

Tilapia Germplasm in China: Chance and Challenge

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A. The largest tilapia production in China is totally depended on some limited introductions

- Tilapias are exotic species and originated from the African.
- Since 1950s, **9 species/hybrids** have been introduced to China, which formed the germplasm founder of Chinese tilapia industry.



奥利奥罗非鱼亲本



hornorum female



Oreochromis mossambicus

O. niloticus

O. aureus

O. hornorum

O. andersonii

Tilapia zillii

Sarotherodon galilaeus

S. melanotheron

Fushou tilapia: *O. mossambicus* x *O. niloticus*

Red tilapia: *O. niloticus* x *O. mossambicus*

- **Brief introductions**

Species	Introduced to	From	Date of first introduction	Purpose
<i>Oreochromis mossambicus</i>	China	Vietnam	1956 1957	Aquaculture
<i>Oreochromis aureus</i>	China	Hong Kong SAR USA	1981 1981	Aquaculture
<i>Oreochromis niloticus</i>	China	Sudan Phillipines	1978 1994	
<i>O niloticus x O mossambicus</i>	China	Taiwan	1983	
<i>Sarotherodon galilaeus galilaeus</i>	China	Africa	1981	
<i>Sarotherodon melanotheron</i>	China	America	2002	
<i>Tilapia zillii</i>	China	Africa	1981	

Long history introduction

Original or second-handed

Repeat

Common cultured species

- Through many species/hybrids/strains and many times introductions and extensive applications, **GIFT strain of *O. niloticus*** and the **hybrid *O. niloticus* × *O. aureus*** are two most common cultured species in Chinese inland fisheries.
- Other species or strains are not extensively used due to lacking of superior performance.

- The NEW GIFT strain is famous for high growth rate.
- The hybrid of *O. niloticus* × *O. aureus* is for high male percentage.

- Meantime, other **hybrids** are partially applied.

Red tilapia

O. niloticus × *O. mossambicus*

GILI tilapia

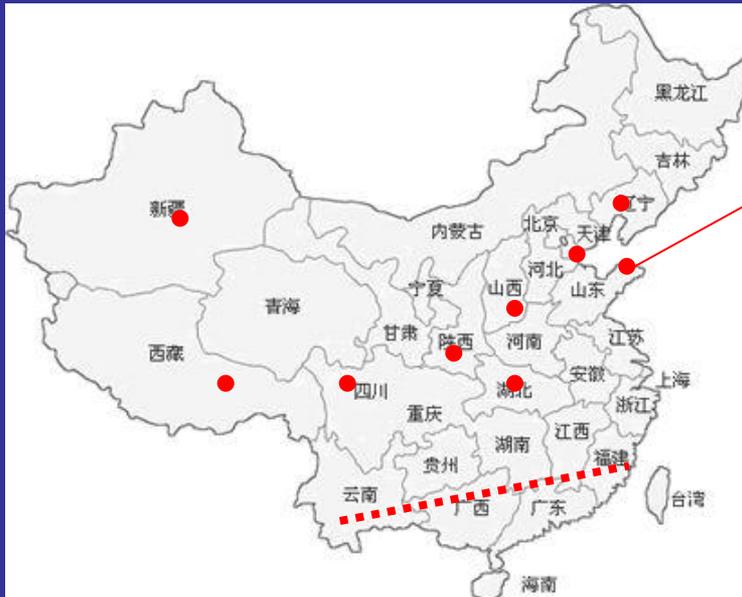
O. niloticus × *S. melanotheron*

Mohe tilapia

O. mossambicus × *O. hornorum*

Major Production Areas

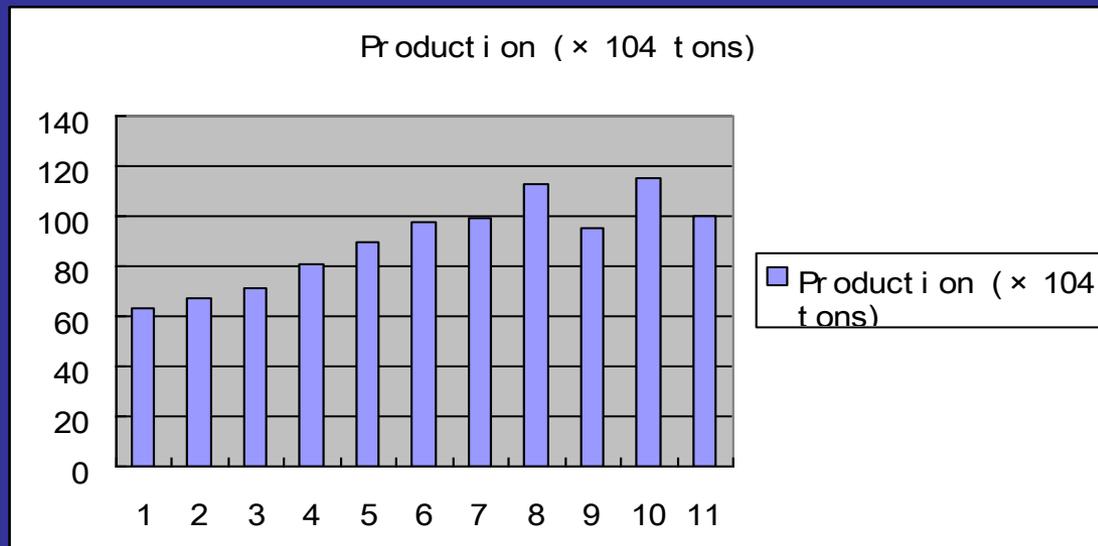
Due to warm climate requirement, the major tilapia production area is in south China (>90%), it also be cultured in north China using heat generation.



