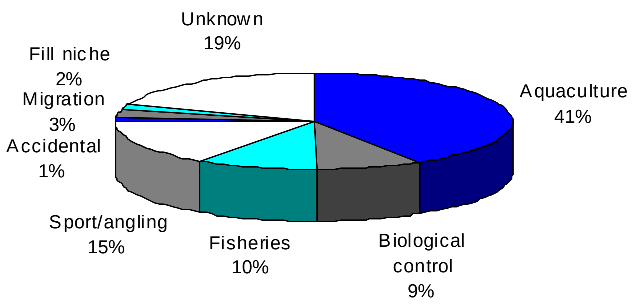


Figure 2. Purpose of introductions - Africa

Regrettably, very few broad spectrum analysese that take into account ecological as well as socio-economic parameters have been done on the introductions in Africa (Bartley, 1993; Reinthal, 1993; Coates, 1995). Where analysis have been undertaken (Lake Victoria and River Nyong) it is reported that the fish fauna has been drastically altered; native species have been eliminated; the situation is virtually irreversible and the introduced fauna is established and cannot be removed easily in economic or practical terms. Ogutu-Ohwayo and Hecky (1990) report, however, that while the introduction of *L. miodon* into Lake Kivu and Kariba reservoir has established highly successful fisheries, the effect on the pre-existing fish community or trophic ecology is very small.

It is important to note also that the effects of introductions could take a long time to manifest themselves. In the three flourishing fisheries cited in this study, the time frame was 15 to 20 years. In general terms, the negative effects of introductions include the degradation of the host environment, the disruption of the host community through competition and displacement, stunting and predation as well as nuisance to the fisheries (Leveque and Quensiere 1988, Ogutu, Ohwago and Hecky 1990, Moreau et al 1988).

In view of the potential harmful impacts of introduction, and recognizing the necessity, in the interest of present and future generations of humans, to protect the environment and its biota from any potential negative impacts, fisheries professional societies, governments, intergovernmental organizations, non-governmental organizations, etc. have contributed to the enactment/adoption of regulations, biosafety protocols and codes of practice on the responsible use of exotic species (FAO 1995a, 1995b; Pullin 1994). Foremost in this regard are the ICES/EIFAC Codes of Practices and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms (Turner, 1988). This code has been adopted by the Committee for Inland Fisheries in Africa (CIFA).

These instruments emphasize a precautionary approach to species introductions in order to reduce the risk of adverse impacts, to establish corrective or mitigating procedures in advance of actual adverse effects, and to minimize unintended introductions to wild ecosystems and associated capture fisheries (FAO 1997).

## Conclusion

Africa faces a major challenge. There is, on the one hand, public outcry at the undesirable ecological consequences of some introductions and, on the other hand, there is the undeniable and significant contribution of some introductions to much needed food fish supplies. The challenge (which is not limited to Africa alone) is to work out strategies that balance the need to address hunger and poverty and the sustainable use of natural resources and ecosystems.

Table 2. Status and impact of African introductions according to most common reasons for introductions

| **Reason for introduction** | **Ecological effects** | **Socio-economic effects** |
|---|---|---|
| Aquaculture - *of the 153 reported introductions, 74 became established in the wild.* | adverse 4<br>beneficial 3<br>undecided or<br>no information 146 | adverse 3<br>beneficial 6<br>undecided or<br>no information 144 |
| Fisheries (sport and commercial) | adverse 7<br>beneficial 5<br>undecided or<br>no information 82 | adverse 0<br>beneficial 11<br>undecided or<br>no information 83 |
| Biological control - *of 32 reported introductions, 22 became established in the wild.* | adverse 0<br>beneficial 2<br>undecided or<br>no information 30 | adverse 0<br>beneficial 3<br>undecided or<br>no information 29 |

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# PROJECTS AND OTHER ACTIVITIES...

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## MEDITERRANEAN AQUACULTURE NETWORK NEWS

### SIPAM

**Technical meeting in Salerno, Italy**

The second SIPAM meeting for 1997 took place in Salerno, Italy, from 29 October to 1 November. The meeting was combined with an ICRAM meeting of the project "Aquaculture Observatory for the Mediterranean". Ten SIPAM National Co-ordinators attended the meeting (Croatia, Cyprus, France, Italy, Malta, Morocco, Portugal, Spain and Turkey) as well as the Regional Co-ordinator and the Aquaculturist of the Regional Centre. Mrss. Coppola and Pedini from FAO Fisheries Department (FIRM and FIRI respectively) and representatives of the Italian Institutes ICRAM and IREPA also participated. The meeting had three objectives: to verify the use by the countries of the new SIPAM WINDOWS Software version, to reviewe the situation of the databases with regard to data entry, and to discuss possibilities and modalities to place SIPAM on the INTERNET.

As announced in FAN Number 13, the WINDOWS version of SIPAM software was developed on the basis of the current SIPAM DOS version with the assistance of the Institute of Marine Biology of Crete (IMBC), Greece and with financial support of the French trust fund GCP/REM/055 FRA.The first issue of the WINDOWS version was distributed to the SIPAM National Co-ordinators for comments during Bari meeting last March 1997. The new version is satisfactory and seems to be working without any major problems. The meeting decided that SIPAM for WINDOWS will not be immediately transformed into a 32 bit version. Some modification were agreed to improve the software functionality and reporting capabilities. The group proposed that the next SIPAM technical meeting be held preferably within the eight next months, subject to the identification of a host.. In the meantime, the Regional Centre jointly with IMBC and FAO Rome will work to modify the software to include comments and suggestions of the national coordinators.

SIPAM will be on INTERNET in 1998. A prototype home page prepared by FAO and displayed on the FAO WEB site for test and comments by National Co-ordinators was presented and discussed. The INTERNET version of SIPAM should have a potential to show interested readers part of the functions of the systems but not the entire data base.

