Fishgen - a global aquaculture company

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Executive Director Fishgen Ltd

Tilapia 2015 Kuala Lumpur

What are tilapia?

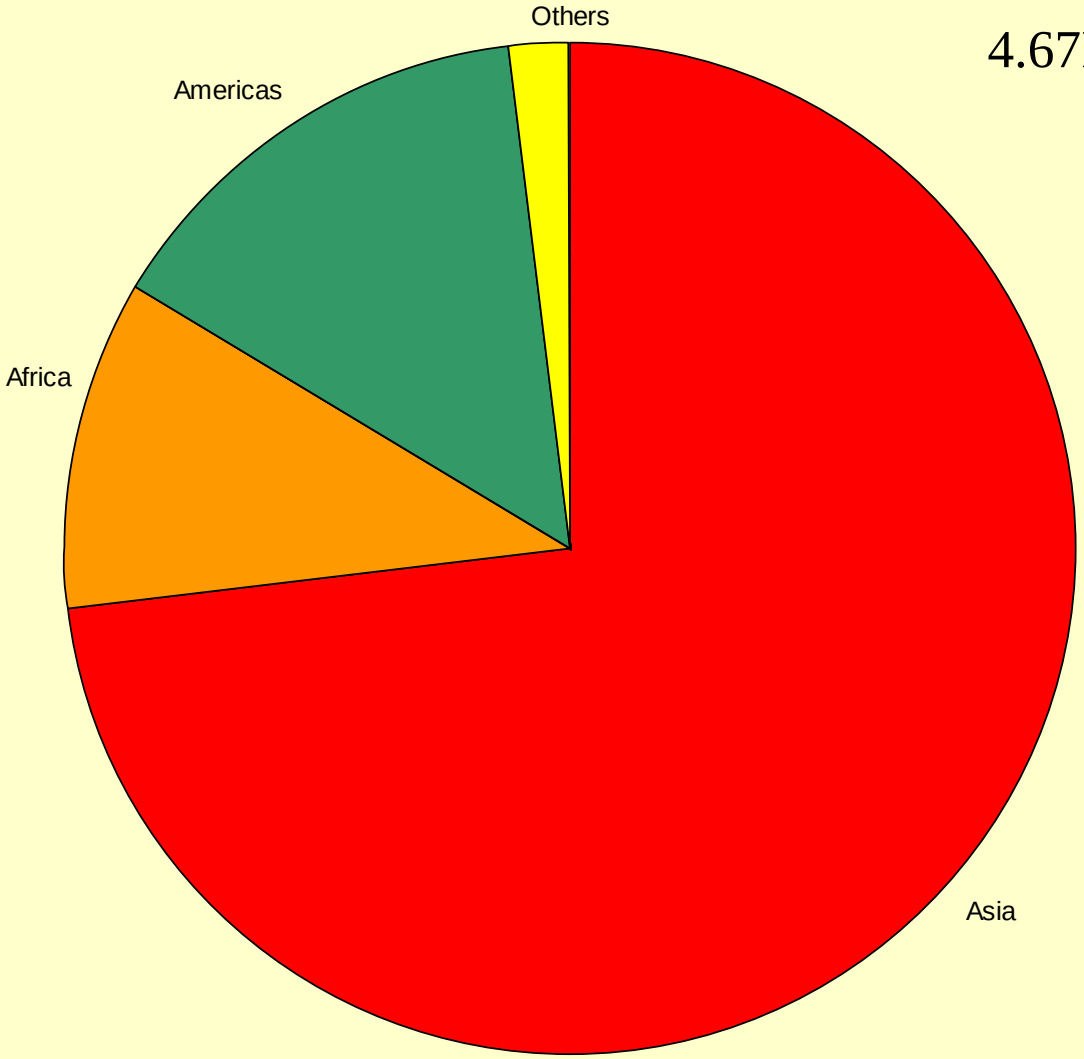
- A tropical freshwater fish species originating in Africa (over 100 species, but Nile tilapia - *Oreochromis niloticus* most common) and farmed by the ancient Egyptians over 4000 years ago to feed the Pharaohs.

- Eggs hatched and fry reared on the International Space Station and just a few months ago another space launch carried tilapia fry into orbit.

- Well suited to aquaculture
  - Hardy, adapts to a wide range of culture systems from freshwater to highly saline conditions
  - Easy to breed and fast growing, replacing over-fished local species
  - Introduced worldwide for aquaculture ranging from traditional extensive to modern intensive systems
  - Known as the “aquatic chicken”

