INGA News

Aquaculture Genetics Research and Issues in INGA Member Countries/Institutions

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Abstract

The information presented here is extracted from the presentations and discussions at the Sixth Steering Committee Meeting of the International Network on Genetics in Aquaculture (INGA) held in Hanoi, Vietnam on 8-10 May 2001. The main topics discussed were: review of genetics research progress and planned activies in member countries and Associate Member institutions; genetics improvement technologies; strategies and action plans for distribution of improved fish breeds to small-scale farmers; ecological risk assessment for genetically improved fish breeds; methods for monitoring the uptake of improved strains and impact assessment; and network activities and collaborations.

Introduction

Development of better fish breeds that can contribute to increased fish production while ensuring protection of biodiversity and the environment is seen as one of the key solutions to meet future food demands of the growing world population. Genetics research and the successful application of breeding programs in crops, livestock, Atlantic salmon and most recently on Nile tilapia by industry have provided the impetus for the governments of developing countries, advanced scientific institutions, international and regional organizations to establish linkages for the genetic improvement of commercially important aquaculture species.

With the present membership of 13 countries in Africa, Asia and Pacific and 12 advanced scientific institutions, regional and international organizations, the International Network on Genetics in Aquaculture (INGA) has been acting as a catalyst for collaboration among member institutions and initiation of national genetic improvement programs for commercially important aquaculture species. Majority of the member countries have initiated national breeding programs and some are already reaping the benefits from investment in genetics research in the form of improved fish strains. These developments have raised a number of issues that need to be addressed before full benefits of genetics research can be achieved.

The Sixth Steering Committee Meeting of INGA was held from 8-10 May 2001 in Hanoi, Vietnam and was hosted by the Research Institute for Aquaculture No 1 and the Government of Vietnam. The meeting brought together 34 scientists from 11 member countries and seven Associate member institutions of INGA including representatives of institutions who have informally expressed their interest in joining the network.

Progress in Fish Genetics Research

The meeting reviewed the on-going and planned fish genetics research in member countries and Associate member institutions and progress made to date. Details of research activities in progress and achievements made are in Table 1 and 2, which include a number of strains that are ready for dissemination to farmers. The highlights of the meeting are detailed below:

Genetic Improvement Technologies

A number of selection programs are in-progress in many INGA member countries, involving a variety of species, traits and selection methods. Apart from selection, other strategies are also available for genetic improvement (e.g. chromosome set manipulation, genetic engineering). However, each

Table 1a. Summary of fish genetics research in progress in member countries of INGA.

Member country	Genetics research in progress
Bangladesh	• Stock improvement of silver barb (*Barbodes gonionotus)*: performance evaluation of F1, F2, F3 and F4 crossbred and non-selected control groups • Genetic improvement of catla (*Catla catla)* and rohu (*Labeo rohita)* • Further genetic improvement of GIFT strain Nile tilapia (*Oreochromis niloticus)*: manipulation to produce monosex male population; • Genetic manipulation in *Heteropneustes fossilis* • Population genetics of *Tenualosa ilisha*
China	• Genetic improvement of blunt snout bream (*Megalobrama amblycephala*): 6th generation certified by the Ministry of Agriculture for extension; second phase of selection in-progress • Genetic diversity and selective breeding of red common carps • Introduction of improved bream strain to inner Mongolia area and other areas
Côte d'Ivoire	• Genetic improvement of Nile tilapia
Egypt	• Studies on reproductive performance of three farmed stocks of Nile tilapia • Genetic characterization and evaluation of growth performance of three farmed stocks of Nile tilapia and their crosses • Performance evaluation of four local strains of Nile tilapia under different farming systems. • Growth performance of tilapia species under different salinity conditions
Fiji	• Genetic improvement of cultured tilapia • Initiation of selective breeding of GIFT strain
India	• Conservation and genetic characterization of commercially important and endangered fish • Establishment of fish biodiversity database • Age effects of parents, rate of inbreeding and RAPD analysis in carps • Field testing of genetically improved rohu. • DNA fingerprinting of selected and unselected stocks of second generation of selected rohu and correlation of performance to DNA markers • Genetic characterization of catla • Studies on genetic diversity, induction of triploidy and sex reversal in common carp (*Cyprinus carpio*) • Mass selection and/or cross breeding of common carp • Evaluation of imported and local strains of common carps under different environments. • Development of transgenic fish technology
Indonesia	• Genetic characterization of common carp strains, catfish, milkfish and groupers • Selective breeding of common carp: diallel crossing experiment undertaken • Further selection of GIFT strain using between and within family selection • Individual selection of giant freshwater prawn *(Macrobrachium rosenbergii)* • Hybridization of *Clarias* sp. and *Pangasius* sp.
Malawi	• Genetic improvement of *Tilapia rendalli:* • Development of breeding plan for *Oreochromis shiranus* using combined selection • Studies on genetic diversity of *O. nyasalapia* species and *O. mossambicus*
Malaysia	• Molecular genetic study in river catfish, tilapia and marine turtles • Studies on the use of molecular markers to distinguish different strains of Nile tilapia
Philippines	• Performance evaluation of *O. spilurus, O. aureus, O. mossambicus* and *O. niloticus* and their crosses in saline waters, normal conditions and cold environment • On-farm growth testing of the FAC selected line of Nile tilapia • *Ex-situ* conservation of freshwater fishes with emphasis on native catfish

