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SPRING DIET AND PARASITES OF THE SPOTTAIL DARTER, *ETHEOSTOMA SQUAMICEPS*, IN SOUTHERN INDIANA

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ABSTRACT: The spring food items and parasites of 44 spottail darters from Sanders Creek, a second order stream in southwestern Indiana, were examined. Early instar isopod crustacea and chironomid larvae were the major components of the juvenile diet, respectively contributing 64.0% and 18.7% to total diet. In older age classes, late instar isopods, amphipods, and odonate naiads were major dietary constituents. Small decapods, fresh water snails, and simuliid and tabanid larvae were incidental to the diet. The majority of specimens examined were parasitized by the acanthocephalan, *Acanthocephalus dirus,* which uses the isopod *Asellus* as its intermediate host.

INTRODUCTION

The spottail darter, *Etheostoma squamiceps,* is abundant in direct tributaries of the Ohio River in Kentucky and southern Illinois (Braasch and Mayden, 1985) but is limited to 3 known localized populations in Indiana (Jordan, 1890; Page, *et al.,* 1976; Grannan and Lodato, 1986). Page, *et al.* (1976) suggested that the limiting factor for *E. squamiceps* in Indiana was the availability of potential nesting sites (i.e., slab rocks) due to the degradation of stream substrates by intensive agriculture and recommended that the species be added to the State's rare and endangered list. Studies of reproductive behavior (Bandoli, *et al.,* 1991) and early life history (Simon, 1987), as well as recent surveys (Grannan and Lodato, 1986; Cervonne, *et al.,* 1989), have contributed to our understanding of the ecology of the spottail darter in Indiana. Little information is available concerning the resource requirements of local populations. This study was conducted to supplement the ecological data available on the spottail darter.

METHODS

Darters were collected from Sanders Creek, a second order tributary of Bayou Creek in western Vanderburgh County, approximately 1 km east of the Posey-Vanderburgh County Line on Old Highway 62. The stream drainage basin consists of 25 km^2 of small wood and agricultural lots. Available habitats in Sanders Creek include soft, mud-bottomed pools with steep and often undercut banks supporting thick stands of *Equisetum* and shallow riffles with large (30 cm diameter) limestone rip-rap from bridge banks. Other darters in the Bayou Creek drainage include the mud darter (*Etheostoma asprigene*) and the slough darter (*E. gracile*). These fish are rarely syntopic with *E. squamiceps* in Sanders Creek.

Individuals of rare or of difficult to capture species can be used for initial dietary studies, even if sampled for other purposes (Rachlin and Warkintine, 1987). Due to the rarity of *E. squamiceps* in Indiana, most of the darters examined were collected during studies of the reproductive behavior of the spottail darter (J. Bandoli, pers. comm.).

Darters were collected by seine during March and April, 1990 and 1991. Specimens

were preserved in 10% formalin and brought to the laboratory for processing. Food items were identified to the lowest practical taxon. Diet content was determined by percent contribution by item and by the percentage of stomachs in which each taxon was found. Each specimen was also examined for endoparasites.

Diets were examined for ontogenetic shifts by dividing all darters into one of three size and associated age classes following Page (1974) and Bandoli, *et al.* (1991). Specimens < 43 mm standard length (SL) were considered first year (Age 0), between 44 mm and 57 mm SL second year (Age I), and > 57 mm SL third year (Age II).

RESULTS

The stomach contents of 44 spottail darters were examined—15 from the spring of 1990 and 29 from the spring of 1991. Specimens were distributed across the three age classes: 16 Age 0 (34 to 42 mm SL, $\bar{x}$ = 38.1), 22 Age I (45 to 56 mm SL, $\bar{x}$ = 50.2), and 8 Age II (57 to 70 mm SL, $\bar{x}$ = 62.5).

The diet composition of all age classes were similar (Table 1). However, the contents differed in the proportion each taxon contributed to the total diet. Isopod crustacea were the most important food item for all year classes. Age 0 and Age I darters consumed predominately the smaller early instars, while Age II individuals preyed only on late (adult) instars. Chironomid larvae contributed proportionally more to the diet of first year (Age 0) individuals (18.7%) than to the diet of Age I darters (13.9%). Chironomid larvae were present in 75.0% of the Age 0 and 25% of the Age I specimens examined. Larger darters consumed relatively fewer chironomids (14.0% of total diet). These larvae were found in only 25.0% of the specimens examined. Amphipod crustacea were preyed upon by all age classes in roughly the same proportions. Gastropods were most important to first (Age 0) and second (Age I) year individuals, while odonate naiads occurred only in the stomachs of Age II darters. Simuliid larvae, tabanid larvae, and early instar decapods were incidental to the diet.

