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Life History of the Least Darter in Dinner Creek, Becker County, Minnesota

By Jay T. Hatch
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Introduction

In order to fill in some of the gaps in our knowledge of darter natural history, a series of studies funded by the Nongame Wildlife Program of the Minnesota Department of Natural Resources was begun in 1983 to elucidate the life histories of all fifteen Minnesota darter species. The approach has been to intensively study different but overlapping assemblages of darter species in geographically disjunct and physically diverse drainages.

In the first report on these studies (Hatch 1986), I presented basic life history data for 5 species of darters occurring the Upper St. Croix River drainage (Etheostoma nigrum, Percina caprodes. P. evides. P. maculata and P. phoxocephala). I now report the results of a study of the least darter (Etheostoma microperca) in Dinner Creek, Becker County, conducted from May 1984 through October 1985. The life history of this species has not been studied previously in Minnesota, and has been studied little elsewhere. Burr and Page (1979) studied a population in the Iroquois River, Illinois, and apparently Kossel (1967) and Starostka (1967) studied a population in a pond near the campus of the University of Wisconsin-Stevens Point, although neither published their results (mimeos cited in Lutterbie 1976). Lutterbie (1976) provided additional information on the growth and seasonal gonadal weights of Wisconsin specimens. Petravicz (1936) and Winn (1958) reported on the fecundity and reproductive behavior of least darters from Michigan.

This study was originally funded under the title, "Comparative ecology of the Iowa darter (E. exile) and the least darter (E. microperca) in Dinner Creek and Lake Itasca." Funding of the study was continued and the study was modified in a subsequent proposal entitled, "Continuation of Minnesota Darter Life History Studies" under the subtitle of "Mississippi Headwaters Study." The specific objectives of the study were: 1) to determine growth rates; length-weight relationships; fecundities; fecundity relationships to length, weight, and age; and seasonal diet for a population of E. microperca from Dinner Creek, 2) to determine spawning periods and reproductive habits of this population, and 3) to describe its seasonal habit use. This life history of the Iowa darter is reported in a separate document, which accompanies this one.

Materials and Methods

Field Work

Least darters (E. microperca) were studied in Dinner Creek, Becker County, from May 1984 through October 1985 (Figure 1). Most of the work was done in the 300 m of stream below the culvert of County Highway 46 (T141N, R36W, S11). In 1984, additional specimens were collected below a large beaver dam about 1 km downstream of Little Dinner Lake (T142N, R36W, 535). Destruction of the dam in late 1984 prevented further use of this area. Adult darters were collected using small mesh (1.6-3.1 mm) bag seines with heavily weighted lead lines, Erickson nets (Erickson, 1980), and backpack electrofishers. Larval darters were collected with a 500 gm dipnet. Dates of collections and numbers of darters collected from the two primary study sites are given in Table 1.

Laboratory Analyses

All specimens used were fixed in 10% formalin and rinsed in water for at least 24 hours prior to analysis. Standard (SL) and total lengths (TL) were measured to the nearest 0.1 mm with a dial caliper. Total body weight (TBW) was measured to the nearest 0.01 g on a Mettler H15 analytical balance after surface moisture was removed by blotting. Adjusted body weight (ABW) was determined in a similar manner after all viscera except gills and kidneys were removed. Gonads were blotted dry and weighted to the nearest 0.0001 g. Sex was determined by examination of whole gonads or gonad squashes in the case of very young specimens (Hatch 1982).

Specimens were aged by the scale method. Key scales were taken from the scale row just above the lateral line beneath the junction of the spinous and soft dorsal fins. Validity of the method was determined by examination of scales from seasonally collected specimens (Erickson 1977, Hatch 1982).