World Tilapia Production of

4.67MMT in 2013



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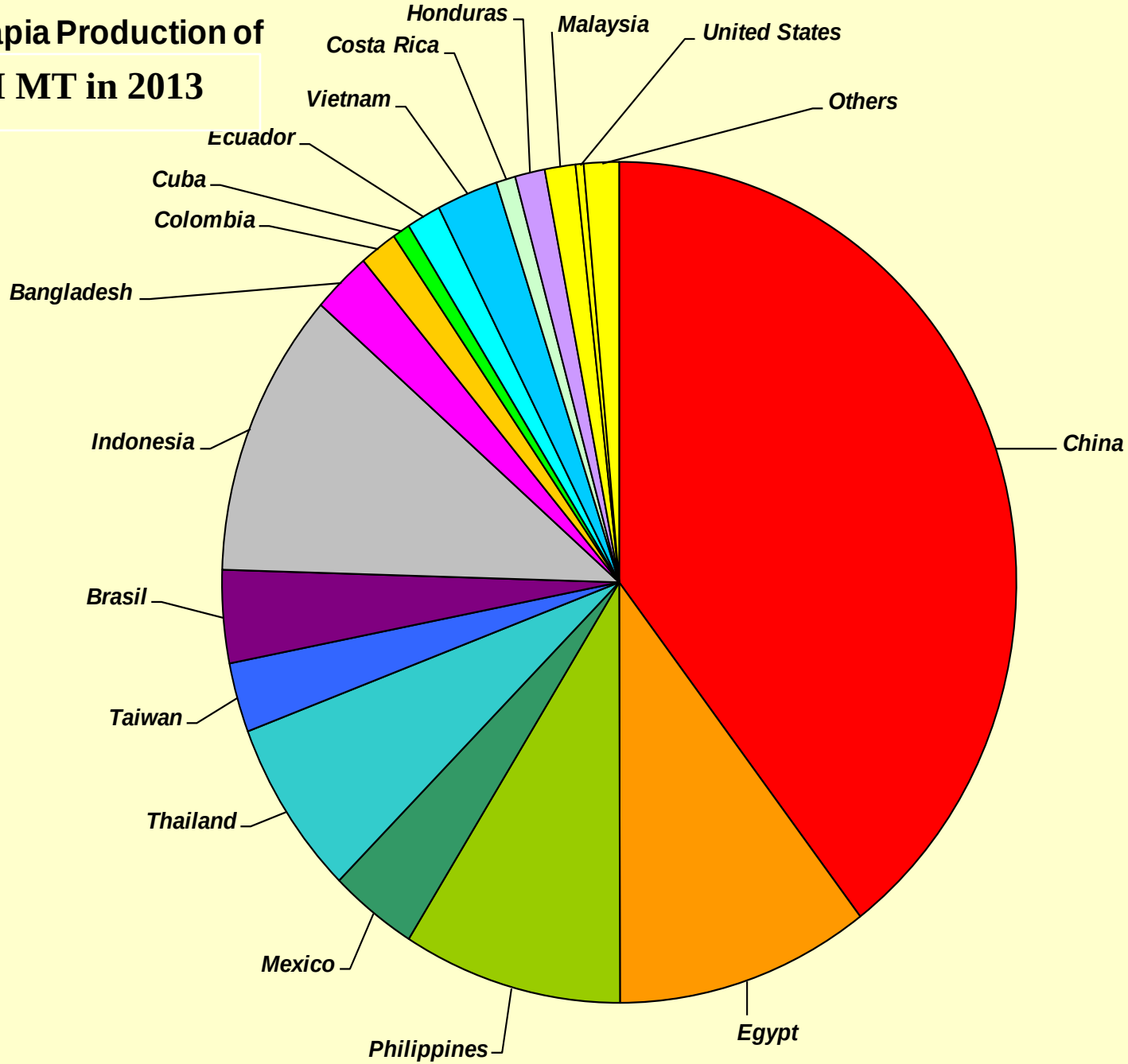


Regions of rapid production growth

- Vietnam – conversion of catfish cages to tilapia and increased exporting
- Bangladesh – from zero to 150,000 MT in 15 years.
- Indonesia – cage culture, polycultures
- Malaysia – government support and private sector investment
- Thailand – better reporting and increased exporting
- Egypt – continued intensification
- Sub-Saharan Africa – commercialization

In 2014 World Bank produced a report **"Fish to 2030"** which predicts that 62% of food fish will come from Aquaculture by 2030 with the fastest supply growth coming from tilapia carp and catfish. Global Tilapia production is expected to reach almost 8 million metric tonnes by 2030.

According to **SOFIA 2013** (State of the World's Fisheries and Aquaculture) released by **FAO**, Aquaculture currently produces just over **50%** of all fish eaten around the world. This is a massive rise from just 9% in 1980. The future for fish farming particularly tilapia farming is looking promising.

Tilapia Culture Systems

Costa Rica Tilapia Farm

Ivory Coast fisherman

Intensive tilapia hatchery in Brazil

Cage farm in Zimbabwe

What is Fishgen?

- A U.K. company based at Swansea University in Wales, UK dedicated to supplying quality fish stocks for aquaculture worldwide
- We have exported to over 50 countries
- Initial emphasis on tilapia species
- Identified with Genetically Male Tilapia (GMT®), a product unique to Fishgen
- Continuous R & D programme for development of new and better fish

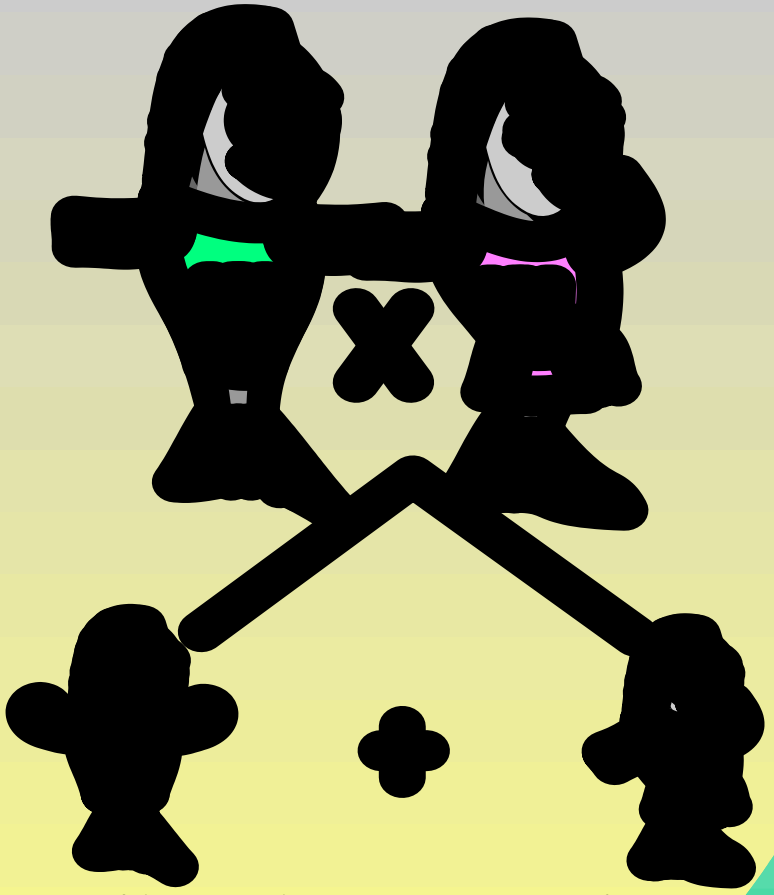
Fishgen's YY technology

Through several years of intensive research Fishgen has developed a unique genetic breeding programme to produce novel "supermales" which sire only male progeny known as Genetically Male Tilapia (GMT®)

