THE SWAMP EEL, *MONOPTERUS* SP. *CF. M. ALBUS*, IN THE CHATTAHOOCHEE RIVER SYSTEM, FULTON COUNTY, GEORGIA.

Carrie A. Straight, Thomas R. Reinert, Byron J. Freeman, and Jay Shelton.

AUTHORS: Carrie Straight, Research Ecologist, Institute of Ecology, University of Georgia, Athens, GA 30602, Thomas Reinert, Research Ecologist, Institute of Ecology, University of Georgia, Athens, GA 30602, Byron J. Freeman, Director, Georgia Museum of Natural History and Senior Public Service Assoc., Institute of Ecology, University of Georgia, Athens, GA 30602, and Jay Shelton, associate professor, Warnell School of Forest Resources, University of Georgia, Athens, GA 30602.
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Abstract. In the mid 1990's, researchers discovered a member of the swamp eel, family Synbranchidae, inhabiting the ponds at the Chattahoochee Nature Center (CNC). The swamp eel (*Monopterus albus*) is the species most similar to eels found at the CNC, although recent genetic studies indicate the CNC specimens are most likely a separate species. Swamp eels are air breathing and highly adaptable and could interfere with ecosystem function through competition with native fish species in the Chattahoochee River system if their population spreads beyond CNC boundaries. This study investigates the role of *Monopterus* sp. *cf*. *M*. *albus* in the food web of one CNC pond. Eels in this pond appear to occupy a similar trophic position as an insectivorous fish, *Gambusia* sp., with *Lepomis* and *Micropterus* remaining the top predators in this particular system.

INTRODUCTION

Swamp eels (Family: Synbranchidae, Genus *Monopterus*), are native to Asia, with one *Monopterus* species native to Africa (Berra 2001). The swamp eel is subject to provisions of Federal legislation (Aquatic Nuisance Species in the Waters of the United States and the National Invasive Species Act of 1996 [16 U.S.C. 4701]). One species of swamp eel (*Monopterus* sp. *cf. M. albus*) occurs in several ponds of the Chattahoochee Nature Center (CNC) near Roswell, Georgia. These ponds connect via overflow pipes directly to the adjacent marshes that border the Chattahoochee River in the Bull Sluice Lake reach (Chattahoochee River National Recreation Area [CRNRA], National Park Service – Vickery Creek and Gold Branch Units). Freeman and Burgess (2000) summarized the history of this population and performed preliminary life history studies, noting that the population has persisted since before 1995. They documented reproduction and one occurrence of an adult eel in the CRNRA marsh complex near the out-flow pipe of a CNC pond.

Monopterus albus is the most closely related known species and is assumed to be behaviorally similar to individuals captured in the CNC and adjacent marsh (Starnes et al. 2000). Swamp eels frequent ponds, swamps, and rice fields and are known from creeks and fast-flowing rivers (Liem 1961, Merrick and Schmida 1984).

Swamp eels have many adaptations to increase survival in their native habitats, which undergo frequent drying-out events resulting in oxygen-poor conditions. Swamp eels are obligate air breathers, with young that possess a blood vascular system that allows for survival in poorly oxygenated environments (Liem 1961, Liem 1981, Graham 1997). Another adaptation includes sex reversal, which allows small populations to breed after drought events (Liem 1963). In addition, this species burrows, to remain closer to the water table during dry periods (Liem 1987). *Monopterus albus* may travel short distances over land (Liem 1987), in response to over-population and food-limitation.. These attributes also make this species a management concern, because of its unique ability to disperse, adaptability to many different environments, and ability to reproduce under limited population size.

One management concern for this species within the CNC and the similar species within Florida is its role in the food web of non-native environments. In its native habitats, this species is nocturnal (Graham 1997), feeding on small fishes, prawns, crayfish, snails, insect larvae, insects, fish, frogs and frog eggs, and tadpoles (Liem 1980). Previous studies within the CNC indicated prey items were mostly of aquatic invertebrates (96%) with fish representing the other 4% (Freeman and Burgess 2000).