**Regional data base**

Soon after the holding of the meeting at Salerno, the second release of the SIPAM regional database, REG001, containing more than 3,000 data cleared by the National Centres in the 12 participating countries, was distributed via E-mail to the National Co-ordinators. Data are related to aquaculture production statistics, directories (experts, production centres, suppliers), research and development programmes, laws and regulations, national reports, etc. It was proposed that the TECAM group on pathology should meet soon to redesign the pathology database.. The next issue of the regional data base, REG002, will be ready at the beginning of 1998.

**Missions to SIPAM member Countries**

The network is entering a phase in which National SIPAM networks have to be established, by linking secondary national users to the SIPAM Centres in the countries. The SIPAM Regional Co-ordinator visited France in June 1997 and Egypt in September 1997 as scheduled, and Turkey will be visited in December 1997. Concerning missions to expand SIPAM, preliminary contacts were established with Algeria and Bulgaria, and it should be possible to assist them to establish their SIPAM National Centres in 1998.

**Co-operation with other Networks**

SIPAM is working in close co-operation with the other active Mediterranean Aquaculture Networks under the aegis of the GFCM, especially SELAM and TECAM. In the near future, a meeting of the specialised Group on Pathology of TECAM will be organized to design the SIPAM Pathology database. With regard to SELAM, a joint meeting SIPAM - SELAM-FEAP (Federation of European Aquaculture Producers) is planned to be organised early in 1998 to discuss the design of the marketing data base.

## TECAM/SELAM Networks

### TECAM and SELAM Coordination Committee and future programme

The agreement between CIHEAM and FAO, besides entrusting the co-ordination of the TECAM and SELAM networks to CIHEAM, calls for the establishment of a Coordination Committee whose function is to assist in the setting of activities and work plans and their prioritization. The Coordination Committee meets on a biennial basis in Zaragoza, Spain, and consists of the co-ordinating institution (Instituto Agronomico Mediterraneo de Zaragoza IAMZ), two experts from each network, selected by rotation, and the Technical Secretary of the GFCM Aquaculture Committee. The experts invited to attend the second session of the Coordination Committee were Prof. Carmelo Agius, from Malta and Prof. S. Cataudella from Italy for the TECAM network and Mr. Hedi Gazbar from Tunisia and Mr. S. Ioakimides from Greece (who could not attend) for the SELAM network. The meeting was also attended by the assistant co-ordinators, Mr. I.Arnal, from Spain and Mr. P. Paquotte from France.

The meeting reviewed the activities carried out since the first meeting of the Coordination Committee, and discussed priorities for the work to be carried out in the coming biennium, based on proposal from past meetings, the requirements for activities expressed by the GFCM Aquaculture Committee, and opportunities for financial assistance to carry out the activities. In order to provide a better focus and to avoid an excessive dispersion of effort it was decided to provide a general framework to serve as a screen for the selection of activities to be retained for funding. A holistic approach was considered necessary to promote aquaculture development in the region and thus activities leading to sustainable and responsible development of aquaculture (in line with the FAO Code of Conduct for Responsible Fisheries), would take priority. The activities which have been prioritized for the various subgroups are indicated below.

***Nutrition group:*** The first activity for this subgroup would be the organization of a Workshop on Aquaculture Feed Manufacturing Practices, in conjunction with the forthcoming ***"II Conference-Show*** of Mixed-Feed Manufactures of the Mediterranean" being organized in Reus, Spain, 25-27 March 1998. This workshop aims to review trends and outlooks in commercial aquafeed manufacture, including production and usage, within the Mediterranean region; to review exisiting guidelines/codes and legislation for aquafeed manufacture within the region and elsewhere, and to draft technical guidelines for good aquaculture feed manufacturing practice for use by aquafeed manufacturers within the Mediterranean region. The workshop is jointly organized by the CIHEAM-IAMZ, and the Fisheries Department of FAO. Among the guest speakers are: Albert Tacon (FAO), Andrés Martin (ProAqua, Spain), Al Fattah El-Sayed (Univ. of Alexandria, Egypt) and Q.D. Stephen-Hassard (Montana, USA). The workshop caters for a maximum of 25 professionals with a university degree directly engaged in aqua/animal feed manufacture within the public (government) and private sectors. Preference will be given to candidates presenting a contribution. Those interested in the workshop may obtain information from the Mediterranean Agronomic Institute of Zaragoza at the address below. The deadline for the submission of applications is 15 February 1998.

Information can be Obtained from Bernardo Basurco at IAMZ:
Apartado 202, 50080 Zaragoza (Spain)
Tel: 976 57 60 13 - Fax: 976 57 63 77
e-mail: iamz@ciheam.mizar.csic.es

Other activities included in the proposed plan of work of this subgroups are: (i) a Workshop on Good Feeding Practices in Mediterranean Aquaculture Systems, (ii) a Seminar on Nutrition in Aquaculture and Environmental Impact, (iii) Universidad la Laguna, Gran Canaria to produce a newsletter of the TECAM Group on Aquaculture Nutrition, including the listing of persons/institutions within Mediterranean member countries engaged in activities related to aquaculture nutrition, interesting information published on aquaculture nutrition from within the region, and updates of the TECAM Working Group activities. Such a Newsletter could be produced in paper and electronic/ INTERNET format; the latter integrated within SIPAM , (iv) a Workshop/seminar on Small Scale Feed Manufacture

***Pathology group:*** A meeting of the group is foreseen. Items to be discussed as first priority include: ranking of main problems encountered in the Mediterranean related to the institutional and legal framework, production problems, and research. Work on responsible use of hormones, drugs and disease control chemicals is also planned. In addition a Workshop on Mediterranean Health Legislation and Quarantine aspects is also envisaged. The group will organize short technical training and conduct a survey of experts and research projects to establish a special database to be incorporated in SIPAM. The repetition of short term specialized laboratory courses was considered but given a lower priority.

***Diversification group:*** The main priority of this group is the preparation of research project to be submitted to the ***INCO*** initiative of the EC . As a second priority, the group is to organize a Second TECAM Seminar on New Finfish Species for Diversification (for 1998) which will also consider market-related issues in the selection of new species. The group will also prepare a Synopsis of New Farmed Species in the Mediterranean, in the next biennium.

