Faculdade de Ciências do Mar e do Ambiente
Masters in Marine Biology
Genetics and Selection

Selection Programs for Tilapiine Fish (Cichlids): The Relevance of Fish Improvement for Aquaculture

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Relevance of Tilapiine Fish to Aquaculture

Most successfully cultured species worldwide:

- Enormous adaptability and ability to reproduce under a wide range of physical and environmental conditions;
- Excellent growth rates on a wide variety of natural and prepared diets;
- Resistance to handling and disease-causing agents;
- Broad consumer appeal.

Endemic to Africa, Israel and Jordan freshwater

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Introductions elsewhere in the 20th century

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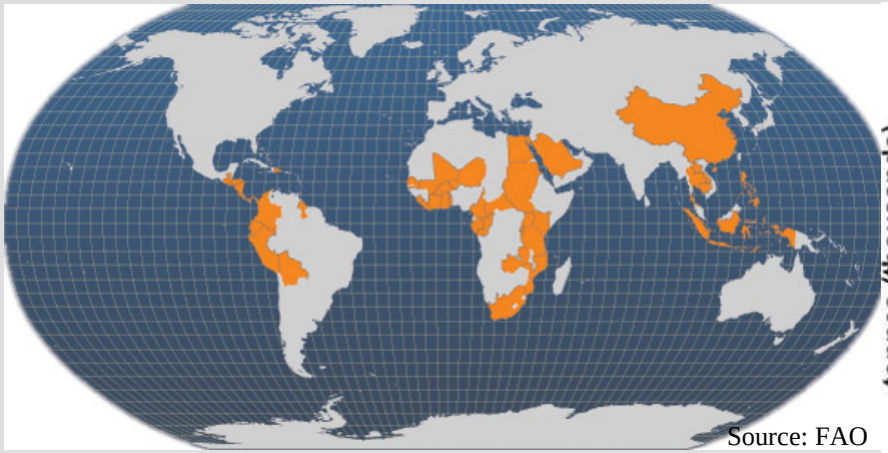
Cultured in virtually all types of production systems

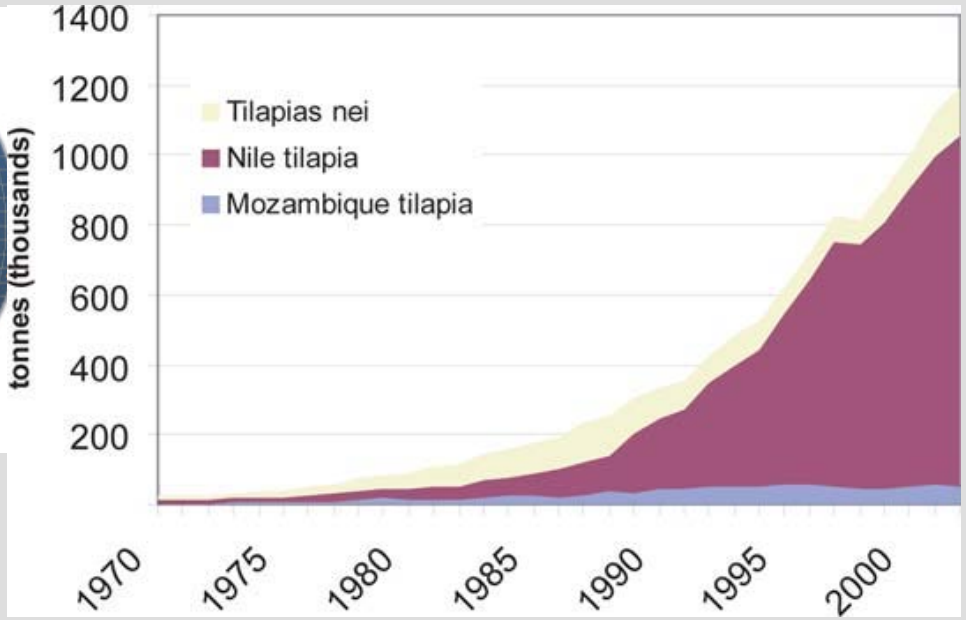
3 commercially important groups:

- *Tilapia* spp. guard the developing eggs and fry in the nests;
- *Oreochromis* spp. females incubate eggs and fry orally;
- *Sarotherodon* spp. males and/or females incubate eggs and fry orally.