The individual growth histories of specimens were determined by using the equation:
$\mathbf{L_i = c + (S_i/s)\ (L-c)}$, where $\mathbf{L_i}$ is the total length of the darter at the time of the **i**th annulus formation, **c** is the Y-intercept of the body-scale length regression equation for each sex of each species, $\mathbf{S_i}$ is the length of the middle anterior scale radius at the time of capture, and **L** is the total length of the darter at the time of capture. For specimens collected in September, October, and May (before annulus deposition) the length at capture was considered to be the length of the fish at the conclusion of its latest growing season. Mean lengths at age calculated from these data were denoted **empirical** growth estimates as opposed to **back-calculated** growth estimates. The former estimates were used to evaluate the effects of using "**c**" as a correction factor in the back-calculation equation above. The two estimates were mathematically combined only when computing weighted mean growth and were always identified separately in the results reported. Differences in lengths of males and females at age were tested with Student's t-test.

Relationships between TL and SL, between TBW and TL, and between ABW and TL were determined by least-squares regression (Ricker 1975). .

Measures of fecundity was estimated two ways: 1) by measuring the weight of ovaries from females collected just prior to and during the reproductive season (May 1984 and June 1985), and 2) by making direct ova counts of both right and left ovaries. Only yolked ova of $\geq$ 0.4 mm in diameter were counted. Relationships of fecundity to SL and ABW were determined by least-squares regression. In order to help describe the timing of gonadal development throughout the life cycle of each species, a gonadosomatic index (GSI) was calculated for most specimens. The index was determined by dividing the adjusted body weight into 100 times the gonad weight.

Food habits were determined from examination of stomach contents. The entire digestive tract was removed and divided into 3 portions: stomach, proximal intestine, and distal intestine. The latter 2 portions were analyzed qualitatively only to help Organisms from the stomach were identified to family or genus and enumerated. After counting, the entire stomach contents were placed in tared aluminum containers, dried to constant weight and weighted to the nearest 0.0001 g. To compare seasonal feeding activity, an index of fullness was calculated by dividing of the adjusted body weight of the fish into 1000 times the dry weight of its stomach contents.

Results and Discussion

Habitat and Seasonal Movements

Dinner Creek is a small (3-10 m wide), low gradient, spring-fed stream that flows about 6 km from the outlet of Dinner Lake to Two Inlets Lake. It meanders through a small portion of the sandy glacial outwash plain just south of the Itasca moraine, where it drains a small catchment of mostly jackpine and mixed second growth forests, pasture land and a small amount of agricultural fields. The lower reaches of the creek are bordered by a broad expanse of willow and alder swamp. The water of Dinner Creek is quite clear most of the year, and its flow regime is greatly influenced throughout its length by the activity of beavers.

Least darters were found most often in pools and along stream margins just downstream of pools or beaver dams. They were nearly always in association with thick aquatic vegetation, especially Anacharis, Valesnaria and sometimes Carex spp. Substrates in these areas ranged from sand with detritus to deep *gyttja* (black organic sediment). Sometimes in late summer least darters were found dispersed over a wider area of stream just below large pools, but still in association with submerged Valesnaria and Potamogeton.

Least darters studied at the beaver dam and culvert sites showed seasonal movements associated with breeding and overwintering. In the spring (early May), least darters were most abundant in the deep water of the pools. As the spawning season approached (mid to late May), first males and then females moved to the margins of the pools and then to shallow, weedy areas immediately downstream. Spawning occurred in these areas, and the young, as well as some adults, dispersed more widely across these areas in late July and August. By early fall (September-October), most darters had moved back to the deeper waters of the pools, where it is presumed that they overwintered.

Age Composition and Longevity

Table 2 shows the age composition of the 295 least darters aged in this study (fish captured in June were considered either 12, 24 or 36 months old, fish collected in July were 1, 13, 25 or 37 months old, and so on). Although these data should not be viewed as demographic statistics because of the biases in the sampling regime, they do suggest that during the two years of study the Dinner Creek population was comprised predominantly of fish less than 2 years old. Surprisingly, 6 individuals were found to have survived a third growing season. The oldest specimens were a 36-month male and a 37-month female. Three-year old least darters have not been reported previously (Lutterbie 1976; Burr and Page 1979). Young-of-the-year were not collected very effectively with the Erickson nets until they were 3 to 4 months old (September to October), which is why the relative catch of 1 to 12-month old fish appears small in Table 2. However, an examination of the composition of monthly catches (Figure 2), shows that at any point in time the population was comprised mostly of fish of the latest year-class. The data in Figure 2 were taken from the May to September 1984 and October 1985 catches.