Member country	Genetics research in progress
	• Further genetic improvement of GIFT strain; DNA profiling and gene mapping • Development of farmer-oriented selection procedure for tilapia broodstock • Stock improvement of silver carp (*Hypophthalmichthys molitrix*), bighead (*Aristichthys nobilis*) and carp and common carp through hybridization • Cloning experiments in rabbitfish (*Siganid* sp.) and milkfish (*Chanos chanos)* • Species karyotyping and genetic profiling of commercially important finfish species
Thailand	• Studies on genetic diversity of populations/species of finfish, marine shrimps, prawns, crabs, etc. • Inter-and intraspecific hybridization experiments in oysters, catfish, tilapias and freshwater prawn to improve performance • Mass production of all-female snakeskin gourami (*Trichogaster pectoralis*) • Studies on growth, survival and sex reversal of walking catfish (*Clarias macrocephalus*)
Vietnam	• Documentation and genetic characterization of common carp, silver carp and other local carps • Gynogenesis for common carp, African catfish (*Clarias gariepinus*) and silver barb • Genetic improvement of common carp, silver carp, Nile tilapia by crossbreeding and selective breeding

Table 1b. Summary of fish genetics research in progress in Associate member institutions of INGA.

Institution	Genetics research in progress
Institute of Aquaculture Research Ltd. (AKVAFORSK), Norway	• National breeding programs for atlantic salmon, halibut and cod • International involvement in developing breeding programs for rohu (India); Nile tilapia (Vietnam); rainbow trout (Italy); Atlantic salmon (Scotland); Atlantic and coho salmon, rainbow trout (Chile); sea bream (Greece) and *Penaeus vannamei* (Columbia) • Muscle development in Atlantic salmon and Halibut
Auburn University, USA	• Genetic improvement of channel and blue catfish • Cloning of a variety of catfish genes • Studies on genetic diversity of wild and cultured channel and blue catfish • Studies on impact of environmental pollutants on gene expression • Genetic improvement of Nile tilapia in Sub-Saharan Africa: application of genetic marker technologies; QTL mapping and marker assisted selection
FAO	• Promotion of responsible fisheries and aquaculture • Development of a fishery global information system • Production of taxonomic guides and faunal lists for commercially important species
ICLARM-The World Fish Center	• Selective breeding of GIFT strain Nile tilapia in Malaysia, integrating YY-males and cloned lines • Transfer of GIFT technologies to sub-Saharan Africa and Egypt; selective breeding in Egypt with focus on growth rate and cold tolerance; identification of molecular markers for use in marker-assisted selection • Genetic improvement of carps in Asia: phase 1 completed; phase 2 to beInitiated • Genetic diversity studies in wild black-chinned tilapia (*Sarotherodon melanotheron*) in West Africa and wild silver barbs in South East Asia
Queensland University of Technology, Australia	• Genetic improvement of tilapias in Fiji: genetic markers developed to monitor stock quality; mass selection to improve color in local red tilapias • Genetic improvement of redclaw crayfish • Assessment of freshwater prawn genetic resources • Genetics studies on mudcrab (*Scylla* sp.)

Institution	Genetics research in progress
Research Institute for Fisheries, Aquaculture and Irrigation, Hungary	• Genetic improvement of carps: progeny testing and introduction of new selection criteria (resistance to adverse conditions and disease resistance). • Genetic characterization of carp strains • Live and cryopreserved gene banking for common carp strains • Implementation of national carp breeding program
Stirling University, UK	• Genetic improvement of tilapias: evaluation of wild stocks of *O. mossambicus* from South Africa for genetic improvement; selective breeding experiment using GIFT, GMT and crossbred clonal lines • Development of improvement strategies for exotic carps in Asia: strains evaluated in low-input system • Production and testing of sterile, growth-enhanced tilapia strains • Sex determination in tilapia
School of Biological Sciences, Swansea University, UK.	• Dissemination of improved Nile tilapia strain (GMT) in Philippines, Thailand and introduction to Vietnam; Assessment of wild stocks of *O. mossambicus* in South Africa for genetic improvement • Genetic improvement of carps in India: crossbreeding of catla; introduction of Vietnamese strain of common carp • Genetic diversity studies in silver barb species in Mekong river and wild *O. mossambicus* populations in South Africa assessed • Socioeconomic impacts of GMT in Philippines and improved crossbred common carp in Vietnam assessed • Studies on stock structure of wild *C. macrocephalus*
Agricultural Research Organization, Israel	• Establishment of a synthetic tilapia stock; selective breeding for cold tolerance and growth rate • Evaluation of YY-GMT: YY males replicated with *O. niloticus* females from Swansea, Ghana and Stirling red tilapia; replicated crossbred families being tested for growth performance • Studies on immunological traits in tilapia

