Feeding and reproductive biology of the brown hoplo *Hoplosternum littorale* (Siluriformes: Callichthyidae) in the St. Johns River Canal System, Florida

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Abstract

South American armored catfishes, also known as brown hoplos, are established in large numbers in central and south Florida freshwater systems. Interrelationships between brown hoplos and native species have not been documented. A preliminary study was conducted to identify various aspects of the life history of *Hoplosternum littorale* to better understand how they interact with native species. We investigated diet preference among size classes, and seasonal reproduction of *H. littorale* from two populations in the St. Johns River canal system, Florida. Stomachs of juveniles and adults were examined and occurrence of food items was found to be significantly dependent on size class. Copepods were not common in adult stomachs (11%), but occurred in 56% of juveniles. Ostracods and Nematodes both frequent in adults (56% and 44%, respectively) were less common in juveniles (39% and 33%, respectively). The numbers of eggs removed from three gravid females collected August 2002 were as follows: 4700 (137mm), 5505 (130mm), and 6126 (127mm). The gonadal somatic index (GSI) for specimens collected in March was greater than for specimens collected in August. The possible impact of brown hoplos and other armored catfish on fish communities is reviewed and discussed.

Key words: catfish, ontogeny, reproduction, diet, gsi

Introduction

Over the past 40 years more than 50 species of fish have become permanently established the freshwaters of Florida (Courtenay 1997; Fuller *et al*. 1999), competing with native species and contributing to major changes in aquatic ecosystems (Courtenay et al. 1974; Shafland and Pestrak 1982). There are at least three species of South American armored catfishes established in central and south Florida: the butterfly sailfin catfish (*Pterygoplichthyes multiradiatus*) and vermiculated sailfin catfish (*Pterygoplichthyes disjunctivus*) both members of the family Loricariidae and often called "plecos" in the aquarium trade feed heavily on vegetation. Their impacts on Florida aquatic ecosystems have not yet been documented, however, a study conducted by Devick (1989) found *Pterygoplichthyes* in Hawaii contributed to increased siltation by excavating thousands of tunnels in reservoir and stream banks.

Hoplosternum littorale (Hancock 1828) also known as currito or brown hoplo is a medium to large sized fish (66-208mm) of the family Callichthyidae (Fig. 1). The biology of *H. littorale* has been well documented (Machado-Allison and Zaret, 1984; Mol, 1995; West et al, 1999). In brief, *H. littorale* is a facultative air-breather, omnivorous feeder, and heavily armored. In addition, it is tolerant of extreme water conditions, such as, high salinities (Mol, 1994, 1995), hypoxic, acidic, and hydrogen sulphide rich waters, and possibly short cold periods (Brauner et al; 1995; Bailey et al; 1999). Although temperature experiments conducted on *H. littorale* have mostly focused on reproduction and thermal tolerance to heat (Hostache, 1992; Ramnarine, 1994), one study found that in the Amazon, *H. littorale* is unique being able to survive the harsh phenomenon known as a "friagem" where the atmospheric temperature drops and the water column is mixed creating cold hypoxic and acidic water conditions (Brauner et al; 1995). In conjunction with all those attributes mentioned above, *H. littorale* employs a highly r-selected reproductive strategy (Winemiller, 1987; Ramnarine, 1994, 1996). In this study we provide a quantitative assessment of diet and fecundity of *H. littorale*, and discuss its possible impact on native fish communities, and freshwater ecosystems.