Although the data in Table 2 are not conclusive, they suggest that survivability and longevity may be slightly greater for females. From the results of this study and the others cited, it appears that most adult least darters die at the conclusion of their first spawning season at about 13-14 months of age. Nearly all those that survive a second growing season (perhaps 99% or more), die soon after their second spawning at 24-26 months of age. Despite the unprecedented longevity of a few specimens reported here, the average life cycle of Dinner Creek E. microperca should be considered two years as it is elsewhere (Page 1983).

Growth

Table 3 summarizes the average annual growth increments for the Dinner Creek least darters. The data from the 1984 and 1985 collections were combined to produce the table, which means that 5 year-classes (1981 through 1985) are represented. Back-calculated lengths at annulus showed a slight Rosa Lee's phenomenon; however, individually calculated growth histories did not support the hypothesis that older fish are generally slower growers. Further, the unweighted grand means of back-calculated values were very close to the values obtained by empirical calculations. For instance, the back-calculated mean lengths at first annulus for females yielded an unweighted mean [(30.2+28.8+28.6)+3] exactly equal to the mean length at first annulus calculated from empirical data [e.g., 29.2]. Because the various calculations are in close agreement and because 5 year-classes are represented, I believe that the weighted means and, therefore, the annual growth increments in Table 3 are reasonable estimates of the growth in length characteristics of Dinner Creek least darters.

Based on mean length calculations, it appears that both sexes grow at the same rate, reaching about 29 mm TL after one growing season and 34 mm after two seasons. The weighted mean length of females after 3 growing seasons was significantly ($P < 0.05$) longer than that of males, but the sample sizes were really too small for a meaningful comparison. However, the 10 longest females captured were significantly ($P < 0.05$) longer than the 10 longest males (Table 4). In fact, the 12 longest females all exceeded 37 mm TL, while the longest male was 36.9 mm TL. Thus, it is likely that females are capable of growing to a longer ultimate length than males. Burr and Page (1979) noted a similar trend in the Iroquois River population and attributed it to the greater longevity of females. This attribution may also apply to the Dinner Creek population.

As expected there was substantial overlap in the lengths of darters of different ages. One-year olds captured during the non-growing season ranged from 17.4 to 35.2 mm TL, while two-year olds ranged from 30.6 to 37.5. Such extensive overlap in size may be obscuring the subtle sexual dimorphism noted above. Maximum total length appears to be about 40 mm for this population. Similar overlap in length at age was reported for the Iroquois population, although lengths at given ages were longer (e.g., about 3 mm for 12-month fish).

In Dinner Creek, least darters attained approximately 80% of their lifetime average total length in the first growing season (Figure 3). This is the highest first year percentage growth we have determined for darters from Minnesota, and it agrees closely with the 85% relative growth calculated from the Iroquois River data of Burr and Page and the central Wisconsin data of Lutterbie. Rapid first year growth is essential for this species since its life span is basically two years, and individuals must be ready to reproduce at 12-13 months of age. Increase in weight was considerable slower; both males and females attained only 40% of their lifetime average adjusted body weight in their first growing season. On average, weight increased by 56% (0.16 g to 0.25 g) in the second growing season compared with a 16% increase in total length. The weight increment in the third growing also was quite substantial compared to the length increment. In part, this is a reflection of the power function relationship between length and weight, but it also is an indication of improved condition (as in "condition factor," see Carlander 1969) with age. One might hypothesize that such an increase in somatic condition factor should lead to a disproportional increase in reproductive potential with age. In the case of females, at least, this hypothesis was not supported by fecundity data (see "Reproduction" below).

