Photo: Dr Roger Doyle

To preserve the genetic diversity of Indonesian carps, scientists collect the various strains and keep them in underwater cages.

can be inhibited by competition, especially for food, from larger fish. The small fish hide and don't eat properly. Although they may possess the genetic potential to grow quickly into large fish, the competitive pond environment has, in effect, masked this desirable characteristic. And when it comes time for the fish breeder or geneticist to select brood stock from the pond, the small ones are automatically passed over.

A number of selection procedures developed at Dalhousie should help to prevent this problem in future. One of them calls for fish to be separated into groups by size (size-specific selection) at the beginning of an experiment. Selection of the fastest-growing fish can then proceed without many of the negative effects of competition.

A technique that allows a fish's sex to be determined sooner and before size differences become established is also being developed by Dalhousie. It is based on the measurement of various physical characteristics of the young fish (called multivariate morphometry). One advantage of knowing the sex early is that males and females can be separated at an early stage. This eliminates the cues that trigger sexual development and reproductive behaviour, and allows the fish to put their energy into growth instead.

The same technique will also become indispensable in working with tilapia and the multitude of hybrid combinations possible, in order to determine strain, population, and species composition of individual fish.

Inbred lines of tilapia are being established so that simple techniques for measuring and controlling inbreeding can be developed. (A certain level of inbreeding can result in undesirable characteristics such as susceptibility to disease.)

Early results from the network projects support the hypothesis that domesticated fish are tamer and grow faster than their wild counterparts. This is further support for the belief that aquaculture systems should be genetically closed, that is, not supplemented with fish from wild stocks.

The exchange of staff, data, techniques, and ideas is essential to the success of the Asian research network. In addition to the contact made possible through training programs and site visits, researchers regularly see each other at network meetings and workshops. There, results are discussed, research plans updated, and data analysis problems shared and solved. Three such workshops have been held — in Singapore, Thailand, and Indonesia.

The network is currently focused sharply on the selection and domestication of fish. It omits important areas of fish genetics such as genetic sex manipulation and cytogenetics (the study of heredity using the techniques of cell biology) that are legitimate concerns in the Asian region.

The philosophy of the network has been to concentrate its efforts and "go for the gold" — that is, use modern selection techniques to produce new strains with higher yields. As the demand for more profitable, disease-resistant fish becomes urgent, even the best of the current strains will soon prove to be genetically inadequate. ■

Roger Doyle and Gary Newkirk are faculty members of the biology department of Dalhousie University, in Halifax, Canada. Dr Doyle leads the IDRC project that supports the fish genetics network in Asia. Both are active in research and teaching at Dalhousie, in addition to their network activities. The above article is a longer version of one published in NAGA, the ICLARM Quarterly.

PERFECTIN THE PROL TILAPIA

IN THE PHILIPPINES

MARK TIMM

In the coming decades, aquaculture will become a growing source of fish protein in the human diet. It will be of special importance to developing countries such as the Philippines where other sources of protein are not always readily available at a low cost.

It is in Asia that aquaculture is most widespread and has been practised longest. In 1983, Asian aquaculture produced 5.2 million tonnes of fish or 75 percent of world production of cultured fish. But that represented only 15 percent of all the fish produced in the region. As the world's catch of wild fish levels off or declines, aquaculture will have to come to the rescue.

Aquaculture is moving quickly to complete dependence on stocks propagated artificially on fish farms. This increases the importance of genetic research to improve the quality of fish "seed". The aquaculture industry also faces increasing production costs — particularly in the area of feeds. Genetic improvement would enable fish farmers to save on these costs by improving production efficiency.

"Asian countries are just developing the trained scientists who can work in this field," says Mrs Zubaida Basiao, a fish geneticist in the Philippines. Her research aims to help hatcheries to identify very early which young fish will grow quickly into healthy fish. It is part of an Asian–Canadian network that brings together geneticists from six countries. (See previous article.)

Three projects in the Philippines are focusing on *Oreochromis*, a freshwater fish commonly known as tilapia. At the Central Luzon State University, researchers are selecting tilapia strains for pond culture in keeping with the network's overall objective of increasing domestication in the industry.

Tilapia is quickly becoming one of the most popular species in Asian aquaculture. It eats virtually anything and is prolific. Its market versatility has earned it the nickname "aquatic chicken".

