

CHAPTER I

INTRODUCTION

1.1 The Ornamental Fish Industry in Malaysia

Ornamental fish and other aquatic creatures are fascinating to watch. The attraction of ornamental fish and their value in the market depend on the diversity of species, great variety of colour, shape, behaviour and origin. The keeping of ornamental fish is the most widespread animal related hobby in the world. The rapid development in fish breeding technology results in hundreds of species and varieties all over the world. Now these fish are bred commercially and play important roles in generating foreign exchange earning. In 1996, the world export value of ornamental fish and invertebrates was over US \$200 million, approximately US \$130 million went into the economies of developing countries. Since 1985, the international trade in ornamental aquatic organisms has been increasing at an average rate of 14% annually (Anon, 1999). More than 100 countries are involved in this trade. The top five exporting countries in 2001 were Singapore (22.8%), Malaysia (7.9%), Indonesia (7.5%), Czech Republic (6.2%) and Peru (5.4%). The top five importing countries were the United States of America (25.2%), Japan (11.6%), Germany (9.2%), United Kingdom (8.6%) and France (8.4%) (Anon, 2002).

Malaysia is rich in ichthyofaunal resources. Varieties of fish can be found in numerous rivers, swamps, lakes and coral reefs. These resources have been exploited for food, recreation and the ornamental fish trade. Aquarium fishery is one of the important and fast growing fisheries sub-sector in Malaysia recently. Fish keeping

has become one of the favourite pastime for Malaysians. Changes in domestic or home environment influence the demand for aquarium fish. The ubiquitous aquarium has become part of the modern interior decoration. Besides, aquarium fish are easier to be kept as pets in apartments than other animals.

In Malaysia, the ornamental fish trade is almost exclusively made up of freshwater fish species. The ornamental fish industry started in the 1950's in Johor. The activity was mainly based on the collection of wild indigenous stock from the rivers, streams, and swamps. The fish were subsequently distributed to Singapore. This activity continued till the early 1980's. Land development and pollution threatened the indigenous aquatic fauna. This led to the development of ornamental fish farms. Today, over a hundred species and varieties of ornamental fish are bred. In addition to the great variety of ornamental fish, aquatic plants and aquarium fish feed are produced (Lim & Gopinath, 1989).

The major groups of farm-bred ornamental fish are gold fish, harlequin, barbs, tetras, loach, discus, angel fish, danio, mollies, gourami, guppies, cichlids, swordtails, fighting fish, platy, catfish and sharks. A great proportion of them are not native to this region (Lim & Gopinath, 1989). Efforts towards natural propagation in captivity for the ornamental fish trade have been intensified in the last few years. Breeding of a number of exotic and indigenous ornamental fish species has been successful. For example, 309,937 pieces of *Osteoglossids* are produced annually (Anon, 1998a).

The growth of ornamental fish industry in Malaysia has been significant in the recent years. In 1988, the total production was 324,542,970 pieces of fish worth RM70,401,481. Johor, followed by Perak, Selangor and Pulau Pinang are the leading ornamental fish producing region. These four states produced 99.9% of the total volume of ornamental fish (Anon, 1998b). The ornamental fish industry is export orientated. 188,651,560 pieces of fish valued at RM 33,833,795 were exported (Anon, 1998c). Brunei Darussalam, Japan, Singapore, Taiwan and USA are great market for Malaysia (Annon, 2001).

The National Agriculture Policy calls for the development of commercial aquaculture, including ornamental fish culture in a sustainable manner. In line with this policy an Aquaculture Development Action Plan has been drawn up for the period 1996 to 2010. The ornamental fish industry is expected to increase its production to about one billion pieces by 2010 (Anon, 1996).

1.2 Arowana Trade

1.2.1 Myth of Arowana

The arowana is one of the most expensive and sought after fish in the aquatic world. The attraction of the arowana lies in its great beauty and Chinese belief. The Chinese believe that it is the reincarnation of the dragon. It is believed to bring good fortune to its owner. A gold arowana will bring good fortune and prosperity while a red arowana will protect its owner against evil spirits.

1.2.2 Background of CITES

CITES is an acronym for the Convention on the International Trade in Endangered Species of Wild Fauna and Flora. This convention began at the 8th Meeting of International Union for the Conservation of Nature. A treaty was proposed to regulate the trade in endangered species of animals but the proposals were not discussed at the meeting. The idea arose again in several meetings and in February 1973, eighty-one countries launched the agreement and the convention went into effect on 1 July 1975. Under this convention, international trade in wildlife and wildlife products is regulated.

Wild fauna and flora are categorised in the three appendices. Appendix I is the highest risk category. It is for plants and animals that are in danger of extinction. Commercial import, export and sale are normally prohibited. Appendix II includes animals and plants that are considered to be endangered but may be traded commercially provided that import or export permits have been obtained. Appendix III is for species that are abundant and are not endangered.

1.2.3 Arowana And CITES

Factors such as low fecundity rates, oral brooding habit and being an openwater spawner, coupled with habitat degradation and loss have threatened the survivability of the arowana (Khan *et al.*, 1996). It was once close to extinction because of high demand and low supply from the river. As a result, this fish is listed as an endangered and commercially threatened fish in Appendix I. Arowana can be

traded freely in the local market but fishing for this fish is banned as it is protected under the State Fisheries Enactment, 1991. However, there may be illegal fishing.

At the Rosanne Review Congress, 1989, it was agreed that only the F_2 generation from Commercial Captive-breeding Operations can be exported. This agreement aimed to encourage the conservation of animals included in Appendix I through captive breeding. Nowadays, commercial captive breeding has been successfully established in Indonesia, Malaysia and Singapore.

F_2 arowana from CITES registered farms are tagged when these fishes reach 15cm in length. They are tagged with coded microchips, known as Passive Implanted Transponders (PIT) for identification and the code can be read with a tag scanner. The buyer will receive a certificate of authority and a birth certificate.

1.3 Application of Genetics in Arowana Stock Management

Conservation of genetic resources is the ultimate task for long-term management in fisheries because changes in genetic structures due to stock separation can occur in a matter of decades (Vuorinen *et al.*, 1991). Changes in genetic structure can be associated with changes in population fitness (Carvalho, 1993). Hence the genetic identification and discrimination of arowana stocks are fundamental requirements in breeding programme. Breeders require genetic identification systems to minimize the deleterious effects of inbreeding (Gjedrem, 1992) by the introduction of supplementary stocks.

1.4 Goals of This Study

The Asian arowana consists of geographically isolated strains distributed in South East Asia. More work is needed to understand the genetic structure and the process of diversification in arowana. The present study has the following aims, first, to study patterns of genetic variation within and among seven strains of arowana, namely the wild and hatchery strains of green arowana, the Malaysian red-tail gold arowana, the wild and hatchery strains of Malaysian yellow-tail gold arowana, the Indonesian gold arowana and the Indonesian red arowana by using microsatellites. Second, by examining microsatellite structure, the loss of genetic variation in the arowana strain was estimated. In doing so, the effect of any severe bottleneck event due to captive breeding was determined. In addition, the conclusions based on the microsatellite marker data were compared with those based on the mitochondrial DNA sequences. The highly variable microsatellites provided a perspective on the diploid nuclear structure of each arowana strain and the less variable mitochondrial DNA sequences provided a phylogenetic perspective. Finally, the divergence time was estimated. These data would be useful in the identification of particular strains, and in the assessment and control of inbreeding and broodstock management for long-term genetic conservation of arowana.