Otolith Microchemistry of the family *Cichlidae* from the Rio Negro, Brazil

Rogerick L. Magee
Jackson State University, Jackson, Mississippi
Trika Gerard, Estrella Malca, Samatha Whitcraft, John Lamkin, Barbara Muhling
Early life History Laboratory, NOAA, SEFSC, Miami , Florida

Acknowledgements

Introduction

Otoliths can be characterized as unique recorders of information and provide current environmental conditions on the environment in which fish live (Campana 1999). The current project intends to assess the environmental conditions of the Rio Negro, Brazil of the following speices of *Apistogramma -agassizii*, *diplotoenia*, *paguamquis*, *perternsis, rupununi.* To understand these environmental conditions we must evaluate these isotopic fingerprints, we applied otolith microchemistry to obtain information about the chemical signatures of ^{13}C and ^{18}O stable isotopes (Iacumi et al 1992). This information will help fisheries managers ultimately make sound decisions on the conservation of these different species of fish. In doing so, those decisions can lead to a better economy relative to ornamental fish industry.

Goals of the Project

•To identify fish from the family *Cichlidae* into taxonomic species level

•To determine variation in otolith stable isotopic chemistry between five of the species of Apistogramma

• To determine the variation among the isotopic signatures from the five sites that were selected

Figure 1 Mangroves From the Rio Negro, Brazil

Background

Area of Study

The Rio Negro is the largest left tributary of the Amazon and the largest black water river in the world. It spans along the watershed between Orinoco River and the Amazon Basins, and connects with the Orinoco River by way of the Casiquiare canal (http:/www.ywat.org/knowledgebase/riverbasins/sa-amazon.html). In 2005, the Rio Negro had a catastrophic drought(Marengo et al 2008). Globally, the export value of ornamental specimens for aquariums was estimated at $200 million in 1996 with $ 130 million going to developing countries, and trade in ornamentals has increased, on average, 14% annually (FAO 1999).

Otolith Microchemistry

Otoliths are the ear bone of fish and are the most commonly used structures from which daily , seasonal or annual records of a fish's environmental history are recorded. They are also used as indicators of migration patterns, home range, spatial distribution, stock structure and life history events (Campana 1999;Mendoza 2006). The calcified structures are used for stability and or hearing in all telost fish. Stable isotopes are used to find different chemical signatures of carbon and oxygen.

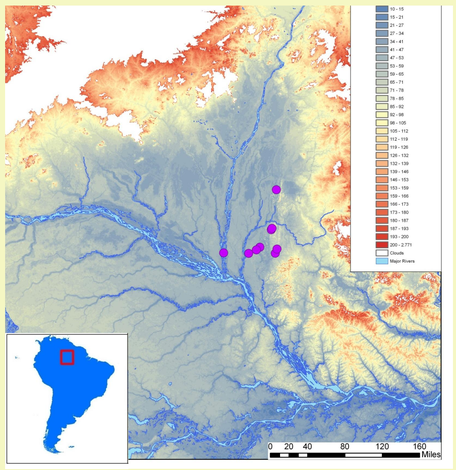


Figure 2 Map of the area and stations

The genus *Apistogramma* is a group of small cichlids from South America. Most of the species originate in the Amazon River. The fish of the genus *Apistogramma* are the most attractive freshwater tropical fish. They share a few common characteristics, chief among these is their small adult size. The largest *Apistogrammas* might reach 3 ½ inches or slightly larger depending on the species. *Apistogramma* males are larger than females and often the differences can be visible. There is also a significant coloration difference between males and females. The tail or caudal fin also shows great variation in shapes and colors (www.dwarfcichild.com/Apistogramma.php;http://fish.mongabay.com/apistogramma.htm).

Methods and Materials

•In 2005, 665 fish were collected from the Rio Negro Upper Amazon River, Brazil, from a total of 13 sites.

•All fish were measured in standard length (mm) and total length (mm).

• A subset of samples was identified to species taxonomic level using a LeicaE24D microscope, at magnifications from 8x-35x.

•A subset sample size was chosen from five sites, each site that contained 10 samples of each species was chosen for otolith removal

•The sagittal otoliths were extracted from the cranial cavity of each fish while using a dissecting microscope and glass probes.

