Conservation of Fish Genetic Diversity: Need for Development of a Cryogenic Genebank in Bangladesh

A. Bart

Aquaculture and Aquatic Resources Management, Asian Institute of Technology, Bangkok, Thailand

Bart, A. 2002. Conservation of fish genetic diversity: need for development of a cryogenic genebank in Bangladesh. pp. 107-110. In: Penman, D.J., Hussain, M.G., McAndrew, B.J. and Mazid, M.A. (eds.). Proceedings of a workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia, 12-14 February 2002, Dhaka, Bangladesh. Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh. xxx p.

Background

Bangladesh is ranked 3rd largest in aquatic biodiversity in Asia behind China and India, with approximately 300 species of fresh and brackish water fish species (Hussain and Mazid, 2001). This species diversity has been attributed to one of the world's largest wetlands (Bengal Delta) and three large river systems (Brahmaputra, Ganges and Jamuna) that flow from the Himalayan mountains into the Bay of Bengal. Enormous freshwater fisheries resources feed millions of people living in the Delta. Recent acceleration of aquaculture production (700,000 tons of fish) in Bangladesh has begun to relieve fishing pressure from a few large rivers and water bodies. It is expected that the consumption demand for fish will reach over 2 million tons by the year 2002 (DoF, 1999). Unfortunately, overharvesting of fish with an increasing fishing population is likely to continue and place greater pressure on most small and large size water bodies. Rapid extraction of seed (for stocking) as well as broodfish (for seed production and consumption) from natural waters combined with destructive and unregulated fishing practices that use dynamite, cyanide, electrofishing and gillnets has led to the endangerment and possibly extinction of a number of rather valuable native species (Hussain and Mazid, 2001).

Loss of aquatic habitat due to siltation, dam construction (for irrigation, flood control and hydroelectric generation), and other anthropogenic activities has been one of the primary causes of species loss. Siltation in the upstream reduces water flow and water depth, impairing the opportunity of riverine fish to feed, navigate, and migrate and spawn. Construction of embankments for flood control and dams interferes directly or indirectly with fish migration, reproduction and ultimately survival of species. Deepening of channels by removing silt is a temporary and costly solution to improve habitat. While long term and effective measures are being sought, more effective and immediate measures are needed to protect and conserve threatened and endangered species.

Aquaculture practices (domestication, typical genetic manipulation: selection, sex reversal, hybridization and crossbreeding) and release of fry into natural water bodies also contribute to indigenous species degradation. The decade-long practice of stocking exotic and indigenous carp seed in the rivers and reservoirs already makes it difficult to determine the negative impact resulting from gene introgression and inbreeding. In other words, indigenous species in nature are probably contaminated to a level where it becomes difficult to compare performance against hatchery stock.

While little can be done to bring back lost species of Bangladesh, currently 56 species of freshwater species including 11 cyprinids are endangered or near extinction (IUCN, 1998), needing immediate measures to protect and conserve them. Establishment of *ex situ* gene banks, live and/or cryogenic, in the immediate term would ensure the maintenance of genetically pure stocks of fish while "buying us the time" necessary to improve habitat conditions for restocking.

Ex situ **Preservation and its Importance to Bangladesh**

The ideal strategy for conservation of threatened and endangered species is through *in situ* (conservation of the ecosystem or habitat to maintain them in their natural environment) protection/restoration of the native habitat of the species. Unfortunately, this is costly and requires a great deal of time as habitat restoration is clearly a slow process. One alternative is to maintain *ex situ* (conservation outside their natural environment) live or cryopreserved gene banks. Live gene banks for fish are also costly, requiring purpose built facilities, and being labor intensive are difficult to manage. Past attempts to maintain long-term live gene banks have often resulted in contamination of stocks.

There are fewer constraints to the establishment of long-term *ex situ* frozen gene banks, which are thought to ideally complement habitat conservation and in situ gene banks (Bart, 2001). There are several examples of cryogenic sperm banks for fish in Europe, and North and South America. They are comparatively less costly than live gene banks although some initial investment for equipment, maintenance and collection would be required. Cryogenic gene banking avoids the risk of contamination and requires little space and minimal facilities. While cryopreservation of sperm has been successful for many species, and the protocols have been well developed, cryopreservation of eggs and embryos has been successful only in oysters. Research into teleost egg and embryo is on going (Bart, 2000). Furthermore, it is possible to recover genotypes from cryopreserved sperm using androgenesis to produce viable diploid organisms with paternal only inheritance.

Ex situ conservation via cryopreservation has many potential practical applications. For example, maturation of males and females in a number of species is asynchronous. Bighead carp females come to seasonal maturity when sperm from males is not available. Hatchery producers of Bangladesh often use sperm from another species such as silver carp, which is less desirable as indicated by the lower price of this hybrid. Maintaining sperm in cold storage would facilitate artificial fertilization and subsequent seed production.

Many species of surviving brood animals have reached critically low levels, and this is likely to cause irreversible genetic bottlenecks in Bangladesh. Examples of these species in Bangladesh include 11 species of carps and barbs (Hussain and Mazid, 2001). Cryogenic preservation of sperm could facilitate dramatic increase in the effective breeding population in future restoration efforts.

Conclusions and Recommendations

Clearly, a cryogenic sperm bank has application to both aquaculture and conservation of species in Bangladesh. The Bangladesh Fisheries Research Institute (BFRI) has been charged with collection of indigenous species for propagation purposes. It has the necessary facilities, and pond and tank space to house a number of species and could naturally assume the responsibility of collection of samples from priority species, and the maintenance of collections and a database. Having established such a facility, it could join forces with academic institutions, the DoF and/or local NGOs such as BRAC to facilitate the education and training of hatchery operators and technicians on the use and distribution of cryopreserved sperm for hatchery use purposes.

References

Bart, A.N. 2000. New Approaches in Cryopreservation of Fish Embryos, In: Cryopreservation in Aquatic Species. Tiersch, T.R. and P.M. Mazik, Editors. World Aquaculture Society, Baton Rouge, Louisiana. Pp. 179-187.

Bart, A. N. 1999. Biodiversity and Ex Situ Fish Genetic Conservation. AARM Newsletter. Vol. 4(4) 6-8.

DoF. 1999. A Brief on Department of Fisheries, Bangladesh. DoF, Dhaka.

Hussain, M.G. and M.A. Mazid. 2001. Genetic Improvement and Conservation of Carp Species in Bangladesh. BFRI and ICLARM publication, Dhaka, Bangladesh.

IUCN Bangladesh. 1998. List of Threatened Animals of Bangladesh. Paper Presented in the Special Workshop on Bangladesh Red Book of Threatened Animals, 22 February 1998. Dhaka.