Acanthocephalus dirus infected 86.0% of the individuals of *E. squamiceps* examined ($\bar{x}$ = 11.6 worms/darter). First year (Age 0) specimens had a parasitism rate of 86.7% ($\bar{x}$ = 3.6 worms/darter), while second year (Age I) darters had an incidence rate of 75.0% ($\bar{x}$ = 12.9 worms/darter). All third year (Age II) individuals examined were parasitized by an average of 22.6 worms/darter.

DISCUSSION

The diet of *E. squamiceps* in Sanders Creek is broadly similar to the diet in Big Creek, Illinois (Page, 1974). Differences between the two studies are due to the greater diversity of food items in Big Creek. The Illinois population was reported to prey heavily on chironomid larvae, ephemeropteran naiads, and amphipod and copepod crustacea. Other components to the diet included gastropods, isopods, ostracods, decapods, plecopteran nymphs, and trichopteran and coleopteran larvae. The greater breadth of taxa preyed on by the population in Big Creek reflects differences in habitat and benthic communities. Big Creek has a gravel and cobble substrate as well as a larger drainage basin, covered predominately by hardwood forest. In contrast, Sanders Creek suffers from siltation and serves to drain small agricultural lots. The similarities in the diets of the two populations are striking, considering the differences attributable to habitat.

A trend common to both studies was the selection of larger prey items by larger dart-

Table 1. Age class distribution of spottail darter stomach contents. Percent frequency is followed parenthetically by percentage of stomachs in which food items occurred.

Age Class:	Age 0 34-42 mm (N = 16)	Age I 45-56 mm (N = 20)	Age II 57-70 mm (N = 8)
Taxa			
Asellus			
early instar	64.0 (93.7)	52.9 (70.0)	nc
late instar	3.1 (12.5)	12.4 (25.0)	75.0 (62.5)
Gammarus	11.1 (50.0)	12.1 (40.0)	15.9 (50.0)
Procambarus	0.8 (12.5)	0.6 (5.0)	nc
Orthocladinae	15.9 (75.0)	3.9 (25.0)	6.8 (25.0)
Tanitarsinae	2.7 (12.5)	nc	nc
Simuliidae	nc	2.3 (15.0)	nc
Tabanidae	nc	0.6 (5.0)	nc
Coenagriidae	nc	nc	2.3 (16.7)
Physa	2.4 (25.0)	5.2 (35.0)	nc

nc = not consumed

ers. The larger the individual, the less important chironomid larvae became to the diet and the more significant the contribution of late instar isopods. Shifts in foraging behavior relative to body size and shape have been suggested for darters (Vogt and Coon, 1990). Most small first year (Age 0) individuals were captured in and among the roots and debris of undercut banks. They may forage in this microhabitat, avoiding the open channel. The third year (Age II) darters were associated with limestone rip-rap and may have limited their foraging to that area.

Competition with sympatric darters may not determine the food habits of the spottail darter in Sanders Creek due to the differences in preferred habitat of the different darters. Mud darters occur in the wide, slow moving pools downstream, while the slough darter occupies weedy pools (Cervonne, *et al.*, 1989). Only three slough darters have been collected from spottail darter study sites in four sampling years in the Bayou Creek drainage (J.Bandoli, pers. comm.).

Acanthocephalus dirus (= *A. jacksoni*) had been previously reported parasitizing spottail darters by Page (1974) and Buckner, *et al.* (1985). The intermediate host of *A. dirus* is the isopod *Asellus* (Amin, 1984). This suggests a correlation between the proportion of isopod crustacea in the diet with the number of parasites per individual. The low rate of parasitism in first year (Age 0) darters compared with the high proportion of isopods consumed suggests that earlier, uninfected instar isopods are being consumed by the early age classes.

Page, *et al.* (1976) identified the lack of available habitat as responsible for scarcity of the spottail darter. Whitaker and Gammon (1988) suggested that prime habitat in southern Indiana should be identified and conserved. The preferred habitat of *E. squamiceps* in Big Creek is slab stone pools (Page, 1974), a rare habitat in southern Indiana (Kozel, *et al.*, 1981). Of the known spottail darter populations in Vanderburgh County, all are associated with limestone rip-rap. Rip-rap is usually deposited under bridges as a riparian zone stabilizer (personal obs.), which inadvertently creates the habitat necessary for *E. squamiceps.* The spottail darter has never been abundant in Indiana, and the populations in Vanderburgh County may be the result of the creation of artificial habitat.

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