***Reproduction :*** Although there is no formal group dealing with this subject, it was considered appropriate to organize an Advanced Course on Mediterranean Aquaculture: New Techniques for Marine Hatcheries. The course will take place in Mazarrón, Spain, from 23 February to 6 March 1998. The course aims to meet the needs of Mediterranean aquaculture professionals who wish to receive updated and integrated scientific and technological knowledge on the different disciplines involved in successful and responsible hatchery management. The course is included within the activities of the Network on Technology of Aquaculture in the Mediterranean (TECAM) co-ordinated by CIHEAM-IAMZ. The course is jointly organized by the Mediterranean Agronomic Institute of Zaragoza (CIHEAM-IAMZ), and the Spanish Institute of Oceanography (IEO) with the collaboration of the Fisheries Department of the FAO.

The lectures will be given by qualified lecturers from research centres, universities, private sector and government departments in different countries. Guest lecturers are: E. Abellán (IEO, Spain); C. Aguilera (TINAMENOR, Spain); J. Bonfills (SIAM, France); M. Carrillo (CSIC, Spain); W. Knibb (IOLR, Israel); D. Chourrout (INRA, France); S. de Dominis (Maricultura Italia, Italy); P. Divanach (IMBC, Greece); A. García-Alcázar (IEO, Spain); A. García-Gómez (IEO, Spain); M.S. Izquierdo (ULPGC, Spain); P. Lavens (Univ. de Gent, Belgium); E. Mañanos (CSIC, Spain); J.C. Navarro (CSIC, Spain); R. Prickett (Marine Farm Technology, U.K.) and S. Zanuy (CSIC, Spain). The following topics will be covered: reproduction, breeding and genetics, larval rearing, disease prevention and control, hatchery design and engineering and quality control. Formal lectures are complemented by round table discussions, practical demonstrations, technical visit and a participants' seminar.

The course caters for a maximum of 25 professionals with a university degree who are already directly involved in the subject matter of the course. Those interested in the course may obtain information from the Mediterranean Agronomic Institute of Zaragoza at the address above in the nutrition section. The submission of applications is 10 January 1998.

***Genetics group:*** Within the programme of this group, the following activities were suggested: (i) a survey of industry's needs in the areas of genetics and breeding, (ii) a workshop on establishment of selective breeding programmes (utilizing additive genetic variance) for seabass and seabream (1998)., (iii) an International Symposium on Aquaculture Genetics in Mediterranean Aquaculture species (1999).

***Marketing group:*** The design and implementation of a database on marketing, which has been already been started by a joint group of TECAM and SIPAM will need to be revived seeking the participation of the Federation of European Aquaculture Producers (FEAP).

***Aquaculture planning group:*** A Workshop on Aquaculture Planning in Mediterranean Countries is scheduled to be held in Tangier, Morocco 12-14 March 1998. The workshop aims to analyse the evolution of aquaculture planning and development in the countries of the Mediterranean Basin; to identify the most pressing needs in strategic planning with a view to sustainable and responsible development of the sector; and to determine the role of regional co-operation in the planning process of aquaculture development in the region. The workshop is jointly organized by CIHEAM-IAMZ, the Fisheries Department of the FAO, and the Institut National de la Recherche Halieutique (INRH) of Morocco.

It will be divided into the following sessions: general context; supranational and international guidelines for planning; specific issues (case studies); the planning process; and planning and regional co-operation. The lectures will be given by lecturers from research centres, universities and government departments in different countries. Among the guest speakers are: A. Abouhala (MAROST, Morocco); C. Agius, (NAC, Malta); R. Bates (EU, DG-XIV); C. Breuil (FAO); J. Catanzano (IFREMER, France); S. Cataudella (Univ. of Rome, Italy); J. Duret (CEMAGREF, France); P. Ferlin (IFREMER, France); H. Gazbar (Min.Agriculture, Tunisia); C. Hough (FEAP, Belgium); S. Iaokimides (ABG, Greece); H. Kilic (Min. of Agriculture, Turkey); A. Orbi (INRH, Morocco); P. Paquotte (IFREMER, France); M. Pedini (FAO) and D. Stephanou (Min. of Agriculture, Cyprus).

There is a limited number of places in this workshop due to the highly interactive nature of the activity. Those interested in the workshop may obtain information from the Mediterranean Agronomic Institute of Zaragoza at the address indicated above in the nutrition section. The deadline for the submission of applications is 15 February 1998.

A Workshop on Production Cost Analysis has also been included in the programme for 1999. Holotypes will be determined for the various production methods according to standard guidelines. This workshop could be the starting point for a collaborative research programme in economic modelling. In addition to this activity a Workshop/ Seminar on Integrated Mediterranean Aquaculture Production Systems has been offered by IFREMER, to take place in Nantes.

**Advanced Course on Mediterranean Off-shore Mariculture.**

The above course took place in Zaragoza, Spain 20-24 October 1997. The course reviewed the definition of off-shore mariculture, present trends at global level of production and technology, and described the experience in off-shore mariculture in Malta and Ireland before entering specific subjects such as site evaluation , mooring systems, cage and net types, and support equipment (such as workboats and ancillary equipment). Videos of current operations were also included in the programme as well as discussions on operation of off-shore facilities. A presentation of mollusc production off-shore and discussions on the economics of off-shore mariculture and on the potential for this form of aquaculture production in the Mediterranean were also included in the course. Lecturers for the course came from Malta, Ireland, Spain, France and UK.

## GUATEMALA

A multidisciplinary mission in the framework of the FIMLAP programme was sent to Guatemala on the basis of a request made by the Vice-President of the country in November 1996. The mission had to analyse the aquaculture sector taking into account institutions, production infrastructure, existing or completed projects, development plans and programmes. The mission reviewed the situation of shrimp and prawn culture, tilapia culture at commercial level and small scale rural aquaculture. Shrimp culture is the more important sub-sector, from the economic viewpoint, with a total of about 2 000 ha under production and with potential for expansion to about 5 000 ha. In 1994, the estimated production from about 2 100 ha was over 3100 mt — a very acceptable productivy of 1.47 mt/ha, similar to what was achieved in Costa Rica and better than in the rest of the Central American countries. The sector has recently suffered high losses due to the the Taura disease.

