Exploring Opportunities for the Small Scale Culture of Indigenous Air Breathing Fish for Climate Change Adaptation

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Introduction

Global climate change continues to take its toll on aquatic ecosystems through shifts that include increased temperature, water quality degradation, sea level rise, ocean acidification, and habitat loss—all of which are expected to have significant impacts on fisheries and aquaculture production. Numerous options have been suggested for smallholder fish farmers to address climate change, many focusing on building adaptive capacity and resilience to environmental change. An additional tool for adaptation may be in the culture of air breathing fish. This unique group of fishes belongs to a diverse genera that has developed the ability to utilize atmospheric oxygen for respiration, allowing them to survive in low-oxygen to anoxic conditions and even in aquatic environments with poor water quality.

Under two main categories—obligate air breathers that must breathe air and facultative air breathers that can rely on dissolved oxygen until it becomes necessary to use atmospheric oxygen—these fish inhabit a range of environments and use a variety of mechanisms for breathing air. These characteristics can make them more resilient to environmental change, presenting many advantages for culture in local communities over more conventional, often introduced aquatic species. Whether for human consumption, the aquarium trade, or biodiversity enhancement, the culture of fish resilient to climate change may prove critical for diversifying sustainable solutions in aquaculture. This varied group has not been well studied and the many challenges to culturing them include changes in local climates, threats to critical habitats, and dealing with the high protein diet required by some of the fish in this unique group.

As a means of exploring the opportunities and limitations of culturing air breathing fish, this poster focuses on three species under investigation by AquaFish CRSP researchers; chame (*Dormitator latifrons*), African lungfish (*Protopterus spp*), and gar (*Atractosteus spp.*).

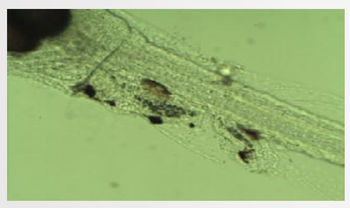
Pacific Fat Sleeper (Chame)

While a popular food fish along the Pacific coast of Latin America, chame or Pacific fat sleeper is locally scarce due to overfishing and habitat loss. Chame culture remains at a bottleneck due to poor growth and survival during hatchery production of eggs and larvae. This research aims to enhance the potential of chame aquaculture by working toward achieving induced spawning and first feeding/weaning of larvae.

Developing nutritionally enriched live food for larvae

- Results show need for smaller prey—50 microns or smaller
- Salinity tolerance is higher than expected for larvae indicating the possibility of prey to originate from a variety of environments such as fresh, brackish, or marine.

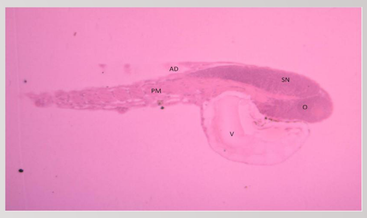
Pacific fat sleeper or "Chame" (*Dormitator latifrons*)



Pacific fat sleeper digestive tract

Histological analysis of the larvae digestive tract

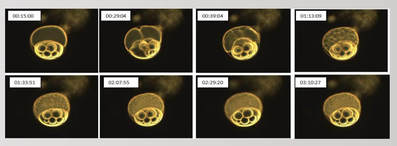
- Significant progress towards the description of morphological development at early ontogenetic stages
- Identification of the presence of an organ with histological characteristics such as the digestive gland as early 4-5 dph
- Still need to identify the specific substrate or diet composition which will provide the highest survival rate for larvae



1 day post hatching (dph) larvae.

Induced spawning

- Succeeded in capturing the full embryonic development on video from an out-of-season spawn
- Potential to induce spawning by the combined effects of environmental conditions manipulation and hormone treatment
- Potential to provide chame breeders the ability to improve gamete production due to early sexual maturation findings

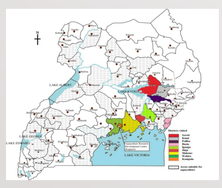


Embryonic development of *Dormitator latifrons*

African Lungfish

The African lungfish is an advantageous fish for culture in Uganda because it is an indigenous air breather with good quality flesh and can act as a bio-control against schistosome vector snails. This research is examining the prospects and potential of lungfish cultivation by assessing indigenous practices and understanding the socio-economic conditions around the species.

Lungfish market in Kampala.



Study locales in Uganda

- Lungfish has become a highly valued delicacy among some groups in Northern, Eastern, and Western Uganda, and now is becoming more broadly accepted in the central region. However, sociocultural beliefs still deter consumers from eating lungfish in some areas.
- Currently most lungfish is captured in Uganda's natural waters, but catches have been declining since 2005. While not currently a common species for cultivation, over half the farmers surveyed were interested and willing to grow lungfish.
- Future studies need to address the reproduction, feeding, and management of farm-reared lungfish, as little is known about these parameters.
- Indigenous knowledge of lungfish culture can be a starting point for formulating a strategy for more widespread lungfish production in Uganda.

Gar

Recent work on gar at the University of Michigan and Universidad Juarez Autonoma de Tabasco (UJAT) in Mexico is enhancing the sustainability of gar aquaculture by improving feeds and developing innovative culture techniques. Gars are popular food fish in various regions of Mexico and Cuba and are gaining popularity in the Southern US. This work investigates ways to more successfully culture gars for food as well as for replenishing wild populations, which have suffered from overfishing and habitat loss.

- Tests run on two populations of spotted gar—one from the Great Lakes region and one from the Mississippi River basin—revealed that gar from the Great Lakes region exhibited a significantly higher growth rate, indicating important genetic and physiological differences.
- Work on ideal stocking density for Cuban gar has revealed the best growth at the lowest density (25 fish/m3) starting with gars weight on average 13.00 g and 15.66 cm in length.

150 cm, 25 kg alligator gar (*Atractosteus spatula*)

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