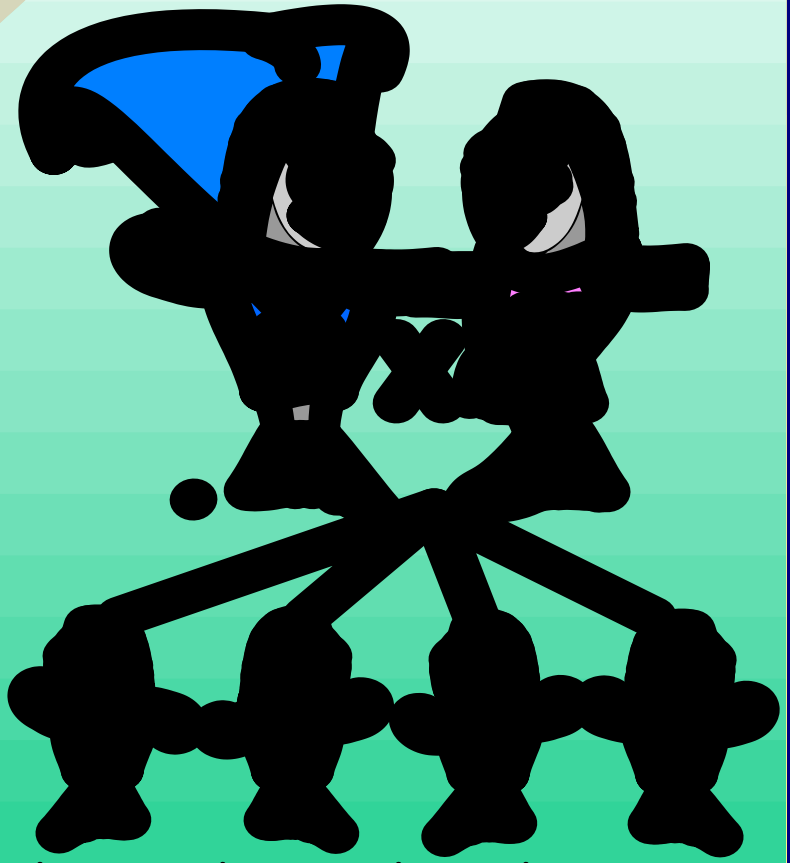
The YY male technology

THEN

NOW



Normal crosses produce equal proportion of males and females

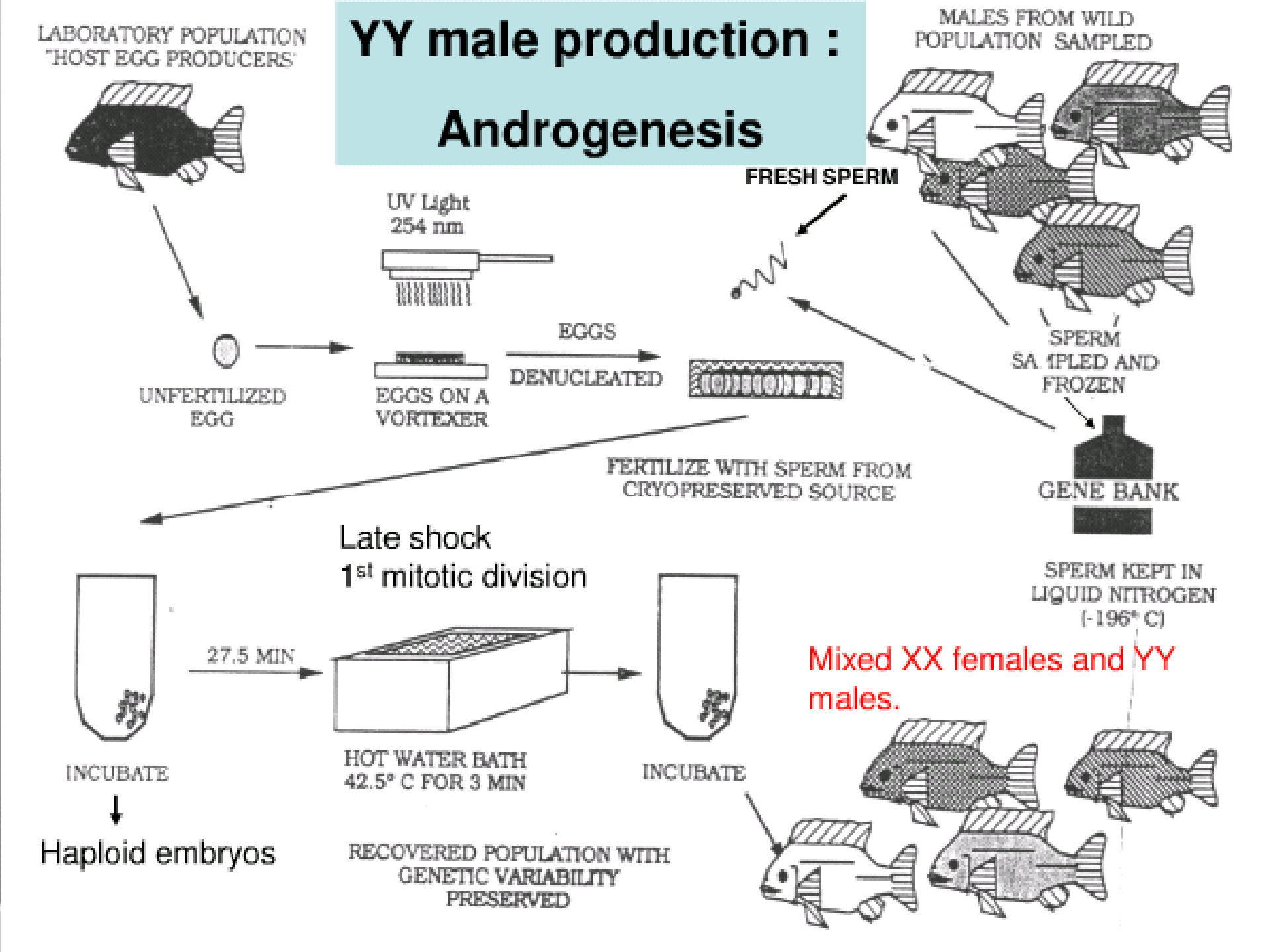


YY males produce only male progeny (GMT®)

Use of Androgenesis to produce YY males

Androgenetic tilapia are produced by treating unfertilized eggs with various intensities and durations of UV light to kill the chromosome material. Treated eggs are fertilized with untreated sperm and pressure shocked before the first cleavage to obtain diploid zygotes. The resultant embryos have either a female XX or male YY genotype.