The recommendations of the mission included a reconsideration of the government's role in aquaculture development in order to adapt to changes in policy and macro-economic orientation. Areas under the responsibility of the government need to be clearly identified, even if the execution of some related tasks will be delegated. Areas of particular concern should be the role of the NGOs, decentralization of aquaculture development, especially rural aquaculture, research management and environmental management, which is of particular concern in the case of shrimp culture.

The mission also recommended examination of the potential for species diversification, which may require external assistance, and the privatization of seed production for finfish, now in the hands of the Government. Private fingerling producers could also take care of extension practices. In the case of rural aquaculture, clear criteria for the selection of target groups are a must as in some cases aquaculture may not be the best activity to which farmers should invest their scarce resources. A medium level rural aquaculture, practiced by farmers with more economic resources has a good potential for development in Guatemala and should be supported.

## ALCOM

By the end of 1997, the present phase of ALCOM will be completed. As our readers will remember, ALCOM has been funded from Swedish SIDA and Belgian BADC funds. As a result of the last project evaluation, the Belgian Government has indicated interest in continuing the funding of ALCOM activities and a new project document has been prepared and is being negotiated with the donor and with SADC, the designated executing agency. Implementation of the project will be carried out with the assistance of the FAO. The new project will take a two pronged approach: practical and applied field work through pilot projects at the farmer level linked to institutional strengthening and capacity building at national and regional levels.

At the farmer level, three interrelated pilot project areas cover the spectrum of smallholder water resource activities: *Surface Water Bodies* (SWB), determining enhanced techniques for reservoir use and water management, including increased fish production; *Aquatic Farming Systems* (AFS), developing means to integrate ponds into small-scale farming systems for water storage and food production, including water harvesting techniques in small-scale irrigation schemes; and *Extension and Outreach* (EXT), identifying methods for establishing effective communication channels with farmers and feedback (monitoring) within the local institutional framework.

At the national level, contact agencies are identified which reflect the inter-departmental management of water and water-related issues. Field activities will be implemented by National Professional Officers with appropriate technical skills. At the regional level, programme staff backstop field operations from the programme's Harare offices, co-ordinating pilot projects and integrating results into regional and national databases. As programme operations become functional within regional agencies, project staff will be gradually reduced to insure an efficient transition to regional operations.

## ZAMBIA

Zambia is embarking in an ambitious programme for the development of the entire agricultural sector with the assistance of the UNDP. The project entitled "Agriculture, Rural Development and Food Security" (ARDFS) has a UNDP contribution of US $ 12.6 million, and includes a component for aquaculture development at national scale. The aquaculture component will have a duration of 5 years and a UNDP contribution of US $ 1.23 million. The main strategy of the new project in which a participation of the FAO to provide assistance is being negotiated at present, is: (a) to develop appropriate fingerling production and feeding technologies as well as improved farming practices; (b) to build capacity in the MAFF aquaculture extension staff at the field level to effectively transfer technologies to small holder resource-poor farmers; and (c) to empower smallholder, resource poor farmers to undertake aquaculture enterprises. The project also aims at developing the capacity of NGOs and CBOs, to ensure wider adoption and sustainability.

### Seventh session of the Working Party on Aquaculture of the Commission for Inland Fisheries for Latin America (COPESCAL), Santo Domingo, Dominican Republic, 11-14 November, 1997

Experts from 8 countries attended the meeting. The Technical Secretary informed on progress of planned intersessional activities: Technical Consultation on Nutrition and Health Management in Latin-American Aquaculture (La Havana, Cuba, 4-8 November, 1996), 1st International Workshop on the Cultivation and Biotechnology of Marine Algae (one chapter; Cumaná, Venezuela, 2-5 December 1996), TCDC from Cuba to Mexico on small water bodies, and preparatory meetings for an agreement with PRADEPESCA on rural aquaculture activities.

Participants were also informed about other COPESCAL meetings as well as other events closely related to this Working Group's interests: other TCDC activities, Special Programme on Food Security, Code of Conduct for Responsible Fishing (Article 9. on Aquaculture Development), on going TCP projects, pipeline projects, technical meetings in other regions of interest to Latin America, and recent publications.

A special session was dedicated to discuss the status and future of the aquaculture information system (SIPAL) which is to be reactivated in the region. The SIPAL system started with AQUILA II project, and when the project was concluded the system was not sufficiently consolidated and was discontinued. Most of the software and experience gained was used to implement the Mediterranean system (SIPAM). The FAO is now trying to reactivate the system in Latin America, based on the successful results achieved in the Mediterranean, and to link it to other regions.

Several background papers were presented and discussed by the participants on thematic subjects covering most of the aquaculture activities in the region: rural aquaculture, tilapia, macroalgae, nutrition, pathology, salmon, shrimp, molluscs, small water bodies, information systems. A meeting report and a supplement including these papers will be published in 1998.

The future of this Working Group was discussed at length. The Technical Secretary informed the Group about the decision taken by the 29th Sesion of the FAO Conference to abolish most of the Working Groups, in favor of *ad hoc* meetings, subject to the approval of the Regional Bodies. The decision will be confirmed or modified by the Commission in Brazil during its next meeting in May 1998. The participants agreed that the new orientation was in line with the recent development of this Working Group whereby the thematic sub-groups or networks have been consolidated and *ad hoc* meetings on specific themes will be called after approval of the Conference decision by the Commission. A strategy of the new approach, which has already been applied by the Working Group, is the association with public and private institutions which share areas of interest with COPESCAL.

### Special programme on food security (Nepal)

In seven areas of the Nawal Parasi district, there are groups of women interested in learning to farm fish more effectively in village ponds. Raising fish will provide an important source of protein to the local community, as well as generate income which could then be used to fund local development works. In its first year of operation, the Special Programme in Nepal (SPIN) has been supporting these women groups to ensure that the aquaculture activities get off to a good start, and to lay the foundation for long-term success. This is done using a two-pronged approach: providing the women with necessary start-up materials (i.e. fish seeds, feed and fertilizer) for semi-intensive polyculture of Chinese and Indian major carps (six to seven species), while at the same time providing training before and after fingerlings stocking to teach the women how to manage the aquaculture activities on their own in the future. The programme covers 1.73 hectares of water area.

