A Review of Fish Breeding Programs and Conservation Issues in Thailand

Supattra Uraiwan
National Aquaculture Genetic Research Institute
Kasetsart University Campus
Chatuchak, Bangkok, Thailand

Abstract

In the past four decades, the aquaculture industry in Thailand has emphasized improving both seed supplies and aquaculture techniques. Six freshwater and two coastal species have been successfully cultivated in hatcheries and induced spawning by hormone injection has been developed to control the reproduction of hatchery stocks. Little attention has been given to the improvement of stock quality. The Cooperative Program of Aquaculture Genetic Network in Asia, which is supported by the International Development Research Center (IDRC), started a program in 1982 that was aimed to genetically improve broodstock quality. The objective of the program was to develop improved strains of economically important species, such as tilapia, walking catfish, common carp and Java carp through selective breeding and broodstock management. These species were raised under farm conditions with the goal of improving growth rate and disease resistance, and a number of selection procedures have been developed to improve growth rate of economically important species. Several improved strains have been achieved after seven years of this program: two improved strains of Nile tilapia (*Oreochromis niloticus*), Chitralada and NIFI strains; one strain of the red tilapia; and one strain of the walking catfish (*Clarias macrocephalus*). Selection programs for other species, such as the Java carp (*Puntius gonionotus*) and the seabass (*Lates calcarifer*), are now being conducted. Population genetics and genetic manipulation have been studied under the European Economic Community (EES) grant since 1990. The project, which continues until 1994, concerns three species; the Nile tilapia, Java carp and walking catfish. In this paper selective breeding programs of economically important species are reviewed and genetic conservation of genetically improved species are also discussed.

Introduction

The aquaculture industry provides an important source of animal protein for the people of Thailand. In 1990, aquaculture contributed 297,000 tons of freshwater and marine fish. This was 61% more than the production in 1980 (Thai Department of Fisheries 1990). Thirty-five percent of the total production (103,800 tons) was from freshwater aquaculture and 65% (193,200 tons) was from coastal aquaculture. During the past several years, the Department of Fisheries (DOF) has placed more emphasis on improving aquaculture production in terms of increasing seed supply and improving aquaculture techniques. Little attention has been given to improving broodstock quality. This has resulted in the deterioration of economically important traits; decreased growth rate, small maturation size and low disease resistance. These problems are seen in common carp (*Cyprinus carpio*), walking catfish (*Clarias* spp.) and tilapia (*Oreochromis niloticus*).

To counteract these problems, the aquaculture genetics program in Thailand, supported by the International Development Research Center (IDRC) under the Network Genetic Project, was started in 1982 where both aquaculture genetic research and staff training have been conduced. The most worthwhile outcome of this project has been the formation of an aquaculture genetic research group and the establishment of the National Aquaculture Genetic Research Institute (NAGRI). In addition, there are four regional research centers that serve to develop broodstock, maintain stocks of genetically-cataloged fishes, and release improved strains to other fisheries stations and farmers.

NAGRI has been involved in joint research with many countries. At present, the institute is supported by two major sources of international funding the IDRC and the EEC. The purpose of the Thai/IDRC project is to develop domesticated strains of economically important species such as tilapia, catfish and common carp. The project started in 1982 and will be completed in May 1993. Dalhousie University in Canada has collaborated with the research program and NAGRI staff has been trained in aquaculture genetics during the program. The Thai/EEC project focuses on two main research areas; population genetics and genetic manipulation. The project started in 1990 and will end in 1994. Since 1982, the Department of Aquaculture at Kasetsart University has studied genetic improvement of economically important species. This work has been supported by the Thai government.

Freshwater fish species

There are six important freshwater species in Thailand: Nile tilapia (*Oreochromis niloticus*), walking catfish (*Clarias* spp.), Java carp (*Puntius gonionotus*), striped catfish (*Pangasius sutchi*) and sepat Siam (*Trichogaster pectoralis*). Breeding programs for these species have been carried out in fifty freshwater fisheries stations around the country. Each station keeps its own stocks and the seed produced is distributed to fish farms in the stations own region. In addition, the stations are responsible for restocking the species in natural waters and village ponds each year. In 1989, the target for restocking freshwater species around the country was 75 million fry. Each year this number tends to increase 10% (Suraswadi 1988).