YY male production : Androgenesis



Genetically Male Tilapia (GMT®)

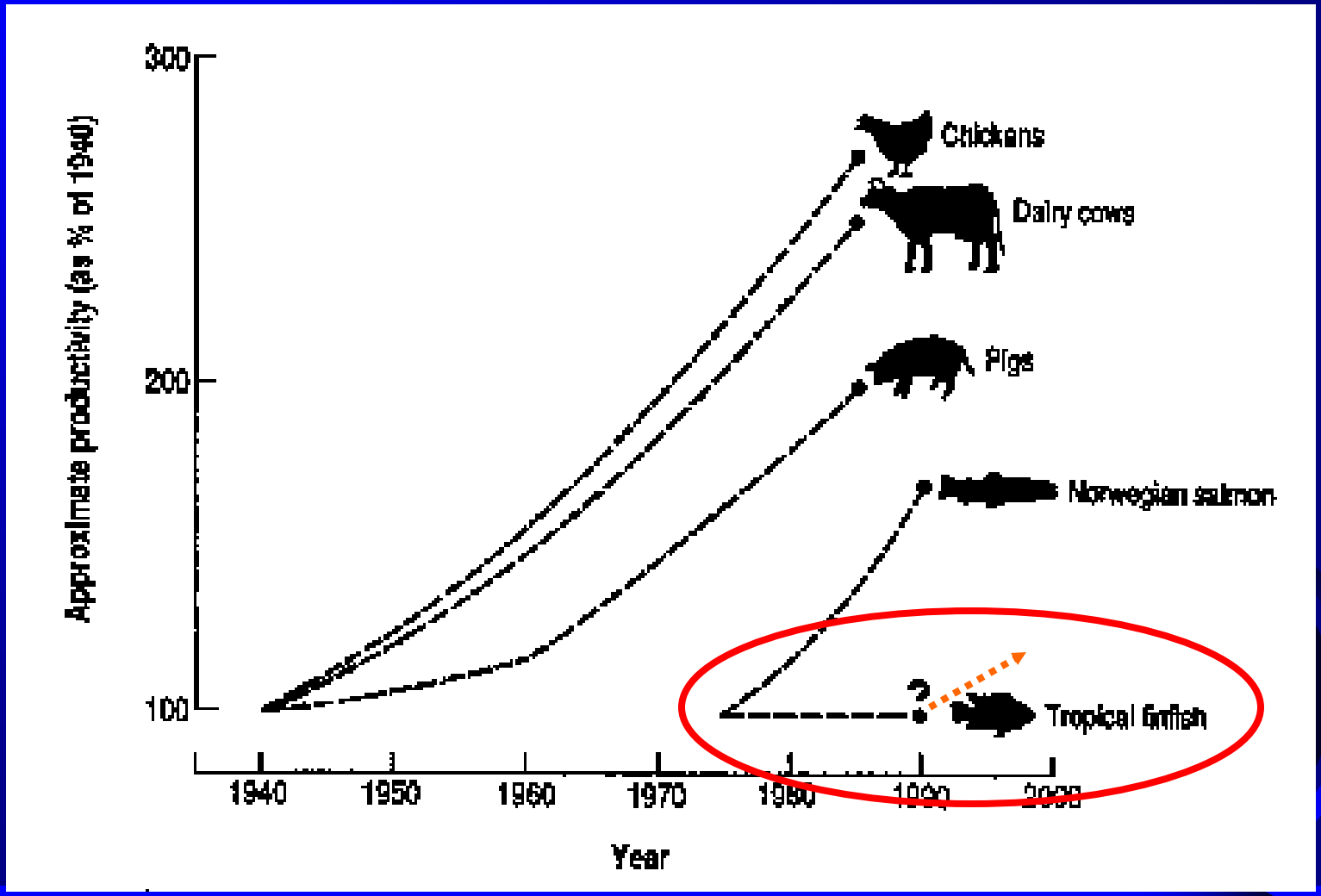
Mixed sex Tilapia harvest

GMT harvest

GMT are not Genetically Modified Organisms (GMO) and are environmentally friendly and organic.