Activities conducted in June-July 1997 included: (I) delivery of fish seed to the 7 women's groups, (ii) provision of a mix of 45% rice bran, 45% mustard oil cake, 10% fish meal feed to the women, who brought the feed from DADO (District Agriculture Development Office) to their villages, (iii) basic fish farming training to a total of 34 women, 5 from each of 6 groups, and 4 from Shanti Women's Group, (iv) provision of fertilizers such as DAP and urea for the women, who picked it up and brought to their villages, along with a bucket and mug for mixing fertilizers. All feeds and fertilizers were provided in sufficient amount for a one month period.

The activities planned for the following two months (August and September 1997) included: (i) one-day tour of Bhairahawa Fisheries Development Center, integrated with training on fish seed production, (ii) water quality analysis of women's fish ponds using HACH kit, (iii) growth check on all 7 ponds to determine to which rate feed should be increased, (iv) to provide feeds and fertilizers for 2 additional months, (v) regular field visits to discuss farmers' problems and progress, and (vi) data tabulation and report writing.

The only difficulty encountered so far is that some of the ponds do not have properly constructed inlets and outlets, which could be a problem during high water levels. Repairing inlets and outlets is difficult when water is in the pond, and must be done during the cold season when the ponds are dry.

This programme has been very encouraging. Women have shown a very high level of motivation and dedication to the programme. Attendance at the first training given at the District Agriculture Development Office was excellent, and subsequent field visits have shown that the women have learned the fundamentals of pond management presented at that training (such as feed formulation and feeding and pond fertilization) and are carrying them out effectively

## MEETING OF FAO/NACA/WHO STUDY GROUP ON FOOD SAFETY ISSUES ASSOCIATED WITH PRODUCTS FROM AQUACULTURE

The joint working group met at the headquarters of the Network of Aquaculture Centres in Asia and the Pacific (NACA)in Bangkok, Thailand from 22 to 26 July 1997. The meeting was attended by more than forty experts from various disciplines including food hygiene and food safety assurance, fish inspection and quality control, veterinary sanitation, and aquaculture. During the first two days numerous interesting presentations were given on important aspects such as :

- global aquaculture production and food supply, occurrence of human pathogenic bacteria in aquaculture use of waste waters in aquaculture
- biological and chemical contamination of aquaculture products
- use of veterinary drugs, water and soil treatment chemicals; development of antibiotic resistance
- integrated aquaculture systems and food safety epidemiology and control of fish-borne parasites
- application of HACCP principles for the control of food-borne trematodes
- applications of HACCP in aquaculture
- post-harvest handling of aquaculture products and potential food safety hazards
- on-farm and post-harvest food quality assurance (including hazard control) in shrimp and salmon culture (Thailand, Norway)
- Codex Alimentarius principles of risk analysis, including risk assessment, risk management and risk communication.

Two working groups were formed to discuss both biological and chemical hazards in aquaculture, as well as possible control strategies related to these hazards.

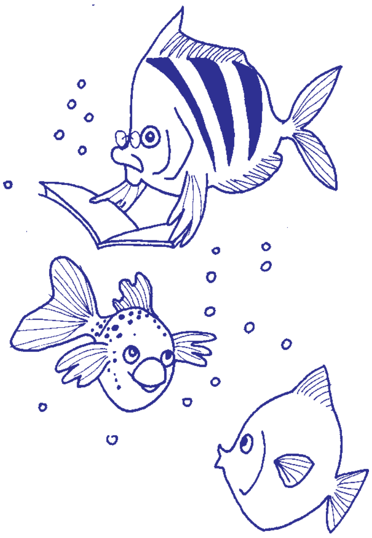
The meeting provided a very good opportunity for exchange of views and information among the experts presenting considerations on food safety and aquaculture production. Intensive discussions were held on actual and perceived hazards, on hazard identification methods, on needs for additional research and general information, and on opportunities and limitations for hazard control measures. It became evident that more work is needed on epidemiological aspects and diseases. Chemical hazards of aquaculture products were also discussed and it was noted that further efforts may be directed towards identification of patterns/levels of product contamination and human toxicology of contaminants (including aspects of probability/ severity of exposure to contaminants among consumers of aquaculture products). It also appeared that there is considerable scope for awareness raising on food safety hazards in aquaculture, consumer education, and capacity building, especially with regard to identification of feasible control methods and their implementation. Food safety issues in aquaculture are likely to attract increasing interest, and future work may include efforts to enhance and facilitate collaboration among experts and institutions concerned with food safety, fish quality control, aquaculture and environmental protection.

The meeting proceedings, including technical information and recommendations, will be published by WHO.

## ISLAMIC REPUBLIC OF IRAN

At the request of Shilat, the Iranian Fisheries Company, Drs Devin Bartley and Krishen Rana undertook a mission to northern provinces in Iran to advise on and evaluate genetic resource management in aquaculture and stock enhancement projects in the Caspian Sea. Shilat is involved in a massive restocking effort to maintain several important fisheries in the Caspian Sea. According to Shilat information, 190 million fingerlings of sturgeon, Acipenseridae, mahi sephid, *Rutilus frisii kutum*, and Caspian trout, *Salmo trutta caspius*, perch, *Lucioperca lucioperca*, and bream, *Abramis brama*, where stocked in 1996. This figure does not include the stocking of other inland water bodies, e.g. reservoirs, with Chinese carps.

Aquaculture production has increased substantially over the past five years, due in part to recommendations made by an earlier FAO-TCP mission. The Government is now seeking advice on how to continue development while conserving aquatic resources. The present mission visited several Shilat and private hatcheries and grow out facilities for sturgeon, mahi sephid, Chinese carps, rainbow trout, and the endemic Caspian trout. In addition, the mission included visits to research laboratories of the Iranian Fisheries Research and Training Organization, Center of Animal Breeding (Ministry of Jihad) and the National Research Center for Genetic Engineering and Biotechnology (Ministry of Education). The mission concluded with a one day seminar on genetic resources and, reproductive broodstock management, gamete management, use of low temperature biology in aquaculture and genebanks, and hatchery enhancement. There is a strong desire and an increasing human capacity in Iran to utilize modern methods and biotechnology to increase production and manage their important fishery resources. Plans for cooperative projects are presently being formulated.