•All otoliths were placed in distilled water and then a sodium hypochlorite bath for five minutes to remove organic matter and again rinsed in distilled water.

•The sagittae otolith was chosen randomly. Previous studies have shown no systematic differences in elemental composition between the left and right sagittae otolith (Rooker et al. 2001).

•After being cleaned and dried, they were sent to the University of Miami's Stable Isotope Laboratory for analysis.

•The ^{13}C and ^{18}O of the carbonate materials was determined using dissolution in phosphoric acid using the common acid bath method (Swart et al. 1991) at 90ºC. The gas produced was analyzed using a Finnigan-MAT 251 mass spectrometer.

•Statistical analysis was performed using PERMANOVA.

Figure 3.
Collection of Samples In the Rio Negro, Brazil

Figure 4. Pair of Otoliths from a sample

Figure 5 Me removing an otolith

Results

Five species of *Apistogramma* were identified to taxonomic species level

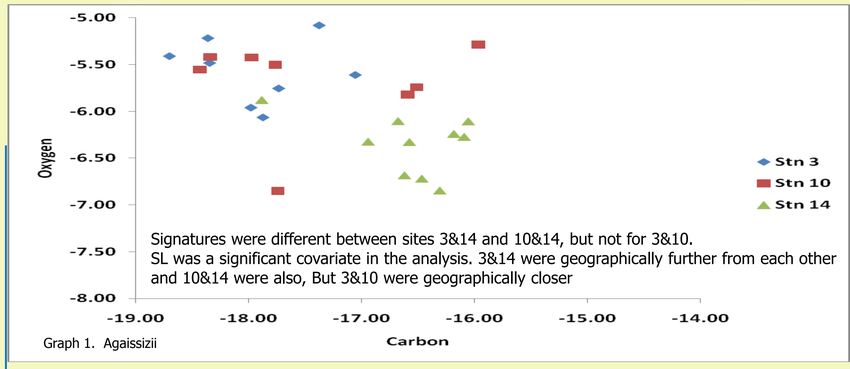
Picture IDs	Scientific Name	Average TL Length (mm)	River	Percent Ratio Of ID Fish
	*Apistogramma agassizii* (Steindachner, 1875)	23.96	Amazon River basin along Amazon Solimoes River from Peru through Brazil to the Capim River Basin	66.05
	*Apistogramma diplotaenia* (Kullander, 1987)	19.3	Amazon River Basin, in the middle and lower Negro River	7.47
	*Apistogramma paucisquamis* (Kullander & Staeck, 1988)	27.65	Amazon River Basin, in the middle and lower Negro River	6.18
	*Apistogramma pertensis* Amazon dwarf cichlid (Haseman, 1911)	27.06	Amazon River basin, in the lower Negro River	9.77
	*Apistogramma rupununi* Two-spot Apistogramma (Fowler, 1914)	32.33	Amazon River Basin in Brazil and Rupununi River basin in Guyana	10.42

*Sources: 2009 **FishBase.** www.fishbase.org.version; and Freshwater Fish Species in Rio Negro (Brazil). http://fish.mongabay.com/data/ecosystems/Rio%Negro.htm

Table 1.

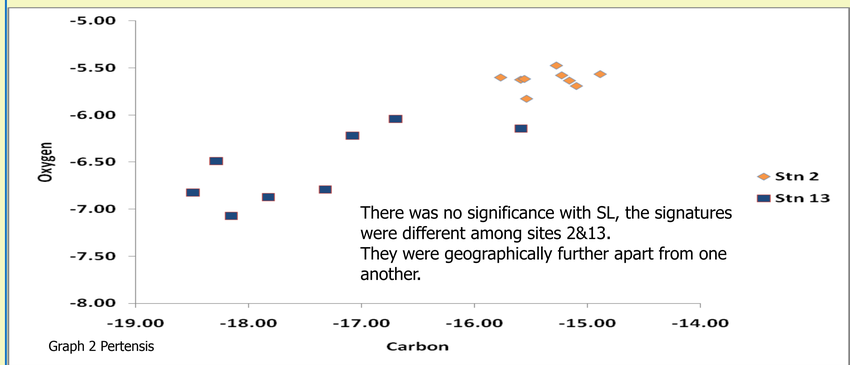
Acknowledgements

Dr. Trika Gerard, Marine Ecologist, NOAA, South East Fisheries Science Center, Early Life History Laboratory, Miami, Florida
Ms. Estrella Malca, Laboratory Manager, NOAA South East Fisheries Science Center, Early Life History Laboratory, Miami, Florida
NOAA Educational Partnership Program, Silver Spring, Maryland
Jackson State University, Department of Biology – Marine Division, Jackson, Mississippi
I would like to give a special thanks to Dr. J Marcon, Prof. C. Brown, and S. Whitcraft of the National Geographic Amazon-2005 project