Body Size Relationships

Least-squares regression relationships between TL and SL and between TL and body weight are given in Table 5. Correlations were very high in every instance. The relationship between ABW and TL show slopes that are well below 3. In fact, these are the lowest slopes we have calculated for a Minnesota darter population (Hatch 1986: p. 17). The higher slope for the female TBW equation probably reflects the contribution of gonad weight. Page and Mayden (1981) have suggested that there is a correlation between length-weight regression slopes and the habitat, of darters. Darters exhibiting slopes of 3.4 or higher typically are found in swift riffles, while those exhibiting slopes around 2.6-2.7 are found in quiet water areas. The results for Dinner Creek E. microperca seem to fit this continuum fairly well.

Reproduction

Spawning Period. In Dinner Creek, least darters spawned over an extended period from late May through most of July. At both sites in 1984, many males and females had well developed gonads on May 5, but did not exude sex products with light pressure. The pelvic fins of the males were bright red and two males were observed paired with females. Both males and females were in ripe condition below the dam on May 19 and June 14. Spawning was not observed but eggs were found on vegetation in June. By July 12, sex products could not be expressed with light pressure, but GSI data suggested that some spawning activity was still possible. All females collected on July 31 clearly were spent. In 1985, spawning began at the culvert site somewhat later. Gonads of females were well developed on May 5 and 26, but males did not exude milt. On June 24, most males and females exuded sex products, and developing embryos were found on vegetation then and on July 4. Darters returned to the laboratory on these dates displayed territoriality and courtship and spawned within 48 hours. On July 22, eyed embryos were still present on vegetation and proto-, meso- and metalarval darters were abundant in the flooded vegetation around the culvert. Evidence of active spawning was not observed on that date but judging from the presence of large numbers of nearly ripe eggs in some of the preserved females, spawning probably was taking place at that time.

Spawning Habitat. Spawning took place in the quiet, weedy margins downstream of and around the culvert pool and in the thick weed beds downstream of the beaver dam. The substrates in these areas ranged from sand to *gytta* (soft silt heavily enriched with organic matter). Eggs were found on the surfaces of leaves of Potamogeton spp., Vallisnaria, and Carex spp. always along stream margins in quiet water. Eggs were not found on plants in the channels of the stream even though current was slow there. Nor were they found on terrestrial grasses that were. inundated by flooding for most of the 1985 spawning season. Although no eggs were discovered on stems of plants in the stream, darters did lay eggs on stems of Potamogeton and Anacharis arranged naturally in aquaria.

Reproductive Behavior. Reproductive behavior was observed in aquaria June 25-30, 1985. Six males and six females from Dinner Creek were placed in a 95 liter aquarium in which we had arranged Potamogeton and Anacharis plants to simulate natural conditions. Epiphytic diatoms, microcrustaceans, and insect larvae were left on the plants as a food source and zooplankton from Lake Itasca was added twice daily to insure an adequate food supply. Observations were made hapazardly during day and nighttime periods. The following is a brief summary of our observations.

Larger males tended to defend small territories by chasing other males, and occasionally even females, away. Several times we observed agonistic displays of head-to-head and head-to-tail fin challenges, but usually males simply chased one another. Territories consisted primarily of one or two plants Potamogeton and Anacharis and a 5-10 cm area around them. Winn (1958) reported territories of up to 30 cm in wild populations. Petravicz (1936) did not observe territoriality in his aquarium specimens, and Winn attributed this to overcrowding. I suspect that our observations also reflect at least some compromise to' normal behavior in response to overcrowding. All of the spawnings we observed took place on plant stem or leaf surfaces. Females would move into the vegetation near one of the males, sometimes followed by other males, and come to rest on a plant surface. Very quickly a large male, usually the nearest one, would mount the back of the female. Sometimes the females would swim on before the male could actually clasp the female with his pelvic fins (as described by Winn). If she did not swim, the male would secure his mounting position and vibrate his body. The female would reciprocate and release a single egg while the male exuded a relatively small amount of milt. Several times when we observed such spawning behavior, it appeared that no egg was laid. We did not observe more than one egg being laid at a time, but on several occasions the male and female spawned again nearby. If we take into account the overcrowded nature of the aquarium, the reproductive behavior we observed was very similar to that reported by Winn and by Burr and Page.