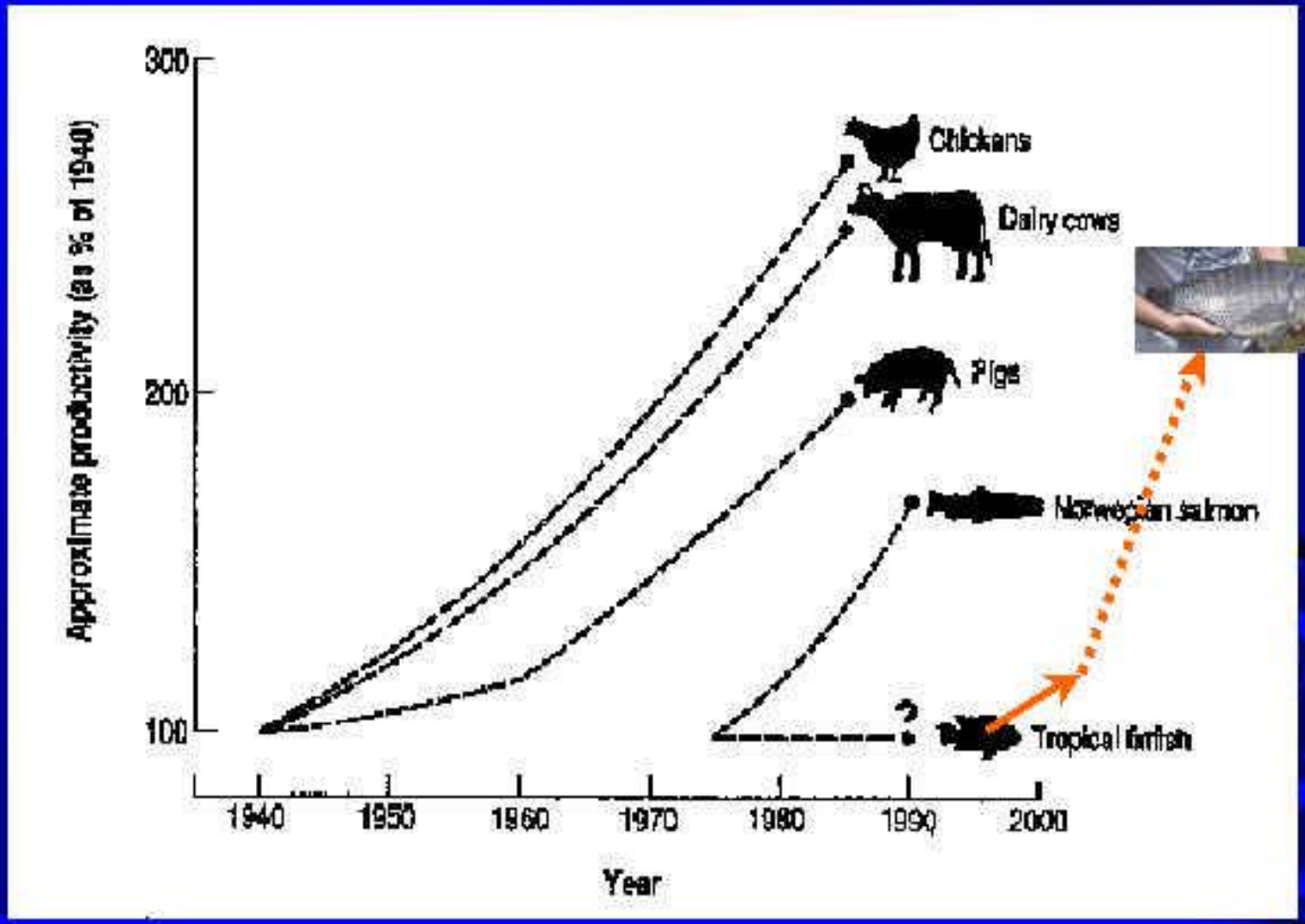
Genetics in Aquaculture

An embryonic science?



(Adapted from Gjedrem, 1997)

Genetic Improvements in Tilapia



Selective breeding and genetic improvements

- Excellent breeding programs
  - G.I.F.T. - Malaysia
  - Genomar - Brazil and Norway
  - Chitralada - Thailand
  - GIFT Excell – Philippines
- - Molobicus – Philippines
- YY Supermale – First Developed by Fishgen in the UK

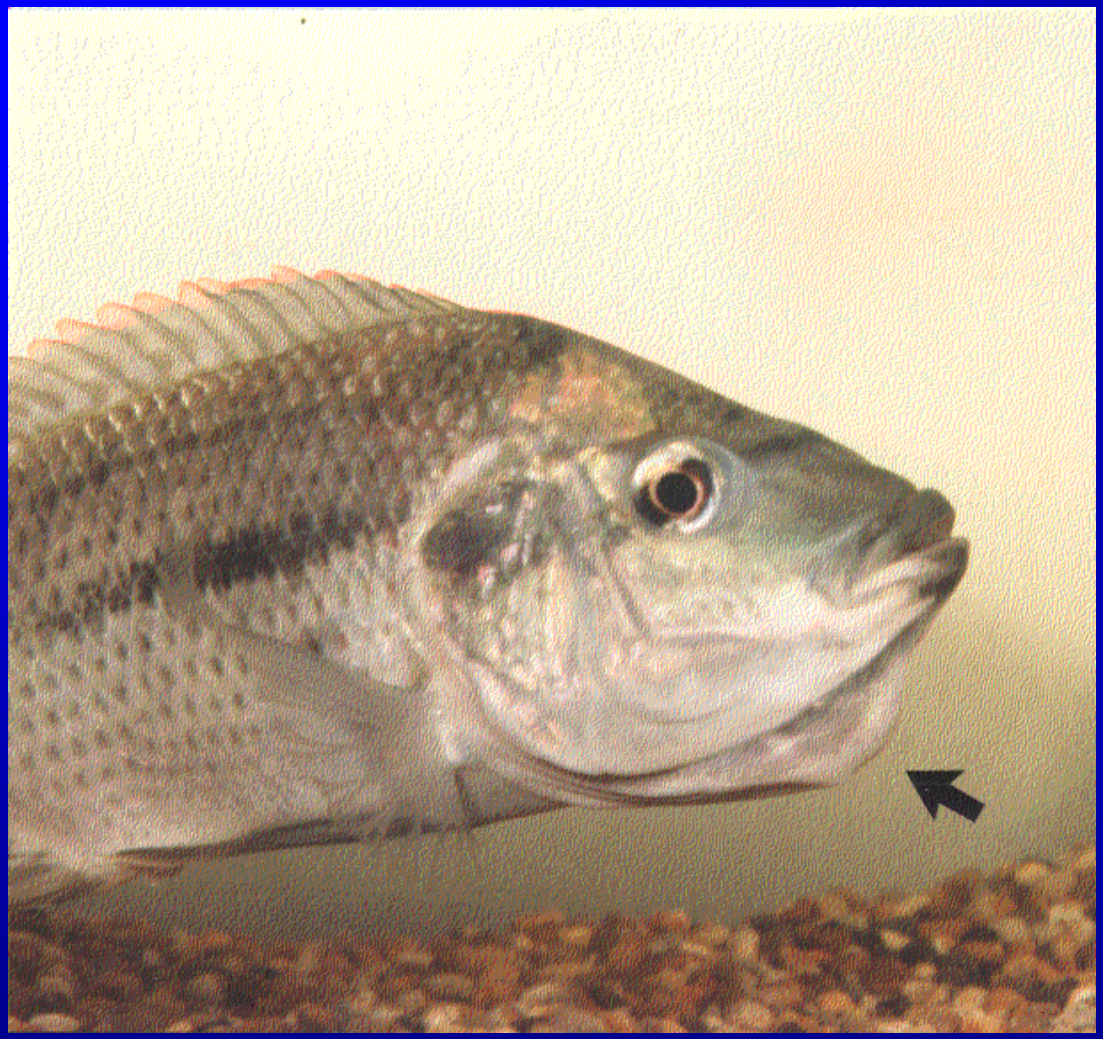

SOMETHING'S FISHY WITH THIS ICE CREAM!
ARANDA

Tilapia Genome Project

- March 2011 - First assembly of the tilapia genome
- *Oreochromis niloticus* – Nile Tilapia
- http://www.broadinstitute.org/ftp/pub/assemblies/fish/tilapia/Orenil1/
- Matching many segments to those known from other fish
- Publically available and freely accessible
- Next frontier of genetic program for tilapia