Materials and Methods

Study site

During 2002, two populations of *H. littorale* were sampled. The first population located at the intersection of the 8-mile canal and the Sllo Canal, Melbourne, Florida (28° 17’ 13” Lat.N; 80° 47’ 15” Lat.W) was sampled in March. The second population located at approximately 6 km northwest of the Blue Cypress marsh recreational boat ramp, Melbourne, Florida (27° 41’ 57” Lat.N; 80° 40’ 36” Lat.W) was sampled in August. Both sites are characterized in being moderately sized canals (15 m wide, 4 m deep, ¼ mile long) with floating and submersed vegetation along margins. Water temperature, pH, and dissolved oxygen were measured at each site using a YSI meter. Specimens were captured using a cast net (2.4-m diameter, 0.6cm mesh) and selected to represent as much of the ontogeny as possible. All fish taken were preserved in 10% formalin and later transferred to 70% ethyl alcohol. All specimens were deposited at the Florida Museum of Natural History FLMNH 136069 (28), 139830 (47).

Data acquisition

All specimens of *H. littorale* were measured to the nearest millimeter standard length (SL), weighed using an analytic balance, and for adjusted mass specimens were weighed after the viscera and gonads removed. For diet analysis, a total of 27 specimens were collected and separated into two size classes, juveniles (SL = 101-128 mm, mean=117 mm; SD=8.957), and adults (SL = 136-197 mm, mean=163 mm; SD=24.020). Adult morphology was determined through the examination of bi-plots showing growth allometry in morphology (Fig. 2). Stomachs were removed from the gastro-intestinal tract at the point where the anterior end of the intestine connects to the posterior end of the stomach. Intestinal tissue differs from stomach tissue in transparency, so the connection point is easily identified. Stomachs were weighed to the nearest 0.01g and preserved in 70% ETOH. To determine diet, stomachs were examined using a dissecting microscope, and food items identified and counted. A Chi-squared test of independence was used to compare percent numerical abundance (NA) of food items found in juveniles and adults.

Gonads were removed from all male specimens and weighed to the nearest 0.001g. Ovaries from three gravid females were removed and weighed the nearest 0.001g, then weighed again after the tissue enclosing the eggs was removed. Five egg subsamples containing 20 eggs of approximately the same size were taken at random from the anterior, middle, and posterior sections of the ovary, and weighed to the nearest 0.001g. The average weight per egg for the five subsamples was used to calculate the number of total eggs per fish. The percent body weight that the gonads comprised, or gonadal somatic index (GSI), was calculated for both males and females. The GSI was compared between a single population sampled in March and a single population sampled in August.

Results

To examine whether condition of *H. littorale* differ before and during the dry season (November – April), we compared total body weight, and standard length between two populations of *H. littorale* (March ’02, August ’02). ANCOVA indicated there was no difference in the slopes of the relationships of SL and total body weight (F=1.960, P=0.166); however, the intercepts were significantly different (F=61.945, P<0.001) (Fig 3.).

Of the 53 specimens examined 27 contained food items other than detritus and sand particles, which were found in all specimens. Numerical abundance of food items found in stomachs of juveniles and adults were significantly dependent on size class (Chi-squared = 33, 10 d.f, p<0.005; Fig. 4). Copepods were the dominant food item found in juveniles, occurring in 56% of non-empty stomach, Ostracods were most frequent in adult stomachs occurring in 56% of non-empty stomachs, and abundance of fish eggs, fish parts (scales, bones, flesh), and unidentified items collectively as a percent of the total was greater in adults (25.8%) then juveniles (8.6%) (Table 1).

The GSI’s for specimens collected in August were greater than for those collected in March (Fig 5.). Fecundity estimates were as follows: 4700 (SL 137mm), 5505 (SL 130mm), and 6126 (SL 127mm). The female with the highest GSI (27.5) also had the highest fecundity.

Discussion

Hoplosternum littorale collected in March (semi-cold dry season) contained large amounts of visceral fat deposits, suggesting they were near the time of the first spawning event of the season, which occurs with the onset of the rainy season (May-September). Specimens collected in August did not contain noticeable amount of visceral fat deposits. Examination of three gravid females captured in August, suggests that a second and probably final spawning event occurs sometime between late-August and mid-September.