Area	Production percentage
South China	
Guangdong	47%
Hainan	20%
Guangxi	15%
Fujian	8%
other	10%

Total production

- Huge human labors, large amount of water area, good strains, new markets, together with the rich aquaculture experience, promote the tilapia production quickly in recent years.
- Chinese tilapia production is about 40% of total tilapia production in the world.



from 2000 to 2010



Export

In those years, the export production also keeps a strong increase and export to many other countries.



Year	Production ($\times 10^4$ tons)
2007	21.5
2008	22.4
2009	25.9
2010	26

Countries	2008	2009
USA	11.86	13.74
Mexico	3.65	3.62
Russia	1.71	2.19
EU	1.45	1.96
others	3.77	4.4
Total	22.44	25.9

Problems on introduction

(1) Unorganized introduction

The purposes of tilapia introduction were for research or commercial use, however, fish introduction was never organized.

Introducing source, number and their characters are less considered.

These tilapias are kept in some separated institutes or fish farms, their genetic variation may not be fully utilized.

Original or second-handed countries

Small effective size

Repeat

Characteristics

(2) Small population

The **effective population size** is determined by the actual mating parent's numbers rather than the total parental numbers.

Because of long-distance transplantation, only a few individuals could survive at last. Therefore, the effective population is much smaller than its original amount, the genetic variation of introduced population was rather low.

In depth, low genetic diversity is the ultimate limitation for its future genetic improving.

(3) Genetic drift

Under the circumstance of small population size, **genetic drift** would happen and severely changed their genetic variation generation by generation.

The introduced population would deviated from the original population.

(4) Poor management

- **Inbreeding** is easily happened for tilapia because they are from the common ancestor, especially from some small population.
- Meantime, **unjust mating scheme** are another source of inbreeding during generation transition.

(5) Hybridization

- Because of easy **interspecific hybridization**, more than two kinds of species kept in the same fish farms would produce interspecific hybrid, these hybrids were often mixed with the brooder stocks.
- Genetic introgression was found in some tilapia fish farms.

- In respect of the germplasm, unorganized introduction, small effective population size, genetic drift, inbreeding, hybridization, poor management of these introduced population further would limit and constrain their long-term utilization.

B Genetic improvements is still on development

1. Growth Rate

Growth rate is the first demand for a good variety.

1.1 GIFT strain of Nile tilapia

- Selected from the combined base populations of four African original strains and four Asian domesticated strains in Philippines by ICLARM and collaborators;
- Introduced to China in 1994;

□ Showing some superior performances

Growth rate, 5-30%,

High capture,

Salinity tolerance,

High production, 20-30%.

Low variation.

□ Became a superior introduced variety (Reg. No. GS-03-001-1997).

中华人民共和国农业部第77号公告：“吉富品系尼罗罗非鱼为适合我国水产养殖生产中推广的从境外引进的尼罗罗非鱼新品系”。

全国水产新品种登记号(GS-03-001-1997)。



1.2 New GIFT Tilapia

- ❑ Developed from the introduced GIFT strain by Shanghai Ocean University and collaborators.
- ❑ Eight generations of mass selection on growth rate and morphology;
- ❑ Possessing higher growth rate than the control group (>30%),
- ❑ superior selected variety (Regis. No **GS-01-001-2005**)

新吉富罗非鱼(GS-01-001-2005),
2006年农业部公告(第641号)推广养殖



Although there are many introductions for different tilapia species or strains, the small effective population size resulted in genetic bottle or genetic drift, the loss of genetic variation made **their selection are not effective in most strains.**

2 Male percentage

□ Excessive reproduction:

Sexual maturation ahead of the commercial size is also perplexing tilapia aquaculture.

□ Growth:

Male > Female

- The **hormone administration** was easily applied at the fingerling stage to increase male percentage, however, its food safety is still on debated.
- Another practical method for producing male-offspring is **inter-specific hybridization**.

The best hybridization combination for high male percentage is *O. niloticus* × *O. aurea*, which claimed to produce more than 95% male percentage.

In fact, some other factors (genetic and environmental) also affected the male percentage.

➤ YY-male tilapia

The sexual chromosome type of Nile tilapia is XY type (XY for male, XX female).