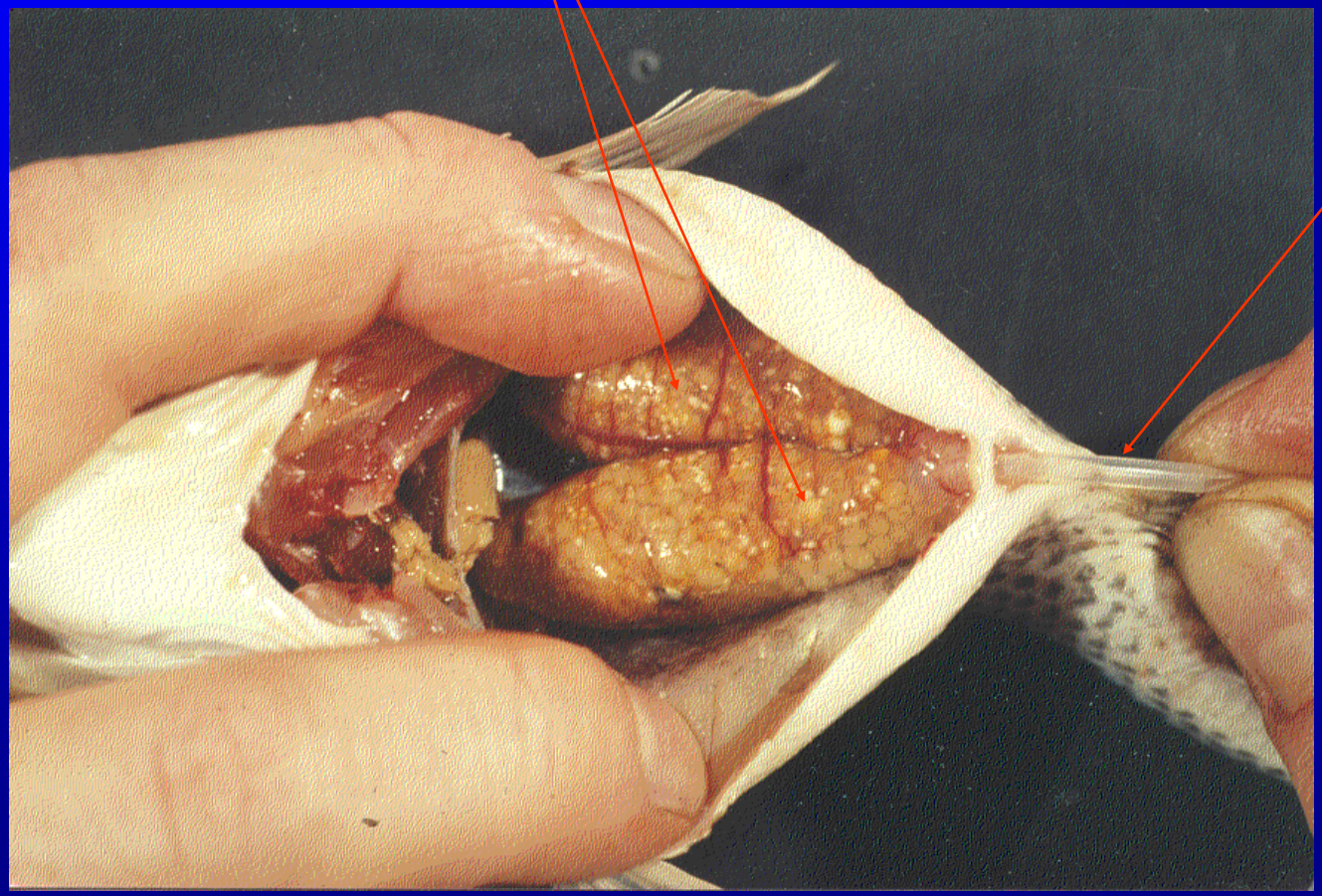
Fishgen’s ultimate goal!

YY Broodstock

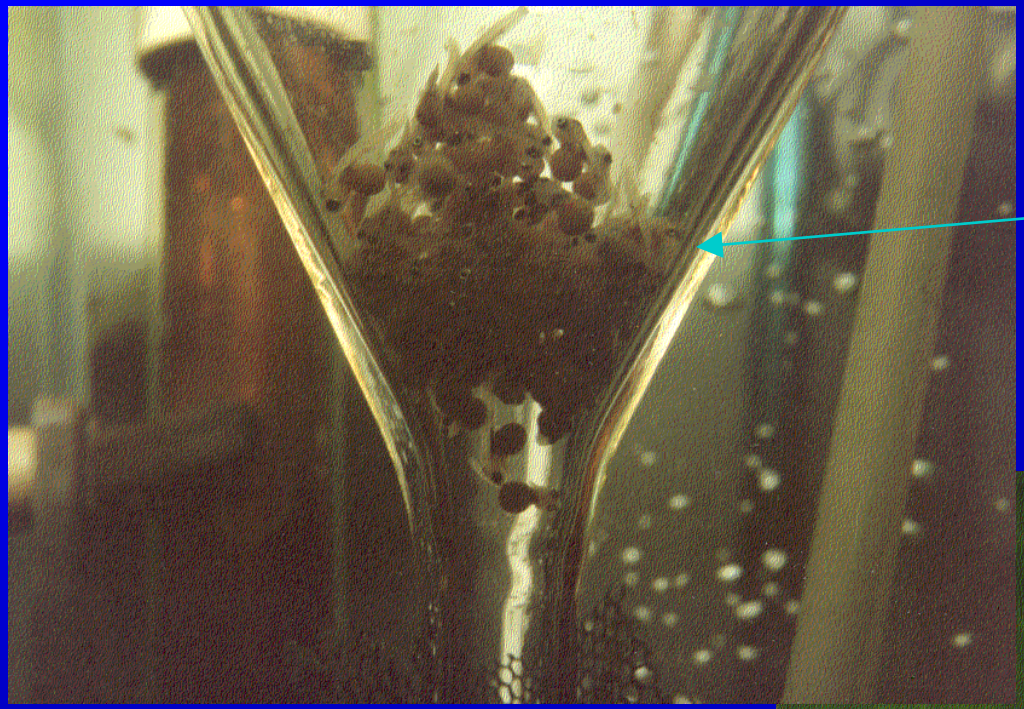


Female Tilapia mouthbrooding eggs. A typical clutch varies from 500 to 1500 eggs, depending on the size of the female.