Juvenile diet may be a reflection of their earlier feeding habits as hatchlings. Adult male *H. littorale* construct foam nests using vegetation and other debris, and these nests may contain a suite of invertebrates that provide food for the hatchlings. As the hatchlings mature into juveniles they move into the larger more continuous patches of vegetation to feed on invertebrates, and as juveniles mature in adults, they move out into the deeper interior of the habitat in search of larger or more abundant prey items. In this study, adults where captured in the deeper interior of the canal, and juveniles along the edges. Possibly by partitioning the habitat resource use, adults and juveniles are reducing intraspecific competition for food items. Consequently, by exploiting multiple niche partitions, they may be competing directly with native species.

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Table 1. Stomach contents of adult (136-197 mm SL) and juvenile (101-128 mm SL) *Hoplosternum littorale*. N = sum of food item; %FO = percent frequency of occurrence of food item.

Food category	Adults N=9		Juveniles N=18	
	N	%FO	N	%FO
Amphipods	3	11.1	0	0.0
Copepods	4	11.1	124	55.6
Gastropods	0	0.0	1	5.6
Nematodes	52	44.4	18	33.3
Odanata	2	11.1	2	5.6
Ostracods	59	55.6	25	38.9
Fish parts	8	11.1	0	0.0
Fish eggs	12	11.1	6	5.6
Seeds	0	0.0	2	5.6
UIP	14	22.2	5	16.7
UI	8	22.2	5	5.6

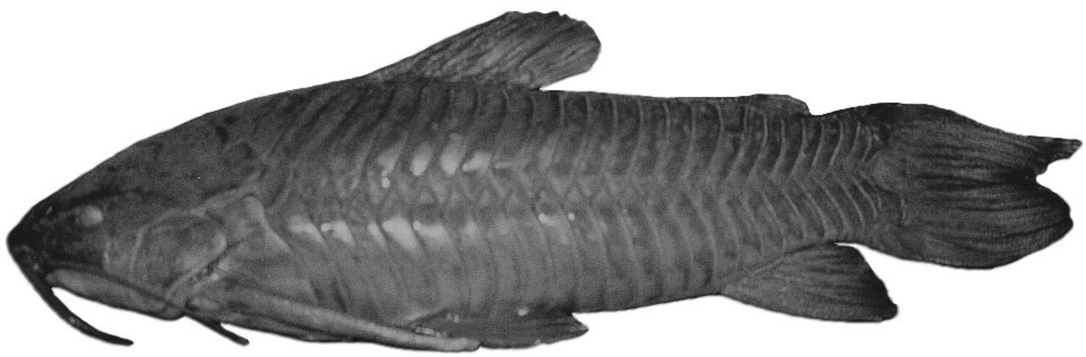

Figure 1. *Hoplosternum littorale* (1909 mm, SL) taken 15 August 2002 near Blue Cypress marsh recreational boat ramp, Melbourne, Florida (FLMNH 136069).