offers opportunities and constraints. There is a need to re-examine whether these 'genetic improvement technologies' and their products can best benefit the poor and reach a wide level of success in application.

Participants were divided into two working groups to review the broad strategies for genetic improvement. The first group focused their discussions on selective breeding and crossbreeding and the second group on other technologies available for genetic improvement. Advantages and disadvantages of mass and family selection were discussed and it was noted that family selection is much better than mass selection; however this needs more facilities which may be a constraint in some of the member countries. The need for assessment of use of molecular techniques (use of genetic tags or as markers for QTL) in member countries was recognized but its usefulness depends on whether it will be applied to a well established breeding program. The participants also discussed other existing and emerging technologies for genetic improvement (F1 hybrids, triploids, monosex, development of QTL and genetic engineering) and noted that while selective breeding can be applied to captive populations of any aquaculture species, the other technologies are much more specific in their application.

Strategies and Action Plans for Distribution of Improved Fish Breeds to Small-scale Farmers

Some member countries of INGA have already developed improved breeds of carps and tilapias and it is expected that within the next two years additional improved fish breeds will be available and ready for dissemination. One of the major concerns about the benefits of genetic improvement reaching farmers is the lack of strategies for efficient dissemination of improved fish breeds to small-scale farmers without loss of genetic gains and without the commercial operators garnering the benefits and propriety rights of the improved germplasm.

The strategies being followed for the dissemination of improved tilapia breeds in Thailand by the Department of Fisheries; in the Philippines by the Bureau of Fisheries and Aquatic Resources and the GIFT Foundation International; for genetically male tilapia (GMT) in the Philippines and Thailand by the FishGen Ltd; and for improved Atlantic salmon in Norway by the AKVAFORSK were reviewed as background information for the discussions. Participants were split into three working groups to address the following issues: (i) strategies for disseminating the outputs of selection programs; (ii) strategies for disseminating the outputs from genetic manipulation; and (iii) targeting the small-scale farmers. Need for national dissemination strategies based on existing state of the industry, nature of genetic improvement/manipulation and target beneficiaries was emphasized. Centralized vs. decentralized dissemination and involvement of state vs. private sector in dissemina-tion were evaluated.

Fig. 1. Participants of the Sixth Steering Committee Meeting of INGA, 8-10 May, Hanoi, Vietnam.

Fig. 2. Participants of the Sixth Steering Committee Meeting of INGA during inaugural session.

Ecological Risk Assessment for Genetically Improved Strains and Impact Assessment

The need for assessing ecological risks associated with introduction/release of improved strains/exotics and development of appropriate policies was recognized by the members as they move towards dissemination of genetically improved strains.

The participants, in three working groups, noted the similarities and differences in risks for genetically improved and exotic species when they escape into natural waters. It was recognized that the risks vary according to the species/strain and the genetic improvement method used/introgression (selective breeding, chromosome manipulation, cross breeding, transgenics, exotic species, etc). The risks could be related to genetic diversity, ecological, habitat degradation, species diversity and disease resistance. The possible indicators that can be used in risk assessment and their practicality, reference points and policy involved were discussed. The elements of risk assessment and their usefulness to INGA members were also identified.

Methods for Monitoring Uptake of Improved Strains and Impact Assessment

When presenting the background information on the subject, the facilitator stressed the need to analyze the impacts of genetic improvement research on the economics, environment, society and institutions. The elements of impact studies at different stages of adoption were outlined.

The participants in two working groups discussed the impact indicators of genetically improved fish and adoption studies and the associated key issues. Participants sought the assistance of INGA in training and sharing of information from adoption studies.

Network Activities and Collaboration

The activities of the network and issues on collaborations were discussed. These included the status and plans for the second phase of the regional carp genetic improvement project; the FAO initiative on Aquatic Animal Diversity Information and Communication System (AADIS); plans for establishment of a regional genebank ; capacity building among network members; interaction between the advanced and developing country institutions; information sharing; network membership and plans for the next INGA meeting.