# NEW FAO PUBLICATIONS

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**Arthur, J.R. and S. Lumanlan. 1997. Checklist of the parasites of fishes of the Philippines. *FAO Fisheries Technical Paper.* No. 369. Rome, FAO. 102p.**

The checklist summarizes information on the parasites of Philippine fishes contained in the world literature dating from the earliest known record (de Blainville, 1882) to the end of 1996. Information is presented in the form of parasite-host and host-parasite lists. Included are 201 named species of parasites, as well as records of parasites not identified to species level. Parasites have been reported from 172 of the more than 2030 species of marine and freshwater fish occurring in Philippine waters, and from another 17 species of freshwater aquarium fish examined in the Philippines but not found in natural waters. The Parasite-Host List is organized on a taxonomic basis and provides information for each parasite species on the environment (freshwater, brackishwater, marine), the location (site of infection) in or on its host(s), the species of the host(s) infected, the known geographic distribution (by island) in the Philippines, and the published sources for each host and locality record. Citations are included for all references and a supplementary list of references contains other literature on Philippine fish parasites. Parasite and host indices are provided.

**Cruz, P. S. 1997. Aquaculture feed and fertilizer resource atlas of the Philippines. *FAO Fisheries Technical Paper*. No. 366. Rome, FAO. 1997. 253p.**

The paper is based on a comprehensive survey conducted by the author in 1995/1996 concerning the feed and fertilizer resources of the Philippines and their availability and use by the Philippine aquaculture sector. Presented in the form of an illustrated atlas, the report compiles information on the fertilizer and feed resources of the Philippines, where they are geographically located, how much is available and when, who is currently using this resource and how, the composition and cost of this resource at source and with transportation, together with an assessment of the status of the existing animal feed manufacturing industry and its regulations, together with information on the feeding strategies employed by the aquaculture sector. It was estimated that approximately 45-75% and 85-95% of the feed ingredients currently used within commercial aquafeeds for fish (i.e. mainly tilapia and milkfish) and marine shrimp were composed of imported feed ingredients, respectively, as compared with only 20-30% for livestock and poultry feeds.

**Tacon, A.G.J., J. Collins and J. Allan. (Comps.) 1997. FAO field project reports on aquaculture: indexed bibliography, 1966 -1995. *FAO Fisheries Circular*. No 931. Rome, FAO. 1997. 192p.**

The aim of the document is to compile a list of available FAO field project reports on aquaculture which have been received by the David Lubin Memorial Library of FAO and input into the FAODOC database. In order to maintain a permanent record of these reports and to supply copies to Member Countries, the FAO Library has made microfiche reproductions of all FAO publications. The microfiche number is given for each record and details of availability are provided.

The document presents a bibliographic list of 1,712 FAO field project reports dealing with, or containing relevant information related to, aquaculture. It does not include the reports produced by the FAO Regular Programme and FAO regional bodies as these have been covered in other, similar publication. The reports presented were produced between 1966 and 1995 as part of the activities of 208 national field projects conducted within 80 countries around the world (including 171 FAO Fisheries Department projects, 16 Agriculture Department projects, 13 Forestry Department projects, 6 Economic and Social Department projects, 1 Legal Office project, and 1 Development Department project); 41 regional field projects (including 39 Fisheries Department projects, 1 Agriculture Department project, and

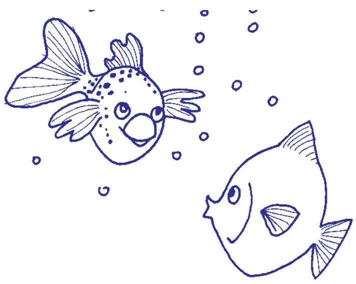
1 Forestry Department project); and 8 inter-regional Fisheries Department projects. The reports are listed by project for individual countries or by region. Author, subject, species, and geographic indexes are provided.

**FAO/NACA. 1997. Aquaculture research development priorities and capacities in Asia-Pacific. *FAO Fisheries Circular* No. 930 Rome, FAO, 1997. 263 p.**

This document incorporates the outcome of two related activities: (i) a synthesis of data from a survey and analysis of aquaculture development research priorities and capacities in Asia, and (ii) the results of a regional workshop which reviewed the findings of the survey, identified themes for regional research collaboration and prepared project outlines for these themes. The synthesis includes the responses of 14 developing countries/regions in Asia to a survey of aquaculture development priorities and capacities conducted in 1996 by FAO and NACA. The information from the survey was supplemented by information provided by or published about the aquaculture development programmes of a number of international and regional organizations in the region. This document also contains the summary of survey returns from the participating countries/regions among which are the major aquaculture producers in Asia and the world. The national aquaculture development objectives and priorities are identified and matched with the research priorities and capabilities of the aquaculture sector; the analysis also points out the weaknesses in the research systems including the research priority setting mechanisms. This is followed by a description of the needs of aquaculture research and an explanation of a list of potential areas and opportunities for collaborative research at the subregional and regional levels. The synthesis also outlines the roles of governments and collaborative assistance agencies and donor organizations, as well as the private sector in regional and national research efforts. The analysis presents a strong case for greater research attention on institutional and non-biological/technical issues in the region. One of the major observations resulting from the analysis is that planning, applying or deriving the full benefit from biological/technical research — in which there is a great concentration of efforts — is largely constrained by the weaknesses in the enabling mechanisms. For the overall research effort to contribute to sustainable aquaculture development, equal attention should be trained on issues associated with the socio-economic, institutional, environmental, policy, legislation and technology transfer aspects of aquaculture development. The workshop report highlights the main outcome of discussions on the conclusions of the synthesis and presents the seven themes and related project outlines for regional research collaboration.

