BRIEF NOTE

Diet of the Rainbow Darter (*Etheostoma caeruleum*) in Rock Run, Clark County, Ohio[1]

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ABSTRACT. The diet of the rainbow darter, *Etheostoma caeruleum*, was studied during fall and winter in Rock Run (Clark County, Ohio), a second-order tributary of the Mad River. Chironomid larvae comprised over half of the diet (by numerical percentage) during both seasons. Other important components of the diet were simuliid larvae, trichopteran larvae (*Cheumatopsyche* and *Hydropsyche*) and coleopteran larvae (*Stenelmis*). Both chironomid and simuliid larvae appeared in the diet of *E. caeruleum* in greater abundance than they appeared in the available benthic macroinvertebrate populations. *Stenelmis* larvae comprised a smaller portion of the diet than of the benthic macroinvertebrate population. *Etheostoma caeruleum* typically feeds heavily on dipteran, trichopteran, and ephemeropteran larvae, but other locally abundant prey may also be an important part of the diet. It appears that dietary selectivity of *E. caeruleum* may be greater during the winter than during the fall.

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INTRODUCTION

Darters (Percidae) are common throughout small streams in eastern North America. Their biology has been reviewed by Page (1983) and Kuehne and Barbour (1983). Rainbow darters (*Etheostoma caeruleum*) feed primarily on benthic macroinvertebrates, particularly chironomid, ephemeropteran, plecopteran, and trichopteran larvae (Adamson and Wissing 1977, Hlohowskyj and White 1983, Grady and Bart 1984, Martin 1984). The purpose of this note is to report the diet of the rainbow darter, *Etheostoma caeruleum* (Storer) during the fall and winter in Rock Run (Clark County, Ohio), a second-order tributary of the Mad River.

METHODS AND MATERIALS

Darters were collected between September and November, 1980 (fall) and during January and February, 1981 (winter). During the fall, darters were collected in the Aberfelda Gorge area of Rock Run (Clark County). It was impossible to collect darters in this area during the winter because of impending construction work. During winter, darters were collected in Rock Run near a bridge where Sintz Road crosses the stream. The stream is 1 to 2 m wide, with a flow velocity of approximately 0.3 $m \cdot s^{-1}$ in the riffles where darters were collected. Darters were collected with a seine (3.0 × 1.0 m, 6-mm mesh) on seven occasions during the fall (at 1-week intervals), and on five occasions during the winter (at roughly 2-week intervals). Collections were made between 1300 and 1700 h, because darters are known to feed primarily during the day (Adamson and Wissing 1977).

Fish were placed on ice when captured and preserved in 10% formalin after their masses and lengths were measured. Stomach contents were identified to genus, except for dipteran larvae, which were identified to family. Diet composition was calculated from the number of individuals of the various prey types. Benthic macroinvertebrate populations were estimated from 10 Surber samples taken at each collection location. Surber samples were collected in pairs (on a transect of the stream) on five different occasions at each study location. The samples were taken at about 2-week intervals. The composition of the benthic fauna in the Surber samples was calculated, like the composition of the diet, from the numbers of individuals of each taxon.

Statistical computations were performed with a microcomputer statistical package (Microstat, Ecosoft Inc., Indianapolis, IN). Ivlev's (1961) electivity index was calculated for prey items constituting at least 1% of the diet. The equation for Ivlev's electivity index is $E = (r_i - p_i)/(r_i + p_i)$, where r_i is the percent of a prey item in the diet, and p_i is the percent of a prey item available in the environment (as estimated from the Surber samples). Values of the index range from +1 to −1, with positive values indicating that a prey type is found in higher proportion in the diet than in the prey community. Negative values indicate that a prey type is found in lower proportion in the diet than in the prey community.

RESULTS

Sixty-five *E. caeruleum* (42 males, 23 females) were collected during the fall, and 73 individuals (45 males,

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28 females) were collected during the winter. Eleven (16.9%) of the *E. caeruleum* collected during the fall had empty stomachs; 17 (23.3%) collected during the winter had empty stomachs. A total of 308 prey items were identified from individuals collected during the fall (average: 4.74/fish); 500 prey items were identified from the winter collections (average: 6.85/fish).

The average standard length of all *E. caeruleum* captured was 5.52 (±0.10) cm (values presented as mean (±2 SE)). The average mass of all *E. caeruleum* captured was 2.07 (±0.15) g.

The results of the stomach content analysis, along with estimates of benthic macroinvertebrate densities in the sampling areas, are presented in Table 1. Only those prey items that comprised at least 1% of the diet during at least one of the sampling periods are shown. Prey items (not listed in Table 1) comprising less than 1% (by numerical percentage) of the diet included odonate larvae; trichopteran larvae (*Chimarra, Polycentropus, Apatania*); coleopterans (*Stenelmis* adults, *Psephenus*); ephemeropteran larvae (*Caenis, Stenonema*); dipteran larvae (Tipulidae); snails (Lymnaeidae, Physidae); freshwater shrimp (Gammaridae); water mites (*Hydrocarina*); worms (Oligochaeta); and isopods (Isopoda).