Some countries are finding that tilapia has good export potential. Israel, for example, is already exporting to the United States where the market is estimated at US$100 million.

A number of Asian countries such as the

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Photo: Mark Timm

Dr Cesar Villegas checks up on tilapia broodstock at the SEAFDEC research station in Tigbauan, Philippines.

Philippines have extensive coastal areas where seawater and freshwater come together. Because tilapia is a "euryhaline" or salinity-tolerant species of fish, such brackish waters could be used for tilapia culture. This would reduce the pressure to convert crop lands to aquaculture. Alternatively, lands where the soil is too saline for rice or other crops could be used to establish tilapia ponds.

Although tilapia can be raised in brackish water, it does not spawn under such conditions. One component of the network research in the Philippines is to develop a tilapia strain that will.

At the Philippine branch of the Southeast Asian Fisheries Development Center (SEAFDEC) in Tigbauan, Iloilo, Dr Cesar Villegas is crossbreeding *Tilapia mozambicus* (a brackish water species) with *Tilapia niloticus*. The goal is to transfer the salinity-resistance of *mozambicus* to *niloticus* without some of the less desirable characteristics of *mozambicus* — such as early maturing and small harvest size.

Like other tilapia geneticists, Dr Villegas has had some difficulties because the two species do not spawn at exactly the same time. Also, the different ages of the males and females that are paired for breeding often causes them to fight rather than flirt. These are the kinds of practical problems that the researchers in the Canadian component of the network, based at Dalhousie University in Halifax, Nova Scotia, are trying to overcome through the use of new techniques and designs of experiments.

Dr Villegas expects to have results useful to industry in five to seven years. Results from other projects in the network may come considerably sooner, however. During 1988, the Thai genetics group, under the technical direction of Mrs Supattra Uraiwan, will conduct extensive testing of several tilapia strains developed during the past several years at the National Inland Fisheries Institute.

As the tilapia industry has grown, breeding farms have not been able to supply either the quantity or the quality of "seed" needed. Farmers complain of poor survival rates for young fish, low growth, and low reproductivity (fecundity).

Thus, Mrs Zubaida Basiao and her colleagues are developing a genetic index to identify at an early stage which fish will perform well according to these and other criteria.

Her research is being conducted at SEAFDEC's Binangonan Research Station in Laguna Lake — the largest freshwater lake in the Philippines. Access to the island station is by a motorized outrigger canoe which threads its way through a maze of fish pens and cages.

The weight and size of tilapia fry are monitored regularly and compared with vital statistics in the same fish at maturity. The idea is to be able to predict adult performance through indicators in juveniles. In addition, the fish are subjected to stresses found on actual fish farms, such as crowding and starvation, to test the general fitness of each strain.

Dr Rafael Guerrero, an aquaculture consultant to industry and the Philippine Government but not connected with the IDRC-supported network, says such efforts to improve broodstock quality are the "long-term key" to the development of the industry. But he questions the relevance of genetics research to an industry faced with vast aquatic resources, limited capital, and poor consumers. He recommends placing more emphasis on improved management and that a next phase of the network's activities be concentrated on extension of research results to industry. According to Dr Guerrero, genetics won't become useful to the Philippine aquaculture industry for another five to 10 years — when intensive management becomes more important.

Those working in the Asian research network are more optimistic. They say aquaculture management and the biology of cultivated fish must be made to fit together much better than they do now. And to do this, management and genetics research programs must work together. "An alliance of this sort has led to a revolution in agriculture," says Dr Roger Doyle, of Dalhousie University, who leads the Canadian team involved in the network. "No one would waste time planting wild grapes in a modern vineyard."

He adds that modern genetics doesn't have to mean high-tech aquaculture management. The aim of the genetics network is to develop fish that are better for ordinary farmers, under artisanal conditions. "New strains of fish that grow faster on cheap feed or suffer less from disease represent a real increase in the ability of farmers to feed their families. And since the gains are biological rather than technological, they are not affected by inflation or other factors out of the farmers' control," says Dr Doyle.

The most visible results of the network will undoubtedly be the successful new strains developed. However, the network's most lasting achievements, say the Canadians involved in the project, will be the new methods for developing strains and the creation of an international pool of qualified geneticists working on the shared problems of aquaculture. ■

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