Selective breeding for genetic improvement has been developed in three species; Nile tilapia, walking catfish and Java carp.

- **Tilapia (*Oreochromis* sp.)**

Selective breeding of tilapia for genetic improvement has been developed under the Thai/IDRC project. This project involves selection methods for increasing growth rate using within-family selection, size-specific mass selection and indirect selection or selection for age at maturation (Uraiwan 1993). There are three improved strains.

Two lines of the Chitralada strain of Nile tilapia were selected. The Chitralada strain was introduced from Japan in 1965. The first line was selected for its high growth rate by within-family selection. The second line was selected for age at maturation. Indirect selection was developed to find the selection method that best accommodates broodstock management practices on fish farms. The indirect selection experiment illustrated that selection for early maturation can improve growth rate, therefore, this type of selection can be applied under farm conditions. After three generations of these selection experi-

ments, the fish in the selected line were compared to the fish in the control line. The results indicated that fish in the selected lines grew an average 36% faster than those in the control line by within-family selection, and 11% faster than the control line by indirect selection (Uraiwan 1990).

One selected line of the NIFI strain of Nile tilapia was modified by mass selection or size-specific selection. The selected strains were distributed to test their performance in Pitsanulok Fishery Development Research Center in the north of Thailand. The strain evaluation experiments have been conducted in both government and private fish farms. The testing will be completed by the end of 1993 (Uraiwan et al. 1993).

In 1968, the Thai red tilapia was found at the Ubonratchathani Fisheries Development Center (Tangtongpirod et al. 1982). Red tilapia were selected for high growth rate using a size-specific selection technique for six generations (Jarimopad 1989). Under farm conditions in the northeast of Thailand the growth rate of the selected red tilapia are now being compared with the local strain.

In collaboration with the ASEA-EES Aquaculture Development and Coordination Programme (AADCP), NAGRI has recently developed genetic manipulation and sex reversal techniques for the Nile and red tilapia. The project began in 1990 and will continue through 1994. Triploid fingerling of the Nile tilapia will be used for an experimental intensive culture system at Nakhornsawan Province, and experiment on monosex male red tilapia has been developed in Chachoengsao Coastal Aquaculture Development Center in Chachoengsao Province.

- **Walking catfish (*Clarias macrocephalus*)**

There are three species of walking catfish in Thailand: *C. macrocephalus*, *C. batrachus* and *C. gariepinus*. A number of selective breeding programs have been developed for these species.

Mass selection for increasing growth rate of *C. macrocephalus* has been conducted since 1986 under the Thai/IDRC project. After three generations of selection, fish in the selected line were 11.8% heavier and 2.35% longer than those of the control line (Jarimopad et al. 1989).

Aeromonas hydrophila is one of the most serious disease problems in Thailand. Strain selection for resistance to *A. hydrophila* has been conducted since 1987 at the Department of Aquaculture, Faculty of Fisheries, Kasetsart University (Na-Nakorn and Lekhaanantakun 1992b). Growth rate and resistance to *A. hydrophila* for five different strains and their hybrids of *C. macrocephalus* have been compared. After one generation of selection for disease resistance, a slight improvement for resistance to *A. hydrophila* was observed with the heritability estimated at 0.17 (Na-Nakorn, personal communication).

To improve growth rate and increase disease resistance, chromosome manipulation and gynogenesis have been developed in *C. macrocephalus*. Unfortunately, the triploid *C. macrocephalus* showed slower growth and lower survival than the diploid (Na-Nakorn and Lekhaanantakun 1992a). Gynogenesis of *C. macrocephalus* is now being investigated at the Kasetsart University, Department of Aquaculture.

The hybrid of the female *C. macrocephalus* and male *C. gariepinus* is a commercial success and is now preferred by farmers. This is because the hybrid grows faster than

the pure *C. macrocephalus* (Nukwan et al. 1990).

- **Java carp (*Puntius gonionotus*)**

The selective breeding program for Java carp has been developed over four decades and has emphasized induced spawning by hormone injection and increased growth rates by optimum management. However, the genetic improvement program just started in 1992. Female carp are known to grow faster than males. Therefore, the objective of the early genetics program was to produce cultured monosex females. Roongratri et al. (1992) produced all female fingerlings using gynogenesis. The gynogenetic offspring had a survival rate of 61%. These offspring were sex-reversed to produce sex-reversed-males, which in turn produced all-female stock.

