Proceedings of the Indiana Academy of Science
(1992) Volume 101 p. 293-298

WINTER FOOD HABITS OF THE ORANGETHROAT DARTER, *ETHEOSTOMA SPECTABILE,* FROM SOUTHWESTERN INDIANA

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ABSTRACT: The winter diet and food item selectivity of the orangethroat darter (*Etheostoma spectabile*) were studied in the lower Wabash River drainage of southwestern Indiana. Major components of the diet were chironomid larvae and isopod crustacea, with trichopteran larvae and amphipod crustacea taken incidentally. Orangethroat darters positively selected for chironomid larvae when overall prey densities were high but were less selective for this taxon when prey densities were low. Isopod crustacea were preyed upon at the same rate in which they occurred in the environment when prey densities were low and were avoided when prey densities were high. These actions suggest that food item selectivity in the orangethroat darter may be influenced by prey availability.

INTRODUCTION

The orangethroat darter, *Etheostoma spectabile,* is commonly found inhabiting unsilted streams throughout midwestern North America. It is rare in the lower Wabash drainage of Illinois, Indiana, and in neighboring Kentucky (Nelson and Gerking, 1968; Burr and Warren, 1986; Cummings, pers. comm.), due to the lack of suitable habitat (Kozel, *et al.,* 1981; Grannan and Lodato, 1986). However, a small isolated population occurs in a first order tributary of the Wabash River in Posey County, Indiana (Grannan and Lodato, 1986). This stream provides a locally rare habitat (i.e., an unsilted headwater stream) and offers an opportunity to study the feeding ecology of *E. spectabile* in a relatively simple and isolated system. Although seasonal changes in the diets and food item electivity of various darters have been examined (Small, 1975; Hlohowskij and White, 1983; Martin, 1984; Fisher and Pearson, 1987), most studies have focused on competitive interactions. Relatively few studies concerning darter food habits have addressed how changes in the density of the populations comprising the resource base might influence food item selection (but see Hansen, *et al.,* 1986). This study was undertaken in order to investigate the winter food habits and food item selectivity relative to food item density of a locally rare species.

METHODS

Road Brook is a first order tributary of the Wabash River located 7 km south of New Harmony, Indiana. The stream drains approximately 3.0 km^2 of hardwood forests within Harmonie State Park. Shallow raceways with fine sand substrates are the predominant habitat in Road Brook, although deeper pools are occasionally found. Stream width throughout the 1 km run varies from 1 to 3 m and ranges in depth from 5 cm to 75 cm. The only other darter species occurring in Road Brook is the spottail darter, *Etheostoma squamiceps* (Grannan and Lodato, 1986).

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Table 1. Stomach contents and electivity indices (E) for specific food items of *Etheostoma spectabile* in Road Brook by month of collection. Percent contribution to diet by food item is followed parenthetically by average number of items per darter.

Taxa	December	E	February	E
Isopoda				
Caecidotea	43.5 (2.4)	0.02	12.2 (1.5)	-0.49
Amphipoda				
Gammarus	5.7 (0.3)	0.23	4.1 (0.5)	0.04
Trichoptera				
Lepidostoma	7.5 (0.4)	0.61	2.4 (0.3)	-0.14
Chironomidae	35.8 (1.9)	-0.10	78.9 (9.7)	0.2
Copepoda	5.7 (0.3)	nc	nc	
Oligochaeta	nc	nc	2.4 (0.3)	0.04

nc = Not consumed or collected.

Collections were made on 20 December 1990 and 22 February 1991. Darters were collected between 12:00 and 15:00 CST from sand raceways with a 1.7 m seine with 4 mm mesh, preserved immediately in 10% formalin, and brought to the lab for stomach content analysis. Only ten darters were collected each sampling period as a precaution against disturbing the apparently small population. The validity of using such small samples was tested by calculating the cumulative diversity (Shannon's H) of successively summed stomach content samples following Hurtubia (1973) and Miller (1983). All darters collected were age 1+ (standard length, SL > 35 mm).