We continue to study the populations of eels within the CNC and surrounding areas to assess their impact on the native communities and their potential to migrate beyond their known range within the Upper Chattahoochee River basin. We used stable isotope analysis to determine differences in the trophic level of various size classes of eels and their place in one pond community where they persist. Stable isotope sampling is frequently used to analyze complex food webs (Peterson and Fry 1987). The quantity of ^{15}N in the tissues of predators is typically enriched 3.4$\pm$1.1% relative to that in their prey (Minigawa and Walda 1984), allowing us to use the ratio to arrange organisms according to trophic levels in the ponds. Conversely, ^{13}C is less enriched than ^{15}N (or not enriched at all), with increasing trophic level. However, it is a good indicator of diet composition (Peterson and Fry 1987).

METHODS

For this study, we collected eels and other fish species, invertebrates, plants, and other materials from CNC's Beaver Pond. Beaver Pond is a 1.3 hectare (3.2 acre) pond that drains into Kingfisher Pond (approximately 1 hectare, 2.4 acre) which, in turn, drainss into the marsh bordering the northwest bank of the Chattahoochee River in Fulton County, Georgia.

Collections. We sampled for adult eels along the littoral zone of Beaver Pond using a Smith Root Model 12B POW backpack electrofisher and 0.32 cm (1/8 in) mesh dip-nets. We chose a subset of eels from 20-cm size classes for stable isotope analysis. To capture immature eels, we used leaf-litter refugia bags. Each bag was filled with available substrate material from the vicinity of placement and staked in the littoral zone just below the water surface (2-20 cm in depth). Litter-bag contents were examined and eels and macroinvertebrates were removed. The litter-bag technique is modified from a method developed for collection of aquatic salamanders (Pauley and Little 1998, Waldron et al. 2003). A random subset of eels from each size class and pond was chosen for stable isotope analysis. Additional aquatic invertebrate samples were obtained using D-nets within the littoral zone of each pond. Plant and detrital material was collected by hand.

Stable Isotopes. For eels a small, 3-5 mm, section from the end of the tail was taken for stable isotope analysis. We also took stable isotope samples from at least seven individuals of other components of the aquatic community. For other fish species, we collected small muscle tissue samples from just below the dorsal fin. Claw or tail muscle samples were collected from crayfish and tail samples were taken from tadpoles. Insects and mollusks were sampled whole. Sub-samples of plant and detrital material also were included. We plotted ratios of stable isotopes of carbon and nitrogen to assign eels to trophic levels and infer dietary habits.

Samples were sent to the Analytical Chemistry Laboratory, Stable Isotope/Soil Biology Laboratory, Institute of Ecology, University of Georgia. Ratios are reported here as standard delta (δ), per thousand (‰) deviation from a standard of $^{15}N/^{14}N$ and $^{13}C/^{12}C$ (Peterson and Fry 1987). We used fingernail clams (family Sphaeriidae) as a baseline to determine trophic position of all consumers using the standard 3.4‰ enrichment per trophic level mentioned previously, $[(\delta^{15}N_{consumer}-\delta^{15}N_{mollusk})/3.4]+2$ (Cabana and Rasmussen 1996). We used mollusks for baseline $\delta^{15}N$ instead of primary producers, because of high temporal variation of $\delta^{15}N$ and $\delta^{13}C$ in primary producers (Cabana and Rasmussen 1996, McKinney et al. 1999).

RESULTS/DISCUSSION

We analyzed 26 eels in the smallest size class (2-19 cm total length [TL]), 15 eels in the middle size class (20-39 cm TL), and 8 eels in the largest size class (40-59 cm TL). The preliminary results of the trophic structure in Beaver pond reveals that all three eel size classes all fall between the third and fourth trophic level of the pond (Figure 1). These eels were closest in level to two fish species (*Gambusia* sp. and *Pomoxis* sp.) and one plant (*Elodea*). The structure of the community within this pond is fairly well defined, with large *Micropterus* (9-15 cm TL and 19-31 cm TL) and *Lepomis* (15-25 cm TL) being the top aquatic predators. Just below the top predators are the small (< 5 cm TL) *Micropterus* and *Lepomis*, small *Pomoxis* (7-15 cm TL), *Gambusia* and the largest eel size class for this pond, 40-49 cm TL. This food web structure matches closely with the gut analysis of eels collected in the pond in 1998. Stomach content of the 1998 eels was comprised of mostly aquatic invertebrates, including larval odonates, larval trichoptera, mollusks, amphipods, and larval diptera (Freeman and Burgess 2000). In 1998, few eels were found fish in their gut analysis of eels taken in this pond. Additionally, the shift in carbon signatures of eels with increasing size class suggests an ontogenetic diet shift in prey base, although this shift did not include a measurable increase in trophic position (Figure 1). From these preliminary analyses, we suggest that swamp eels within this pond are not piscivorous in nature, and their impact may be limited to reducing food resources for other insectivorous fish/invertebrates within the system. However, as changes in habitat occur (e.g., changes within the pond or out-migration to new habitats) and if natural top predators are removed or increased, the role of swamp eels in this or other systems may change.