- Sexual reversal $XY(\♂) \rightarrow XY(\Delta\♀)$,
- Identification $YY(\♂)$ among $XY(\Delta\♀) \times XY(\♂)$ progeny;
- Mating of $XX(\♀) \times YY(\♂)$ will produce 100% male percentage $XY(\♂)$.



3. Salt-tolerance

- *O. niloticus* grow fast but low salinity tolerance (<15),
- *S. melanotheron* grow slowly but high salinity tolerance (0-100).
- It is easy for interspecific hybridization among some tilapia species, hybridization of *O. niloticus* and *S. melanotheron* are less successfully .
 - probably due to their different genera.
 - the mouth hatching parent is female in *O. niloticus*, while mouth hatching parent is male in *S. melanotheron*.

F1 :

The growth and salinity of *O. niloticus* × *S. melanotheron* was better than that of *S. melanotheron* × *O. niloticus*.

The difficulty on getting enough F1 offspring greatly confined their application.

In contrast, the **F2** generation could easily be obtained by the natural mating among F1, and they kept salinity tolerance and growth as F1.

They could be largely propagated in practical.

F2 have been cultured in seawater ponds (20-25) or poly-cultured with shrimp. Meantime, the meat flavor also was improved under salinity culture.

吉丽罗非鱼(GS-02-002-2009)
2009年 农业部公告 (第1339号) 推广养殖

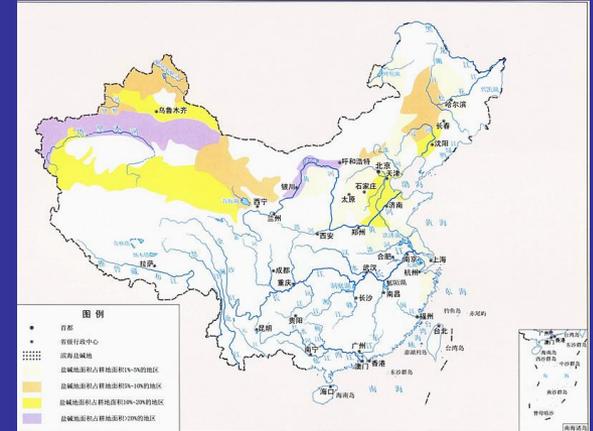


Brackish-alkaline water tolerance tilapia is expected in north China.

Area of brackish-alkaline land is about half of the total arable lands.

Distribution: North-west, North, North-east, Central and East coastal area.

统计显示，中国约有耕地18亿多亩，约有盐碱地约14亿亩，盐碱地分布在东北、西北、华北以及中部和东部沿海地区。



4. Disease resistance

Disease is another problem perplexing the industry.

- Tilapia epidemic disease has broken out in main producing area, South China since 2009
- It mostly attacked young tilapia at 100-200g, with 20-30% morbidity and 95% mortality, thus greatly decrease the total production.
- Recently, *Streptococcus agalactiae* was isolated and identified as the main pathogen in Guangdong and Hainan.



- **A comprehensive program** has been initiated to prevent and control this disease during the whole production process (seed, water, feed, prevention).
- Also, **disease resistance strains** are expected urgently to adjust the aquacultural environmental.

5 Cold tolerance

- Naturally, these temperate tilapia species couldn't survive the winter in most part China. The lethal temperature for *O. niloticus* is 11°C, 7°C for *O. aureus*.
- In north China, tilapia was only cultured under circulated warm waters, supplied by electricity power plants.
- In south China, tilapia could survive the winter naturally, or in the simple plastic-roof rooms.

- Since 2008, the bad cold climate often intruded south China. The low temperature killed the adult fish and decreased the total production; it also killed tilapia breeders and caused the shortage of the next year seed supply.



寒潮来袭 广东清远大批罗非鱼被冻死

南方日报



博白罗非鱼养殖基地受灾严重

玉林日报 2011.1

- The best resolution for safe winter is to provide some warm-keeping apparatus, it is the most effective way to escaping from the cold, although it add some cost to producer.



- Improving their cold tolerance is put forward in recent years, however, it may be a long way to conquer their biological ability and climate change.

广西“罗非鱼耐寒新品种的选育”通过验收

9月13日讯，由广西水产研究所主持的“十一五”国家科技支撑计划课题“罗非鱼耐寒新品种的选育”通过自治区科技厅验收。该课题在国内首次育成耐寒型罗非鱼配套系杂交组合，为实现亚热带罗非鱼全年连续生产提供了科技支撑。据介绍，该耐寒品种在正常情况下，每年可提前半个月放苗，推迟半个月收获，意味着每年增加1个月生长周期，对罗非鱼产业产量意义重大。一旦有寒灾来袭，耐寒鱼能扛10天左右，而不是像普通品种两三天就全死，有充足时间上市，减少损失。该项目正争取进入“十二五”项目规划，有望使广西罗非鱼产业抵御十年、二十年一遇的寒灾。

——《海洋与渔业：水产前沿》2010,10:3