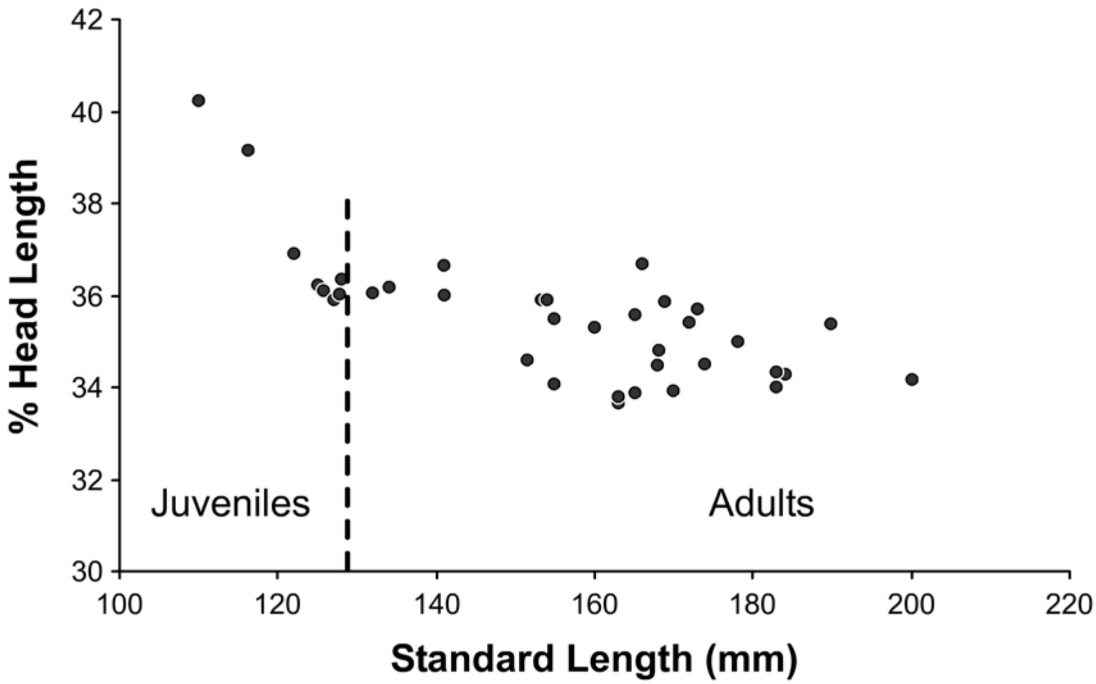

Figure 2. Allometric growth of relative head length (HL%) in *Hoplosternum littorale* (closed circles) showing method of estimating size of maturity. Plot of standard length (mm) and head length as a percentage of standard length. Dashed lines represent point where specimens, at or near asymptotic value of HL%, are considered to have attained adult size.

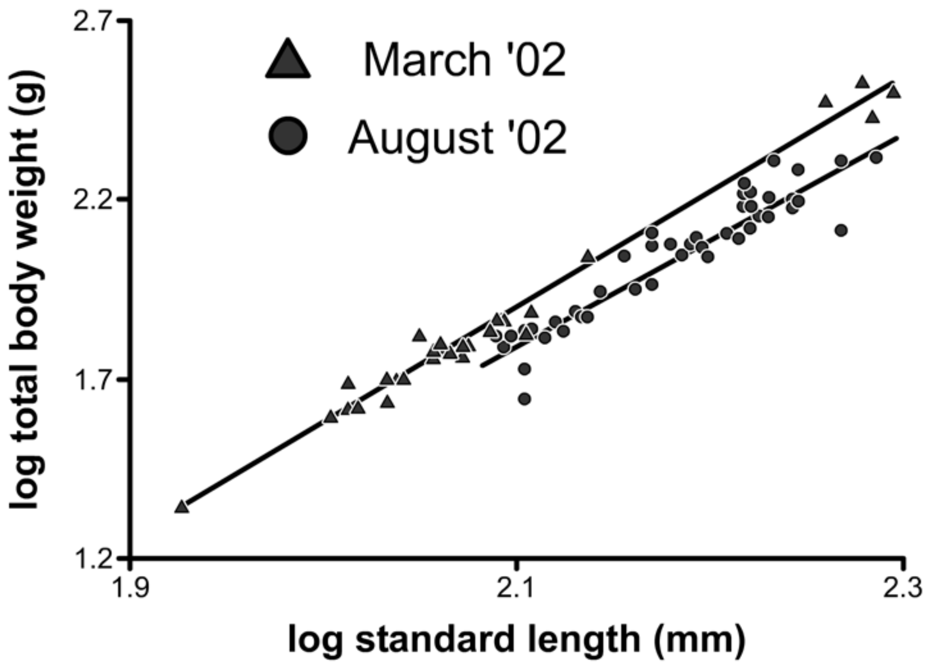

Figure 3. Bilogarithmetic plot of total body weight (g) and standard length (mm) for *Hoplosternum littorale* collected during (March ’02) and before the dry season (August ’02). Both populations captured from similar canal systems in Melbourne, Florida.