**Coche, A.G. and J. Collins. 1997. Supporting aquaculture development in Africa: Aquatic Farming Systems Information Network. *CIFA Occasional Paper*. No. 22. Accra, FAO. 72p.**

This is the report of a mission fielded in October 1996 to visit existing libraries in Côte d'Ivoire, Mali, Kenya, Malawi, Zimbabwe, South Africa and Nigeria, previously identified as potential contributors to an information network on aquatic farming system. Available resources (infrastructure, trained staff, equipment, collections and networking activities) were identified and evaluated. Interest and willingness to participate in the network were ascertained. **Main findings** were the following: There is a continuing loss of institutional memory. Differences between individual libraries are substantial. Libraries in Eastern and Southern Africa have significantly better resources. Even if relatively disadvantaged from resources point of view, francophone Western and Sahelian African libraries undertake several important information and documentation activities. The barrier separating francophone and anglophone sub-regions results not only from linguistic problems, but also from the distribution pattern of information resources. The lack of



access to the results and findings of research between the different African sub-regions and between the anglophone and francophone countries is a major obstacle to development. Major constraints on access to information in sub-Saharan Africa include: relatively recent development of aquaculture and aquatic farming systems in the region, lack of information flow between institutions, publication of research results mostly as grey literature and absence of collection/dissemination of these results by readily available information systems. In conclusion, **the mission recommended**: To establish a regional network between institutions with programmes and information resources relevant to aquatic farming systems. To ensure that the approach to information be as multidisciplinary as necessary to address the production system as a whole. To build this network of existing, geographically separated but closely linked, anglophone and francophone information centres. To have the network initially composed of the libraries at two **co-ordinating centres**, one in each linguistic sub-region (Côte d'Ivoire, IDESSA and Malawi, Bunda College of Agriculture) and eight **satellite centres**. Main objectives and guiding principles for operation of this network are defined. To provide technical and financial assistance to initially strengthen the francophone co-ordination centre and to initiate regional networking activities, as outlined in a project proposal.

**Coche, A.G. (comp.). 1997. Aquaculture in marine waters. An indexed list of non-FAO reference books and monographs, 1961-1997. *FAO Fisheries Circular.* No. 925. Rome, FAO. 1997. 68p.**

This is a bibliographic list of about 600 selected non-FAO books and monographs providing information related aquaculture in marine waters in English, French, German, Italian and Spanish. Author, geographic, taxonomic and subject indexes provide further assistance in locating the information required. The list was prepared to help students, researchers, field workers and laymen locate and retrieve published information on marine aquaculture. Most of the books selected are less than 10 years old and are still available either from the publishers or from technical bookstores. The titles are listed in chronological order of the publication year. For each particular year, they are listed in alphabetical order of authors' names.

**Kapetsky, J. M. and S.S. Nath. 1997. A strategic assessment of the potential for freshwater fish farming in Latin America. *FAO COPESCAL Technical Paper,* No. 10. Rome, FAO. 1997. x + 124p.**

Currently, inland aquaculture production in Latin America is insignificant compared with the output from inland and marine fisheries. Lack of good planning at national level has been identified as a serious impediment to the development of aquaculture. Estimates of potential are scarce that are both comprehensive and comparable over large geographic areas. Accordingly, the objective of this study was to estimate the potential for warm-water and temperate-water fish farming in the fresh waters of Latin America in order to stimulate improved planning for aquaculture development at national levels, and at the same time to provide a tool to plan comprehensively for technical assistance activities by FAO and other national and international organizations.

The present study is patterned on an estimate of warm-water fish farming potential made for Africa. However, a number of refinements have been made, one of which is a fourfold increase in resolution (i.e., to 5 arc-minutes, equivalent to 9 km ´ 9 km grids at the equator), thereby making the results much more usable for assessing fish farming potential at the national level. Another refinement is that, for the first time, a bio-energetics model has been incorporated into a geographical information system (GIS) to predict fish yields over large geographic areas. A gridded water temperature data set was used as input to the bioenergetics model to predict numbers of crops per year for four species: Nile tilapia (*Oreochromis niloticus*), tambaqui (*Colossoma macropomum*), pacu (*Piaractus mesopotamicus*) and carp (*Cyprinus carpio*). By varying input levels and sizes at harvest, opportunities for two levels of commercial fish farming and for small-scale fish farming were identified.

In addition to the suitability of each 9 ´ 9 km grid cell for the production of the above-mentioned species, each grid cell was evaluated for a number of other factors important for fish-farm development and operation. These included urban market potential based on travel time proximity and population size of urban centres, potential for farm-gate sales based on population density, engineering and terrain suitability for pond construction using a variety of soil attributes, water loss from ponds due to evaporation and seepage, and availability of agricultural by-products as feed inputs based on crop potential. Commercial and small-scale aquaculture models were developed by weighting these factors using a multiple criteria evaluation procedure. Areas unavailable for inland fish farming development were identified by incorporating protected areas and large inland water bodies as constraints.

Finally, the yield potential of each grid cell for each of the four species was analysed using the growth model together with the other factors in the commercial and small-scale models to show the coincidence of each class of suitability with each range of yield potential.

Potential for inland fish farming is high in continental Latin America. From 38% to 60% of the continental area scores from suitable to very suitable for small-scale farming of Nile tilapia and carp, respectively. In the same areas, from 0.9 to 1.7 crops/y of Nile tilapia and from 0.9 to 1.8 crops/y of carp can be realized by harvesting at modest weights.

The most important factor for commercial fish farming – urban market potential – scores high across more than one-half of the continent. For Nile tilapia and carp, from 19% to 44% of Latin America rates from suitable to very suitable for commercial farming. From 1.2 to 2.4 crops/y of Nile tilapia and from 1.2 to 2.3 crops/y of carp can be realized on the same areas by feeding at 75% satiation and harvesting at a moderate weight. Tambaqui and pacu occupy an intermediate position in terms of the surface area that is suitable or very suitable for commercial farming. From 0.7 to 1.4 crops/y for tambaqui and from 1.0 to 2.0 crops/y for pacu can be achieved from areas that are suitable or very suitable for commercial farming by feeding at 75% satiation and harvesting at a moderate weight.