The major food items during the fall were chironomid larvae, *Hydropsyche* larvae, *Stenelmis* larvae, and *Cheumatopsyche* larvae (in order of decreasing percentage of the diet). During the winter, the major food items were chironomid larvae, simuliid larvae, *Hydropsyche* larvae, and *Cheumatopsyche* larvae. Electivity indices for chironomid and simuliid larvae were positive, with values greater than 0.9 (indicating strong positive selection) during the winter. Electivity indices for *Hydropsyche, Cheumatopsyche,* and *Stenelmis* were all negative. Electivity indices for some taxa changed on a seasonal basis, with *E* for *Stenelmis* larvae during the fall being −0.28, but dropping to −0.94 during the winter. The electivity index for *Hydropsyche* larvae dropped from −0.07 during the fall to −0.79 during the winter. In contrast, the electivity index for simuliid larvae increased from a fall value of 0.11 to a winter value of 0.97.

DISCUSSION

The diet reported here is generally consistent with other studies of the diet of *E. caeruleum.* Adamson and Wissing (1977), Nemecek (1980), Hlohowskyj and White (1983), Grady and Bart (1984), Martin (1984), and Schlosser and Toth (1984) showed that chironomid, ephemeropteran, plecopteran, and trichopteran larvae are major components of the diet of *E. caeruleum.* Beyond that general agreement, there is variation in the proportions of these taxa in the diet. For example, Hlohowskyj and White (1983) found that chironomids comprised a larger portion of the diet of *E. caeruleum* than found in the present study; Adamson and Wissing (1977) found chironomids to be a less important part of the diet. Comparison of the diet between fall and winter is confounded by the fact that darters were collected from different areas of the stream during the two seasons. Some limited comparisons are possible, however. *Etheostoma caeruleum* exhibited high positive electivity for chironomid larvae during both seasons, with these larvae comprising over 50% of the diet. The electivity indices for *Stenelmis* larvae were negative during both seasons. *Stenelmis* larvae were a major component of the diet during the fall, but were not a major component of the diet during the winter. The drop in occurrence of *Stenelmis* in the diet corresponded with an increase in the occurrence of simuliid larvae. As with chironomid larvae, the electivity indices for simuliid larvae were positive (and particularly high during the winter). Although *Cheumatopsyche* larvae and *Hydropsyche* larvae each made up a considerable part of the diet during both seasons, the electivity indices were negative during both seasons. Hlohowskyj and White (1983) also reported a negative electivity index for *Cheumatopsyche* larvae. There were seasonal changes in electivity indices of several prey taxa, with the general trend being for those taxa showing negative *E*s during the fall having nega-

TABLE 1

Percent occurrence of food items, percent occurrence in the benthos (as determined from Surber samples), and Ivlev's electivity index (E) *for* E. caeruleum.

	Fall (Aberfelda Gorge)			Winter (Sintz Road)		
Prey type*	Percent of diet	Percent of benthic macroinvertebrate population	*E*	Percent of diet	Percent of benthic macroinvertebrate population	*E*
Trichoptera						
Cheumatopsyche	6.82	22.18	−0.53	3.40	13.25	−0.59
Hydropsyche	15.26	17.59	−0.07	4.20	35.34	−0.79
Polycentropus	0.97	0.53	0.29	0.40	0.11	0.57
Coleoptera						
Stenelmis	8.77	15.45	−0.28	1.00	33.57	−0.94
Ephemeroptera						
Baetis	2.60	0.67	0.59	0.20	0.17	0.08
Plecoptera						
Isoperla	0.28	1.09	−0.59	3.20	1.77	0.29
Diptera						
Diptera pupae	3.57	5.06	−0.17	0.40	0.88	−0.38
Chironomidae	53.25	15.72	0.54	55.80	2.60	0.91
Simuliidae	1.62	1.30	0.11	27.60	0.49	0.97

*Larvae unless noted otherwise.

tive Es of larger magnitude during the winter. These changes occurred in concert with the positive electivity indices for chironomid and simuliid larvae increasing from fall to winter. Chironomid and simuliid larvae together comprised over 80% of the diet during the winter.

Hlohowskyj and White (1983) showed that competitive interactions with other species of darters can affect the diet of *E. caeruleum.* In the present study, a few specimens of *E. flabellare* (fantail darter), *E. blennioides* (greenside darter), and *E. spectabile* (orangethroat darter) were captured. It seems unlikely that competitive interactions were of much importance in influencing the diet of *E. caeruleum* in the areas studied owing to the low populations of potential congeneric competitors.

Chironomid larvae have been reported consistently as a major component of the diet of *E. caeruleum.* Simuliid, trichopteran and ephemeropteran larvae are also generally found to be important dietary items for *E. caeruleum.* There is one notable difference between the diet found in this study as compared to previous reports. *Stenelmis* larvae have never been reported as a major component of the diet of *E. caeruleum. Stenelmis* larvae were very common in the benthos of the sampling area, and made up approximately 9% of the diet during the fall.

Etheostoma caeruleum displays some broad consistencies in dietary selection, but appears capable of taking advantage of locally abundant prey items that are not normally an important component of the diet. This is consistent with the suggestion by Martin (1984) that *E. caeruleum* is somewhat opportunistic in its dietary habits. In the present study, however, it was found that *E. caeruleum* was very selective during the winter (much more so than during the fall). It may be that decreased metabolic demands caused by low water temperature allow for a reduction in prey consumption, and a concomitant increase in dietary selectivity, during winter.

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