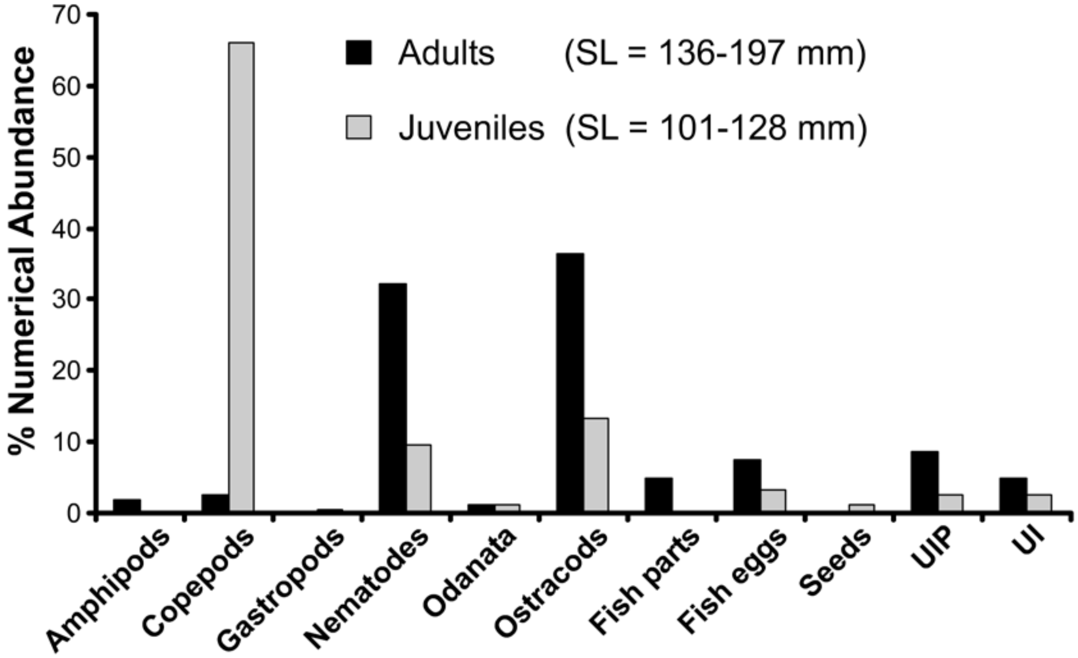

Figure 4. Percent numerical abundance for major taxa of food categories found in adult (136-197 mm SL) and juvenile (101-128 mm SL) *Hoplosternum littorale*.

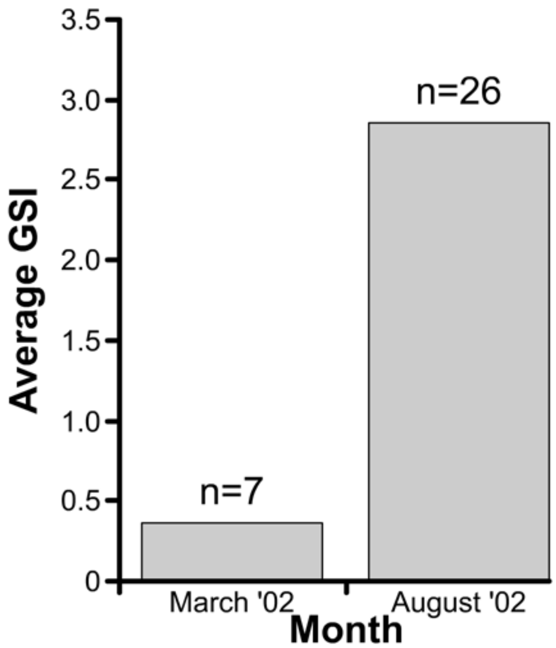

Figure 5. Gonadal somatic index (GSI) for two populations of *Hoplosternum littorale* collected March and August 2002. Both populations captured from similar canal systems in Melbourne, Florida.