Reproductive Cycle and Sexual Maturity. For purposes of this study, four categories of ova-oocytes were recognized. "Ripe" ova (0.83-1.14 mm) were light yellow and translucent with one to two oil globules. The egg envelope was separated slightly from the plasma membrane, except at the point of a prominent indentation characteristic of several species of the subgenera Boleicthys (Microperca) and Catanotus (Page 1985). "Mature" ova were slightly smaller (0.65-0.91 mm), darker yellow, opaque but with oil globules, and lacked indentation and envelope separation. "Developing" ova were smaller yet (0.46-0.61) and lighter yellow. They contained appreciable yolk but without any coalescence of oil globules. "Undeveloped" ova were all remaining ova and oocytes that did not show clear evidence of yolk deposition.

The male and female reproductive cycles as revealed by gonadosomatic indices (GSI) throughout the life cycle are shown in Figure 4. For females, a GSI above 10 indicated spawning potential, with values above 20 being more typical for females with mature ovaries. Ovaries were considered mature if they had at least one ripe ovum. The highest GSI determined for a female was 35.2 for a 24-month fish (33.5 TL) collected May 19, 1984. The relationship between GSI and maturity in males was not quite as clear. On May 5, 1984 no males examined in the field produced milt, but GSI's were as high as 1.5. On June 14, nearly all males examined produced milt and GSI's were as low as 0.4. Still it seems reasonable to conclude that during the spawning season, GSI's between 0.5 and 1.5 were indicative of males with spawning potential. Clearly, both males and females reached sexual maturity in the first spring after hatching, which seems only reasonable in such a short-lived species.

During the first growing season, gondal development was minimal for both sexes. Ova (probably oocytes) of young-of-the-year females captured in the fall were quite small (<0.2 mm diameter) and white. It is not known at what point in the winter or spring the development accelerated, but clearly by early May both sexes showed nearly mature gonads. From May through June, ovaries typically were large and yellow and contained numerous ripe and mature ova. Ovaries of some females continued to contain ripe or mature ova through the end of July, but others were clearly in a state of resorption by middle to late July. By August new ovaries similar to the ones from the previous fall were apparent in most females. The timing of gonadal development in males was similar to that of the females. Fish that survived to a second or third spawning season repeated the same seasonal cycle. An increase in GSI with age was not revealed visually in Figure 4; nor did statistical comparisons of spawning-ready first-year vs second-year fish indicate differences between mean GSI's.

Fecundity Estimates. Estimates of fecundity are presented in Table 6. Since least darters spawn repeatedly over an extended period, an accurate estimate of fecundity can be made only by counting the number of eggs actually laid in a season. Because such a count is impractical, estimates have to be made on the basis of ova counts from preserved ovaries. As I have indicated already, mature ovaries contain ova in several stages of development; so, there remains the question of which ova to count. I believe the counts in Table 6 represent reasonable, albeit low, fecundity estimates for the following reason. The counts suggest that as the mature ova complement develops into a ripe ova complement, it is not replaced by a developing ova complement. Thus, in fish collected early in May (prior to spawning), the sum of mature and developing ova counts probably represents a close estimate of the eggs that will be spawned during the season. In fish collected later in May (at the beginning of spawning), the sum of ripe and mature ova counts represents a minimal estimate of the eggs that will be spawned during the season since some of the ripe eggs may have been spawned already.