Immediately after each collection, the benthic community was sampled to estimate the structure of the resource base and the relative density of prey populations. Ten Surbur samples were taken at the collection site and preserved in 10% formalin. Stomach contents and benthic samples were identified to the lowest practical taxon following Pennak (1989) and Merritt and Cummins (1984).

Percent frequency of dietary and resource base components were used to determine the selectivity of *E. spectabile* for specific taxa with Ivlev's (1961) electivity index (E),

$$E = (r - p)/(r + p),$$

where r is the proportion of the diet comprised of a taxon and p is the proportion of the resource base attributable to the same taxon. Values range from 1.00, when the taxon is

Table 2. Resource base of *Etheostoma spectabile* in Road Brook by month of collection. Percent contribution to resource base is followed parenthetically by average density per m^2.

Taxa	December		February	
Isopoda				
Caecidotea	41.8	(25.5)	36.1	(240.0)
Amphipoda				
Gammarus	3.6	(2.2)	3.8	(24.4)
Trichoptera				
Lepidostoma	1.8	(1.1)	3.2	(20.0)
Chironomidae	43.6	(26.6)	53.1	(336.6)
Ceratopogonidae	1.8	(1.1)	0.8	(4.4)
Tipulidae	1.8	(1.1)	0.3	(2.2)
Tabanidae	1.8	(1.1)	0.3	(2.2)
Libellulidae	1.8	(1.1)	0.2	(1.1)
Oligochaeta	nc		2.2	(14.4)
Total Density	59.8		645.3	

nc = Not collected.

being selected for positively, to -1.00, when the taxon is being selected against or avoided. A value of 0.00 indicates that the prey taxon occurs in the same proportion in the diet as it does in the environment.

RESULTS

Darters captured in December (N = 10) ranged in standard length (SL) from 35 to 52 mm ($\bar{x}$ = 43.4 mm) and had a sex ratio of 1:1. February collections consisted of 1 male and 9 females, with SL ranges of 39 to 52 mm ($\bar{x}$ = 47.5 mm). All darters examined had at least one food item in their stomachs, averaging 5.3 items per individual in December and 12.3 items per individual in February. Analysis of diversity indices for stomach samples indicated that a minimum of eight stomachs were needed to represent dietary diversity for each collection. The overall diversity was relatively low (H = 1.247 and evenness = 0.775 in December; and H = 0.755 and evenness = 0.469 in February).

The diet of *E. spectabile* in both collections consisted predominately of chironomid larvae and isopod crustacea (Table 1). Chironomid larvae contributed less than half of the total diet in December, yet accounted for 78.9% of the total diet in February. The average number of chironomid larvae per individual increased from 1.9 in December to 9.7 in February. *Caecidotea* represented 43.5% of the diet in December, declining to 12.2% by February. The average number of isopods per individual decreased from 2.4 in December to 1.5 in February. Trichopteran larvae and amphipods were minor components in the diet, while copepods and oligochaetes were incidental in the diet. The average number of trichopteran larvae and amphipods per stomach did not appreciably change between the two collections.

Overall prey density increased by a factor of 10 between the two collections (Table 2). All major prey item populations experienced this increase along with subtle changes in the proportional representation within the resource base. The benthic community of Road Brook was dominated by the four major taxa comprising the diet (Table 2). Chironomid larvae made up about 50% of the total available food items in each collection, while *Caecidotea* declined in relative proportion from 46% in December to 36% in February. *Lepidostoma* and *Gammarus* were minor components of the resource base. Other taxa collected from the stream but not found in the stomach of *E. spectabile* included Tipulidae, Ceratopogonidae, Tabanidae, and Libellulidae. These taxa were listed as minor components of the diet of *E. spectabile* in other studies (Martin, 1984; Small, 1975). The simplicity of the diet reflected the nature and structure of the resource base in Road Brook. First order streams generally have less diversity and productivity in invertebrate fauna than higher order streams (Kuehne, 1962; Small, 1975).