Na-Nakorn and Legrand (1992) induced triploid carp by cold shock. They produced 90-96% triploid carp by treating the fertilized eggs at 15°C. A comparison of growth rates for the diploid and triploid Java carp is still being conducted. A new approach for genetic improvement of Java carp is on-farm-selection, which will be addressed in the section on genetic conservation.

Coastal fish species

The economically important coastal fish species are seabass (*Lates calcarifer*) and grouper (*Epinephelus tauvina*). Similar to the freshwater species, there are seven coastal fisheries stations that are responsible for developing culture techniques and producing seed supply. Although the complete life-cycle of these species has been controlled, coastal farmers still prefer to obtain their stock from natural sources because offspring from hatchery stock have lower survival rates than those in the wild. Therefore, genetic improvement programs for this species have not been developed. Most of the earlier research emphasized spawning and rearing techniques. The Coastal Aquaculture Division, Department of Fisheries has developed culture techniques for these species.

- **Seabass (*Lates calcarifer*)**

The seabass has been cultivated in Thailand for over 40 years. In 1973, the first successful spawning of the seabass took place at the Songkhla Coast Fisheries Station (Chomdat and Pucharean 1979). Spawning and rearing techniques have also been extended to the private sector. At present, this species has become one of the economically important coastal species in Thailand.

The fish can be reared in earthen pond and cages and the optimum stocking densities are one individual/m^2 in earthen ponds, and 4-6 individuals/m^2 in cages (Wongsomnik and Maneewong 1976.) The seabass culture is now facing problems of slow growth and lack of natural broodstock. Therefore, selective breeding for improving growth rate is under consideration by the Department of Fisheries. The main goal of this program is to convince farmers to use hatchery seed supplies. Strain selection will be the first step in developing a selective breeding program. The government fisheries stations will then propagate these selected strains for the private hatcheries.

Genetic Conservation

- **Background**

Two aspects of aquaculture development in Thailand that will soon be competing or interfering with each other are genetic improvement and conservation of genetic bio-

diversity. Both activities are urgently required to meet Thailand's rural population needs for food over the short and long-term.

The need for genetically improved aquaculture broodstock is essential. Natural populations of aquatic animals are fished to the point of extinction and aquaculture continues to supply an increasing proportion of the protein requirements for rural people. The value of genetic conservation in aquaculture (as opposed to genetic progress) has been recognized in Thailand.

Maintaining adequate stocks, with their original genetic diversity, is in the long-term interest of countries like Thailand. A national genetic conservation program can be integrated with the genetic improvement program under the responsibility of an institute like NAGRI. A proposal for such a program has been drawn up and submitted for internal and international funding.

- **Program objectives**
  - > To establish genetic improvement and conservation in aquaculture as economically self-sustaining activities within a rural economy,
  - > To determine the overall rate of genetic improvement that can be attained by a farmer-operated, for-profit, aquaculture venture,
  - > To analyze the steady-state level of genetic conservation or genetic erosion that result from a market driven balance between gene flow among farms and regions. To improve the genetic base that leads to genetic improvement and to the differentiation of local breeds.
- **What to expect from a successful outcome**
  - > A number of fisheries stations and individual farmers will participate in the program by developing improved aquaculture seed (fry for sale to other farmers in their areas),
  - > Local farmers benefit because their productivity increases from using genetically improved stock,
  - > The genetic (geographical) heterogeneity of the breeds will be preserved or possibly enhanced by the local improvement process,
  - > NAGRI and its satellite stations will provide broodstock management training and advice to farmers.

Conclusion

Genetic improvement studies conducted in Thailand for the past decade have emphasized economically important freshwater species. A number of these studies have aimed to improve growth and disease resistance because of their importance to farmers. There has been relatively little work on marine species because the culture technology in this area is not well developed and farmers still prefer to collect seed from the wild. However, government fisheries stations hope to resolve the culture problems and begin propagating selected strains in private hatcheries.

The National Aquaculture Genetic Research Institute's genetic conservation program is concerned with maintaining the genetic diversity of local species in Thailand. The program aims to integrate two aspects of aquaculture development in Thailand, genetic improvement and genetic diversity. The goal is to promote aquaculture as a self-sustaining activity, which is important within a rural economy.

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