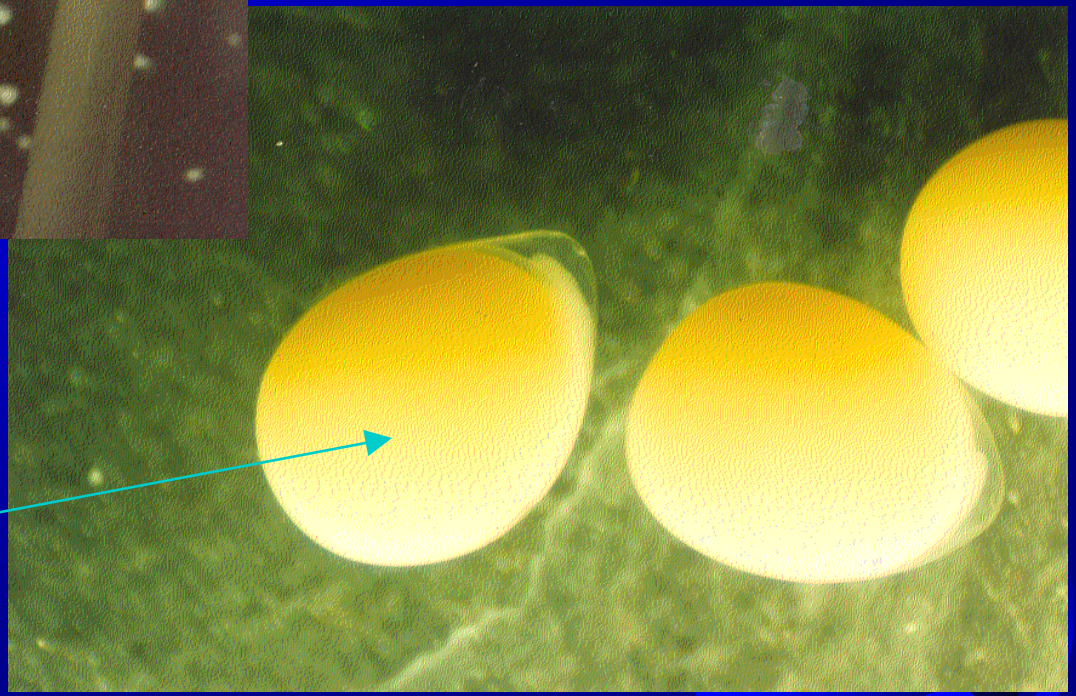
Ovaries showing large numbers of eggs.



Plastic tube inserted for sampling of eggs to determine state of maturation.



Artificial incubation of Tilapia eggs



Tilapia eggs

(rich in yolk)

Advantages of GMT®

- No hormone treatment
- Greater viability
- Much reduced variation in size
- High growth rate
- Improved yield
- Environmentally friendly (organic)