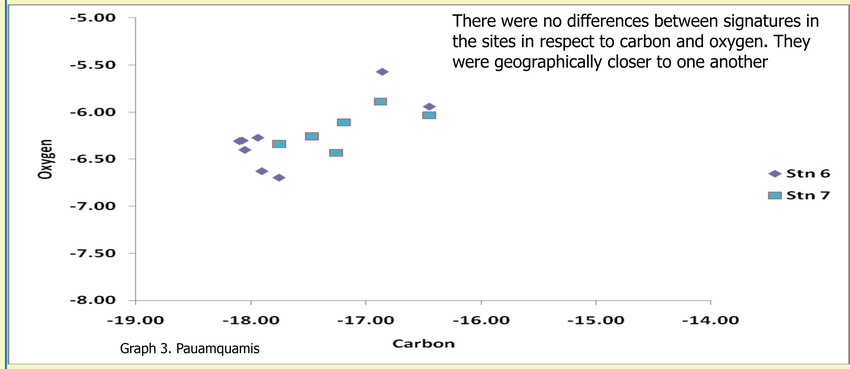
Signatures were different between sites 3&14 and 10&14, but not for 3&10.
SL was a significant covariate in the analysis. 3&14 were geographically further from each other and 10&14 were also, But 3&10 were geographically closer

Graph 1. Agaissizii



There was no significance with SL, the signatures were different among sites 2&13.
They were geographically further apart from one another.

Graph 2 Pertensis



There were no differences between signatures in the sites in respect to carbon and oxygen. They were geographically closer to one another

Graph 3. Pauamquamis

Conclusions

There is some evidence that isotope were different between sites within fish of the same species, with respect to both carbon and oxygen (see graphs). Difference between species within sampling sites could not be assessed for some of the sites.
Due to the significance of information collected from this study through the utilization of fish otoliths, it can be concluded that continued research efforts should be done to enhance the body of knowledge based on how otoliths may be used to access prior research that has been done and future research to be done.

References

Apistogramma. Retrieved from http://www.dwarfcichlid.com/Apistogramma.php

Campana, S. E. 1999, November 3. Chemistry and composition of fish otoliths. **Marine Ecology Progress Series**, 188, 263-297.

Cichlids – Apistogramma. Retrieved from http://fish.mongabay.com/apistogramma.htm

Food and Agriculture Organization of the United Nations (FAO). 1999. Ornamental aquatic life: what's FAO got to do with it? www.fao.org/News/1999/990901-e.htm

Freshwater Fish Species in Rio Negro (Brazil). Retrieved from http://fish.mongabay.com/data/ecosystems/Rio%Negro.htm

Froese, R. & D. Pauly, eds. **2009 FishBase**. www.fishbase.org.version

Iacumin, P. et al. (1992, August). Oxygen and carbon isotopic composition of Fish otoliths. **Marine Biology**, 113(4), 537-542.

Lundberg. J. 2001. Freshwater riches of the Amazon. American Museum of Natural History.

Marengo, J. A., et al. 2008. The drought of Amazonia in 2005. **Journal of Climate**, 21, 495-516.

Mendoza, R. P. 2006. Otoliths and their applications in fishery science. **Riborstvo**, 64(3), 89-102.

River Basin Report: Amazon and Rio Negro. Retrieved from http://www.ywat.org/knowledgebase/riverbasins/sa-amazon.html

Rooker, R. J. et al. 2001.

Swart, P. K., et al. 1991. Fractionation of the stable isotopes of oxygen and Carbon in carbon dioxide during the reaction of calcite with phosphoric acid as a function of temperature and technique. **Chemical Geology**, pp. 89-96.