1997

Dietary Comparison of Eurycea cirrigera (Southern Two-lined Salamander) Larvae from Pond and Stream Habitats in Southern West Virginia

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the concerns associated with using vertebrates in psychological demonstrations and student research (Hull, 1996).

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DIETARY COMPARISON OF *EURYCEA CIRRIGERA* (SOUTHERN TWO-LINED SALAMANDER) LARVAE FROM POND AND STREAM HABITATS IN SOUTHERN WEST VIRGINIA

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ABSTRACT

We give the first dietary report for a lentic population of two-lined salamander larvae (*Eurycea bislineata* complex) and the first dietary comparison of lentic and lotic populations simultaneously. Diets of *Eurycea cirrigera* (Southern Two-lined salamander) larvae were investigated from pond and stream habitats in southern West Virginia during 1994 and 1995. Pond larvae consumed nine prey taxa dominated by chironomid larvae and ostracods, with copepods contributing significantly on most sampling dates. Stream larvae consumed 15 prey taxa dominated by copepods, isopods, and chironomid larvae. Seasonal shifts in diet were apparent at both sites. Comparisons between sites (D = % dietary overlap and r_s = Spearman rank correlation coefficient) indicate that larval diets are different at each site (D = 8.1-41.8; r_s =-0.4091 to 0.5606, p = 0.10-0.96). This is most likely due to differences in prey availability at each site. These results emphasize the generalist nature of Two-lined salamander larvae.

INTRODUCTION

Members of the two-lined salamander complex (*Eurycea bislineata, E. cirrigera,* and *E. wilderae*) are found throughout eastern North America. Larvae are typically found in pools of first-order streams and have a stream-type body shape. They are dusky colored above with six to nine pairs of light dorsolateral spots, and light colored below with numerous iridophores (Petranka, 1998). *Eurycea cirrigera*, the Southern Two-lined salamander, occurs from southern Virginia, west to eastern Illinois and south to northern Florida and eastern Louisiana (Jacobs, 1987; Conant and Collins, 1991). In West Virginia, *E. cirrigera* occupies the southwestern two-thirds of the state in the Allegheny Plateau physiographic province (Jacobs, 1987; Conant and Collins, 1991; Brophy, 1995).

Two-lined salamander larvae are opportunistic generalists that feed on all available prey items in the proper size category. As such, both seasonal and ontogenetic shifts in diet have been documented (Caldwell and Houtcooper, 1973; Burton, 1976; Petranka, 1984; Marcum, 1994; Brophy, 1995). Since Two-lined salamander larvae typically inhabit lotic habitats (Petranka, 1998), all previous reports of diet have come from lotic populations. This is the first dietary report for a lentic population of Two-lined salamander larvae and the first dietary comparison of lentic and lotic populations simultaneously.

MATERIALS AND METHODS

Collections of *E. cirrigera* larvae were made on 10 April 1994 (spring), 11 August 1994 (summer), 30 October 1994 (fall), and 17 January 1995 (winter) from an unnamed pond at the Trump-Lilly Farm near Hinton in Raleigh County, West Virginia, at an elevation of 812 m. Trump-Lilly was an active subsistence farm from the early 1880s to the early 1960s (Nicely et al., 1993), and the pond was most likely constructed as a watering hole for cattle. This small pond (surface area =177 m^2, max. depth = 1.5 m) is located in mesic woods dominated by *Acer* spp., and supports populations of *E. cirrigera, Ambystoma maculatum, Desmognathus ochrophaeus, Notophthalmus viridescens, Rana clamitans*, and *R. sylvatica.*

Collections of *E. cirrigera* larvae were also made on 6 April 1994 (spring), 20 August 1994 (summer), 29 October 1994 (fall), and 14 January 1995 (winter) from Fitzpatrick's Branch, a tributary to Hisey Fork in Wayne County West Virginia, at an elevation of 245 m. Fitzpatrick's Branch is a small intermittent stream that flows through a *Quercus* spp. dominated mixed mesophytic forest. Large rock outcrops line the stream. The streambed contains small pools with a substrate of silt and sand and riffles with coarse pebbles and rocks. This small stream supports populations of *E. cirrigera*, *Desmognathus fuscus*, and *Gyrinophilus porphyriticus.*

Larvae from both sites were captured, euthanized in chloretone, fixed in 10% buffered formalin, and preserved in 70% ethanol. Stomachs were removed and all food items were identified using Merritt and Cummins (1984), Borror et al. (1989), and Peckarsky et al. (1990). Results are presented as the number of each prey item consumed by all larvae and the number of stomachs that contained each prey item.

The degree of dietary overlap between sites is derived from stomach contents using the similarity index:

$$D = [1.0 - 0.5 \Sigma| p_{x,i} - p_{y,i} |] \times 100$$

Where D is the percentage of overlap and $p_{x,i}$ and $p_{y,i}$ are the proportions of the number of items groups x and y utilized in resource category i (Schoener, 1970; Rathcke, 1976; Holomuzki, 1980). Dietary overlap is calculated between sites during each of four seasons. The same comparisons are made statistically using the Spearman rank correlation coefficient (Snedecor and Cochran, 1989), where rankings are based on the percentage of the number of items found in each prey category.

RESULTS AND DISCUSSION

Larvae from the Trump-Lilly pond consumed nine prey taxa (Table 1). Overall, chironomid larvae and ostracods were the primary prey, but copepods contributed significantly on most sampling dates. Chironomids were most important during January and April, ostracods and chironomids during August, and ostracods alone during October. No larvae had empty stomachs.