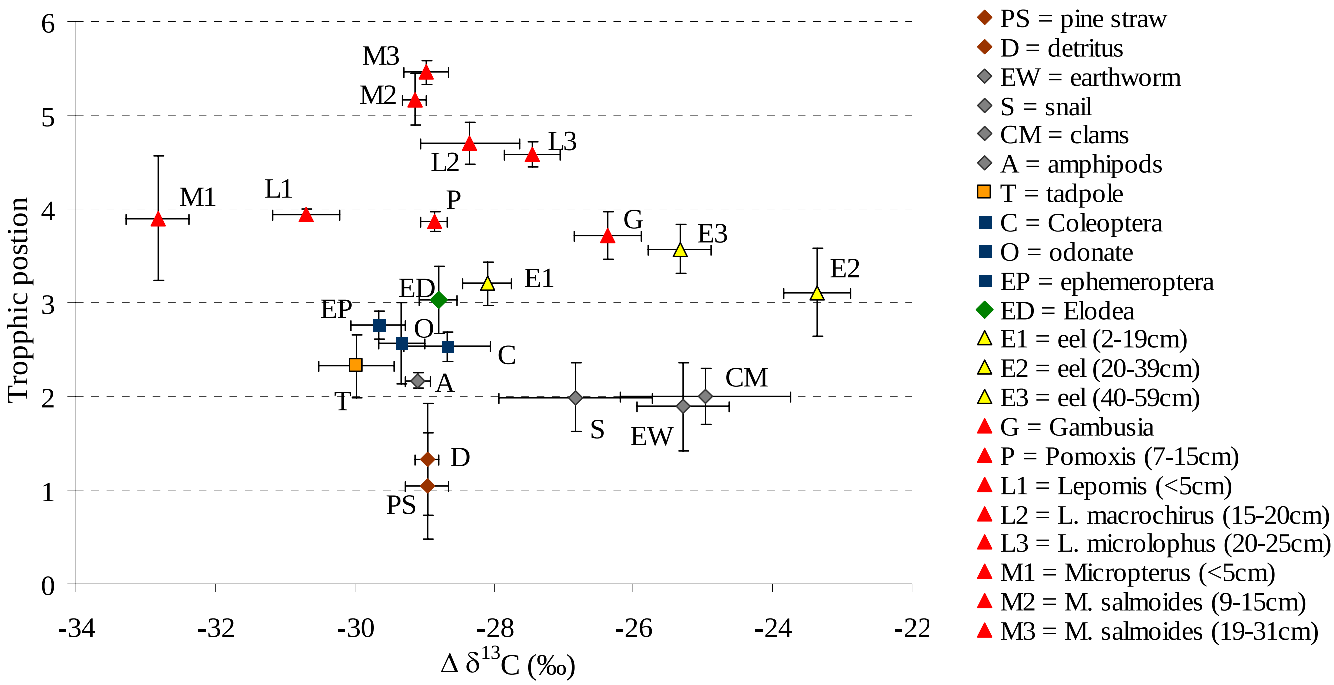

Figure 1. Food web (trophic position) diagram of consumers and potential prey (means ± standard error of $\Delta \delta^{15}N$ (‰) (trophic position) and $\Delta \delta^{13}C$ (‰)) within Beaver Pond at the Chattahoochee Nature Center, Fulton County, Georgia.

Future directions for stable isotope studies of swamp eels within the Chattahoochee Nature Center include a comparison between two ponds with different habitats and community structures. This comparison will examine another pond with fewer, if any, top predators. We will also attempt to obtain stable isotope samples from wading bird species that commonly hunt in the CNC ponds, i.e. green heron (*Butorides virescens*) and great blue heron (*Ardea herodias*) through injured/deceased birds taken to the CNC or from educational specimens. In the future we will also perform gut content analyses of the eels used for the stable isotope analysis to cross-reference the results with single time samples. This process may elucidate variation of diet over time compared to major sources of assimilated nitrogen.

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