State of Culture Worldwide



Source: FAO



Source: FAO

-Increasingly being seen as the species of choice for intensive aquaculture;

- Likely to become the most important of all cultured fish in the 21st century.

Tilapia farming expanded rapidly - 12 to 15 % / year during the past 2 decades

Predicted to continue to grow in the near future…

State of Culture Worldwide

5 % of total fish farming (group of carps account >70% of total)

Worldwide production >2.2 MMT (2002)
- 68 % from aquaculture;
- Rising from 57 % in 2000.

Most cultured species:

-O. Niloticus;
-O. Aureus;
-Hybrid combinations of these species with *O. mossambicus*.

We can improve species

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By using SELECTION to sharpen and increase perfomance and quality of fish

Fish Selection

Fish selection is based on the planned utilization of genetic variation inherent to all living beings in order to:

- **increase growth rate;**
- **increase resistance to:**
  - **.oxygen deficiency;**
  - **.high or low temperature;**
  - **.higher salinity;**
  - **.other deviations;**
  - **.parasites and infectious diseases;**
- **improve nutritive and sensitive properties of fish.**

Where is it done?

SELECTIVE BREEDING FARMS **(studies on how to improve, through selection methods). New fish pedigree is created.**

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Improved fish is then used in Aquaculture.

Types of Fish Selection in Tilapia

Modern Methods

- **Selection;**
- **Crossbreeding;** → Intraspecific
- **Hybridization;** → Interspecific
- **Sex manipulation;**
- **Gynogenesis/Clonal lines;**
- **Androgenesis;**
- **Polyploidy;**
- **Gene transfer;** → TRANSGENICS
- **DNA markers;** → MAS & QTLs
- **Gamete/Embryo Cryopreservation.**

Used in Tilapiine

Experimental

Old Methods

.Mass Selection

- Increasing Response Methods
- Correlated Response

.Genotypic selection

- Family selection
  - sub-selection
- Progeny testing

.Comparative response in mass selection and in selection for relatives

Selection in Tilapia by the Modern Methods

With GENETICS and BIOTECHNOLOGY

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GENETIC IMPROVEMENT

Interspecific and Intraspecific Hybridization

Reveal growth of heterosis

***Tilapia hornorum zanzibarica* × females of Malayan line**

Oreochromis mossambicus* × *O. niloticus

- growth of hybrids was better than pure strains;

- almost the whole progeny (up to 100%) males.

Results

Zanzibar fishes have a genetic mechanism of sex determination different in each line/species.

Fast growing all-male hybrids used because it:

- controls populations;

- prevents overcrowding of the waterbody.

Major PROBLEMS with Tilapiine Fish

Selection in Tilapia by the Modern Methods

Sex Manipulation

Sex-inverted *O. Aureus* males (which became ZZ neo-females) with normal (ZZ) males.

All-male progeny produced

All-male production is done as Tilapiine males grow

20 - 60 % faster than females.

For pollutant resistance:

Tilapia progeny from lines selected for resistance to heavy metals Hg, Cd, and Zn survived 3 - 5 X better than other progenies.

Selective - breeding farms actions with *Oreochromis noctilucus* (Nile Tilapia)

Côte d'Ivoire	***O. niloticus***	**Evaluation of local strains for selective breeding**
Egypt	***O. niloticus***	**Evaluation of local strains for selective breeding**
Malawi	***O. shiranus***	**Mass selection for genetic improvement**
Fiji	***O. niloticus***	**Performance evaluation of Fijian tilapia and GIFT strain**
Ghana	***O. niloticus***	**Evaluation of local strains for selective breeding**
Philippines	***O. niloticus***	**Continuation of multitrait (growth and frequency of spawning females) selection**

Complete gene mapping is needed to improve knowledge of species and improve towards the designated objectives with selection for greater productions in Aquaculture.

Using either short or long-term strategies.

Working on Improvements for Tilapiine Fish

- **Large scale genetic improvement programs have been established for *O. niloticus* in Asia;**
- **Genetic methodologies to control sex have resulted in the reliable production of all-male fry to overcome problems associated with excessive fry production in on-growing ponds;**
- **Future research will aim to improve the performance and expand the environmental tolerance of this species into areas of lower temperatures and higher salinities;**
- **Greater use of genetic markers for the management of broodstock, identification of loci controlling quantitative traits (QTLs) and the development of superior strains through marker-assisted selection;**

Development of tilapia breeds is at a point where tremendous gains could be made with a relatively small technical input.

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