Larvae from Fitzpatrick's Branch consumed 15 prey taxa (Table 2). Overall, copepods, isopods, and chironomid larvae were most important. Copepods were most important during January and April, copepods and chironomids during August, and isopods during October. Sixteen percent of larvae collected in October had empty stomachs, while those from all other sampling dates were never empty.

Chironomid larvae, copepods, ostracods, and isopods have all been identified as major prey items in the diet of Two-lined salamander larvae (Caldwell and Houtcooper, 1973; Burton, 1976; Petranka, 1984; Marcum, 1994). In general, chironomids and ostracods are most important in warm weather with copepods and isopods replacing them as weather becomes cooler. Empty stomachs have been reported for all seasons except spring, with the highest occurrences during winter (Caldwell and Houtcooper, 1973; Burton, 1976; Marcum, 1994).

A low degree of dietary overlap consistently occurs between *E. cirrigera* larvae from Trump-Lilly pond and Fitzpatrick's Branch (Table 3). The greatest amount of overlap occurs in spring and summer whereas very little occurs in fall and winter. Statistical comparisons support these findings (Table 3). All correlation coefficients are non-significant ($p = 0.10 - 0.96$), indicating that larval diets are very different at each site.

Two-lined salamander larvae are euryphagic predators (Caldwell and Houtcooper, 1973; Burton, 1976; Petranka, 1984; Marcum, 1994; Brophy, 1995). The low degree of dietary overlap between Fitzpatrick's Branch and Trump-Lilly pond is, therefore, not surprising. Larval diets are most likely different at each site because of differences in prey availability. Even though specific foods differ, comparison of pond and stream populations simultaneously shows that both behave similarly in terms of diet and dietary shift. This novel comparison emphasizes the generalist nature of larvae from the two-lined salamander complex.

ACKNOWLEDGMENTS

We thank Michele L. Brophy, Peter A. Kramer, and James W. Barron for their assistance in the field and lab. All specimens were collected under WVDNR permit numbers 19-1994 and 52-1995, and voucher specimens were deposited in the West Virginia Biological Survey collection at Marshall University. This study was partially funded by a research grant from the Marshall University Graduate Student Council.

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TABLE 1. Prey items of *Eurycea cirrigera* larvae from Trump-Lilly Pond. Values are number of each prey item consumed by all larvae and number of stomachs containing each prey item (in parentheses), n values are number of stomachs examined during each season.

Food Item	Winter (n=25)	Spring (n=21)	Summer (n=25)	Fall (n=26)
Chironomidae larvae	103 (24)	142 (21)	83(24)	107 (21)
Ostracoda	25 (11)	36 (11)	100 (19)	485 (21)
Copepoda	8 (5)	51 (13)	1 (1)	42 (19)
Coleoptera larvae	2 (2)	5 (4)	0 (0)	0 (0)
Odonata nymphs	0 (0)	0 (0)	2 (2)	0 (0)
Annelida	0 (0)	0 (0)	1(1)	0 (0)
Chironomidae pupae	0 (0)	0 (0)	11 (9)	0 (0)
Ephemeroptera nym.	0 (0)	0 (0)	0 (0)	3 (2)
Unidentified	0 (0)	1(1)	0 (0)	3 (3)

TABLE 2. Prey items of *Eurycea cirrigera* larvae from Fitzpatrick's Branch. Values are number of each prey item consumed by all larvae and number of stomachs containing each prey item (in parentheses), n values are number of stomachs examined during each season.

Food Item	Winter (n=25)	Spring (n=22)	Summer (n=25)	Fall (n=25)
Copepoda	880 (24)	506 (22)	49 (17)	5 (5)
Chironomidae larvae	6 (6)	133 (20)	34 (19)	0 (0)
Isopoda	3 (2)	1 (1)	20 (16)	18 (15)
Ostracoda	15 (9)	0 (0)	1 (1)	0 (0)
Annelida	3 (3)	3 (3)	5 (5)	1 (1)
Trichoptera larvae	6 (4)	2 (2)	0 (0)	0 (0)
Tipulidae larvae	1 (1)	0 (0)	2 (2)	0 (0)
Collembola	1 (1)	4 (4)	2 (1)	2 (2)
Plecoptera nymphs	0 (0)	11(9)	0 (0)	0 (0)
Araneae	0 (0)	1 (1)	0 (0)	0 (0)
Hymenoptera	0 (0)	1 (1)	1 (1)	2 (2)
Ephemeroptera nym.	0 (0)	3 (2)	2 (2)	0 (0)
Acari	0 (0)	1 (1)	0 (0)	0 (0)
Amphipoda	0 (0)	0 (0)	2 (2)	2 (2)
Unidentified	2 (2)	1 (1)	2 (2)	0 (0)

TABLE 3. Dietary comparisons of *Eurycea cirrigera* larvae from Fitzpatrick's Branch (FB) and Trump-Lilly Pond (TLP) for each of four seasons. W=winter, SP=spring, SU=summer, F=fall. Comparisons made using percent dietary overlap (D) and Spearman rank correlation coefficient (r_s), n values are number of prey categories compared between sites.

Comparison	% Overlap (D)	r_s	n	Probability
FB-W/TLP-W	8.1	0.5606	10	0.10
FB-SP/TLP-SP	41.8	0.2044	14	0.48
FB-SU/TLP-SU	30.2	-0.0151	13	0.96
FB-F/TLP-F	6.6	-0.4091	10	0.25