Electivity indices for three of the four major taxa in the diet shifted between December and February (Table 1). *Caecidotea,* the major food item in December, was preyed upon at approximately the same frequency as it occurred in the environment (E = 0.02)but was later selected against (E = -0.49). Chironomid larvae were the only taxa selected against in December (E = -0.10) but were positively selected for in February (E = 0.2). The taxon with the highest positive electivity index was *Lepidostoma* in December (E = 0.61), but this taxon was later avoided (E = -0.14). *Gammarus* was the only taxon in the diet that had a positive electivity index during both months (E = 0.23 in December and E = 0.04 in February). Oligochaete worms were present in the diet at the same frequency as the taxon was in the environment during February (E = 0.04). No electivity index could be calculated for copepoda due to its absence in benthic samples.

DISCUSSION

This diet is consistent with the diet of darters in general (Page, 1983) but differs in the number of taxa reported comprising the diet of the orangethroat darter in other studies. Martin (1984) found that chironomid larvae were the major food item of a population of *E. spectabile* in central Indiana, with ephemeropteran naiads, plecopteran nymphs, simuliid larvae, and isopod crustacea being minor constituents. Tendipedidae (= Chironomidae) larvae and the isopod *Lirceus* were the major components of the diet in a second order Kentucky stream, with ephemeropteran and odonate naiads, trichopteran and coleopteran larvae, amphipod crustacea, annelid worms, and gastropods as food items of minor importance (Small, 1975).

Shifts in the electivity for specific food items suggests a relationship between foraging strategy and prey density. Chironomidae was the major component per item of the benthos but was selected against in December when prey densities were low. The tube dwelling dipterans may not be as easily obtained as *Caecidotea* and may have been passed over in favor of the cursorial isopods at this time. Isopod crustacea are low in nutritional value relative to chironomid larvae (Cummins and Wuycheck, 1971) and were the major component of the diet only when food item availability was low. Isopods have been found to be important in the winter and spring diets of the mud darter (*Etheostoma asprigene*) and the slough darter (*E. gracile*) (Cummings, *et al.,* 1984; Strange, 1992), although this food item is normally associated with the diet of larger darter species (Page, 1983). The importance of such lower quality food in the winter diet of smaller darters may be a function of obtainability and lower metabolic demands during the coldest months.

Orangethroat and rainbow (*E. caeruleum*) darters have been observed to increase foraging activities in habitats with low invertebrate densities (Vogt and Coon, 1990). Although morphology largely determines the diet of darters (Page and Swofford, 1984), the electivity of the orangethroat darter in this study for specific taxa changed concurrently with a general increase in prey density, while proportional representation within the resource base remained relatively stable. If increased search time is the result of decreased prey availability, then the optimally foraging predator would be expected to maximize its foraging efficiency by broadening dietary selection (Pianka, 1983). When food item abundance is low, *E. spectabile* may be an opportunistic forager, preying upon whatever it encounters. At higher prey densities, the darter may be more selective, avoiding or ignoring those items of low nutritive value in favor of more preferred food items. This is consistent with predictions based on optimal foraging models: dietary specialization is favored when habitat production increases and is discouraged when production decreases (Ricklefs, 1979). Although the sample size in this study was small, these results suggest that future investigations of darter food habits should consider prey density (both specific and overall) as a factor determining food item selection.

ACKNOWLEDGMENTS

The author would like to thank J. Bandoli for field work, consultation, and advice throughout all phases of this project; J. Grey of the Indiana Parks Department for access to the study site; B. Burr for data concerning nutritive values of aquatic organisms; and K. Cummings of the Illinois Natural History Survey for distributional records of *E. spectabile* in the Wabash drainage. Special thanks go to B. Coultas for scouting the study site and for her continued inspiration. All equipment, laboratory space, and reagents were supplied by the University of Southern Indiana.

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