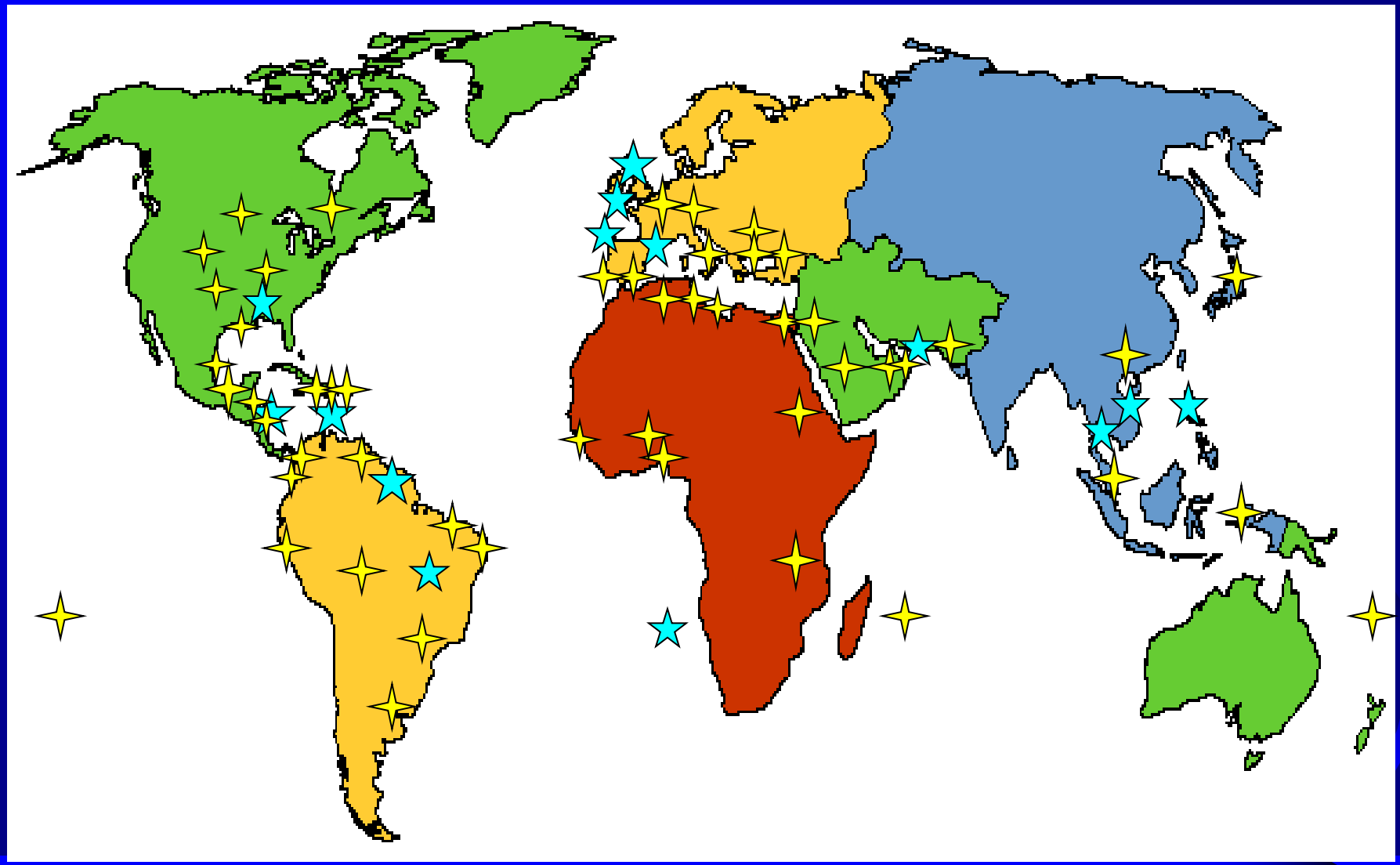
GMT® Performance

Based on our research and feedback from our clients, typical GMT® growth results are –

- ***in the southern USA with good water, 800g in 6 months***
- ***in Central America in raceways, under very intensive conditions, 1Kg in 9 months***
- ***in a European re-circulating system with very high-tech conditions, 900g in 6 months***
- ***in the Philippines in open ponds with low level of inputs, 500g in 12 months (additional inputs have a fairly dramatic upward effect in this last figure)***

We have also seen older GMT® weighing over 5Kg, so clearly the fish does have the capacity to grow to a large size.

Fishgen's Global Partners ★ and Clients ✦



Fishgen exhibiting at a recent aquaculture show in Dubai

Our South African Partner at Stellenbosch University. Cage culture, 6 months Tilapia (hot season), 6 months trout (cold season)

Fishgen's Partner in Spain - Valaqua

Fishgen's USA Partner – Til-tech

Fishgen's partner in Brazil – Sta Isabel

FAZENDA
STA ISABEL
Saint Pierre

Fazenda Santa Isabel
Saint Pierre®
Um peixe absolutamente fresco

O Saint Pierre | Tecnologia | Abastecimento | Onde Encontrar | Receitas

Hapas and concrete tanks used for genetic studies in Fishgen's production centre in the Philippines

Fishgen's partner in Tunisia – Tunipeche in Djerba

GMT grown in flow-through low salinity raceways achieved average weights of 1.3 Kilos after 9 months, with many fish reaching 1.5 Kilos after 10 months.

Recent developments at Fishgen

Collaboration with an International Feed Company to develop a new sustainable tilapia feed which replaces fishmeal with cultured polychaete worms

Research on plant based proteins as an alternative diet for Tilapia with trials currently replacing fish meal and fish oil with algae

Advanced discussions underway for further partners in the Middle East, China and India

Gene Mapping of the YY technology in collaboration with Stirling University

Marker-assisted selection in GMT production

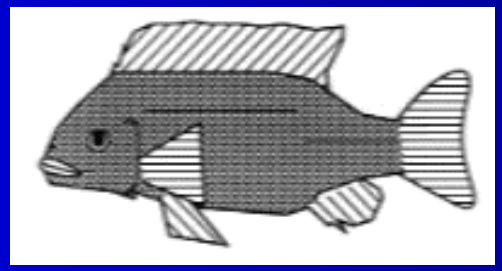
•Research over the last few years has led to the development of a linkage map for tilapia (>500 markers, mostly microsatellites: Lee et al., 2005) and has identified regions of the genome that are associated with sex determination

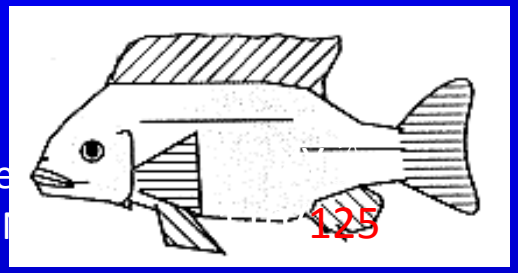
•The XX/XY system is in LG1 (Lee et al., 2003), but it is known that genes in other regions of the genome (e.g. LG3, LG23) can also affect sex ratio (e.g. Shirak et al., 2006).

•This knowledge can be applied to improve GMT production by Marker-Assisted Selection (MAS), e.g.:

- By identifying regions of the genome associated with departures from the predicted sex ratios (i.e. females in GMT) and selecting against the allelic variants associated with this
- By using sex-linked markers to improve the efficiency of progeny testing (see next slide)

Example – using markers to improve the efficiency of bringing new Ys (and genetic variation) into a YY population





Se
UI

125

YY neo♀
117/117

XY male 110/125

YY progeny

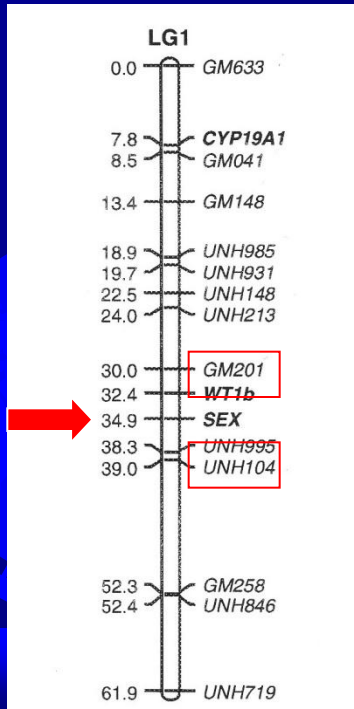
XY progeny

117/125

117/110

Use Y-linked allele (125 in the above example) to provisionally identify YY progeny, thus avoiding extensive progeny testing to identify XY progeny

Such an association will occasionally be disrupted by recombination – better to use markers on either side of the SEX locus.



Our fish come fully trained!

Thank you and for more information please see

www.fishgen.com