From a country viewpoint, at least 18 of the continental countries have some area with potential that rates suitable or very suitable for farming of Nile tilapia and pacu, while there are 19 in the same category for tambaqui. Finally, there are opportunities for carp farming in all 21 countries.

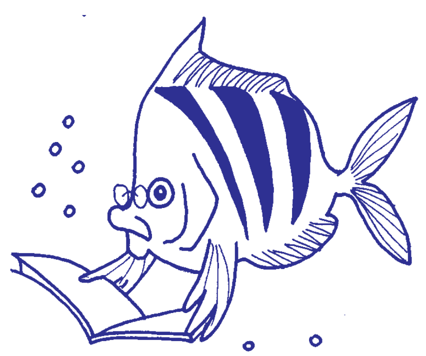
**GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 1997. Towards safe and effective use of chemicals on coastal aquaculture. *Rep. Stud. GESAMP*, (65): 40p.**

The purpose of this report is to provide an overview on chemical use in coastal aquaculture globally and the potential environmental and health implications with the objective of promoting: (i) protection of coastal environments; (ii) protection of human health; and (iii) sustainability of the aquaculture sector.

Chemicals used within the aquaculture industry are identified and, for each chemical, a brief summary of information provided, when available, on its intended purpose, scale of application, the aquaculture sectors and geographic locations of principal use and potential impacts on the environment and human health. Environmental issues arising from the properties of aquacultural chemicals are discussed.

The use of chemicals in aquaculture, if carried out properly, can be regarded as wholly beneficial with no attendant adverse environmental effects or increased risks to the health of aquaculture workers. Concern appears warranted, however, regarding the over-use and misuse of certain chemicals for which proper risk assessments with respect to the marine environment have not been conducted. A further legitimate concern and a barrier to conducting an exhaustive review of these practices is the lack of availability of quantitative data on contemporary chemical use in the aquaculture industry.

Governmental authorities, the scientific community and the aquacultural and pharmaceutical industries all have important roles to play to ensure that chemical use is consistent with protection of environmental quality and human health. In particular, mechanisms need to be put in place and enforced for the registration and control of aquacultural chemicals to protect the environment and human health and to ensure the sustainable growth of the aquaculture industry.



## *Staff contributions to external publications, meetings, etc.*

Tacon, A.G.J. 1997. Global trends in aquaculture and aquafeed production. International Aquafeed Directory and Buyers' Guide 1997-8, Turret Rai Group PLC, Rickmansworth, UK.

Tacon, A.G.J. and U.C. Barg, 1997. Major challenges to feed development for marine and diadromous finfish and crustacean species. In: Tropical Mariculture (S.S. De Silva, Editor), Academic Press, UK.

Tacon, A.G.J. and K. Rana. 1997. Future developments in intensive and semi-intensive aquaculture in Asia, with particular reference to the Far East. Paper presented at 'International Fishmeal & Oil Manufacturers Association' (IFOMA) annual conference, 29-30 October 1997, Rome, Italy.

Toledo, J., A.G.J. Tacon, and M.C. Garcia . 1997. Acuacultura como opcion en sistemas deficientes en energia fosil. Paper presented at the FAO Expert Consultation 'Hacia una agricultura tropical con menos uso de energia fosil', 10-13 November 1997, La Habana, Cuba.

Subasinghe, R., U. Barg, and A.G.J. Tacon. 1997. Health management strategies towards sustainable aquaculture. Paper presented at the 'Second International Symposium on Sustainable Aquaculture', 12-15 November, 1997, Oslo, Norway.

Halwart, M. 1997. Integrated management of the Golden Apple Snail in Asia. Paper presented at the First International Workshop on Ecology and Management of the Golden Apple Snail in Rice Production in Asia, 16-19 June 1997. Phitsanulok, Thailand.

Coupland, J. and M. Halwart 1997. Apple snails: A South-American perspective. Paper presented at the First International Workshop on Ecology and Management of the Golden Apple Snail in Rice Production in Asia, 16-19 June 1997. Phitsanulok, Thailand.

Dr. Robin L. Welcomme, Chief, FAO Inland Water Resources and Aquaculture Service retires in January, 1998. Prior to joining FAO he was employed in the late 1950's and into the 1960's as Assistant Scientific Officer at the Water Pollution Laboratory and later at the Salmon and Freshwater Fisheries Research Laboratory in the UK, then Scientific Officer at the East African Freshwater Fisheries Research Organisation, Jinja (Uganda). From 1964-1967 he was at Makerere College, University of East Africa where he completed a Doctorate on the effects of climatic change on the biology and ecology of certain fishes of the Lake Victoria basin. . With FAO he was first a Fisheries Biologist in Benin, West Africa, then at FAO HQ in Rome from 1971, successively a Fishery Resources Officer, Senior Fishery Resources Officer and in 1989, Chief of the Service. As Chief, he was responsible for the overall supervision of inland fisheries and aquaculture programmes with a staff of 11 professionals and 5 other staff. He continued to deal with technical aspects of river fisheries, biodiversity, fisheries enhancements and rehabilitation and species introductions. Additionally, he was Secretary of the European Inland Fisheries Advisory Commission (EIFAC). Finally, he assisted with the FAO-wide programme on biological diversity. So far he has authored approximately 110 publications including 4 books.

This brief summary of activities and accomplishments, although impressive, fails to capture the substance of his contributions as a fishery scientist of note. Perhaps, the talent that has made him most successful is his ability to identify the issues and problem areas from a global perspective and to synthesise key elements of information to arrive at meaningful solutions.

As Service Chief, his style of management, constructive approach and unfailing support to his staff, both general service and professional, won him the trust and respect of all. He was also equally appreciated by senior management for his dependability and collaborative spirit.

His retirement deprives the Fisheries Department and his staff of an excellent professional, mentor and friend. We can ill afford to lose people like Robin and will continue to seek his advice and assistance in the future. *Robin, old boy, you can't get away that easily!*