If we use the counts from prespawning individuals with no ripe ova, the mean estimate is 168.5 t 38.2 (2SE). The mean estimate using individuals with no developing ova is 128.0 ± 16.8 (2SE), and the estimate using total yolked ova from all individuals is 159.3 ± 45.0 (2SE). A oneway ANOVA showed no significant difference among means ($P<0.05$). In comparison, I calculated a mean of 106.9 ± 28.0 (2SE) for 16 specimens reported by Burr and Page (1979). Their description of ova indicates that they counted the equivalent of my ripe and mature ova categories. Lutterbie (1976) counted 146,, 150 and 194 1-mm diameter ova in 3 one-year old specimens. In contrast, Petravicz (1936) counted 435-751 ova in one-year olds and 650-1102 in two-year olds. It appears that he counted all ova without regard to yolk deposition, size or color. Winn (1958) reiterated these figures reporting means of 594 and 858, respectively, and argued that least darters laid this entire ova complement in a season. If his interpretation is correct, then our estimates of fecundity are very low.

Least-squares regression analysis indicated that there was a significant correlation between fecundity and size of the fish (Table 7). (Standard length was used rather than TL in these equations because caudal fins of spawning females often were damaged:) Total yolked counts and gonadal weight both increased as a function of SL and ABW. Regression of fecundity on age was not done, but mean counts of 1-year olds (126.4) versus 2-year olds (215.7) were significantly different ($P < 0.01$). These relationships plus the inferred increase in condition with age (and, therefore, size) suggest that older and larger females should be capable of producing more eggs relative to their size than younger, smaller fish. However, regressions of weighted egg counts (count=adjusted body weight) and GSI (already a weighted estimate of fecundity) on body size showed no significant correlations. If these relationships hold true in subsequent analyses with larger sample sizes and other collection locations, one would be forced to conclude that although fecundity increases with size, the proportion of energy diverted to egg production is independent of size. In other words, as a least darter gets older and larger, its ability to divert energy to egg production on a body weight basis does not increase. As far as I know, this type of proportional fecundity relationship has not been investigated previously in darters, except in our current research (Price and Hatch 1987).

Petravicz reported a mean and range for 2-year olds that were much higher than those for 1-year olds, but he did not calculate regressions. Burr and Page found no relationships between number of ova and size of fish in their study, but they analyzed only 1-year old fish. It may be that the important factor in determining fecundity is age. The relative contributions of age versus size could be analyzed, and we may have a chance do this in the future.

Food Habits

The diet of Dinner Creek least darters was comprised chiefly of cladocerans, copepods and midge larvae, although the relative contributions of each of these groups changed through the growing season (Figure 5). Chironomid larvae were the mainstay of the diet in June and July with cladocerans and copepods being more important early and late in the growing season. Individuals of a variety of microcrustacean taxa were consumed, but only <u>Acroperus</u> October) and <u>Chvdorus</u> (May) were consumed in any numbers (Table 8). These animals are primarily epiphytic crawlers, which suggests that least darters do feed from plant surfaces, at least sometimes. Other investigators have reported cladocerans, copepods, amphipods and chironomid larvae as the principal food items of least darters (Forbes 1880; Petravicz 1936; Kossel 1967, as cited in Lutterbie 1976; Starostka 1967, as cited in Lutterbie; Burr and Page 1979).

Cordes and Page (1980) reported that least darters from the Iroquois River were diurnal feeders with peak feeding occurring between 1300 and 1900 hrs (in September). All samples except the one from July 4, which was collected 1030-1230 hrs, were collected between 1300 and 1900 hrs. Examination of intestinal contents indicated that darters had been feeding for sometime prior to capture in all cases, although the relative fullness of the intestines varied greatly. Allowing for the variability encountered in the May sample, measures of stomach fullness were fairly comparable for the samples used (Table 8). Thus, the differences seen among stomach contents from different dates should reasonably reflect seasonal rather than diurnal differences in feeding.

Table 1. Collections dates and locations for <u>Etheostoma microperca</u> from Dinner Creek, Becker County, Minnesota.

Yr.	Date	Location	No. Coll.
84	May 4	Culvert	2
84	May 5	Beaver Dam	56
84	May 19	Beaver Dam	34
84	Jun 12	Culvert	10
84	Jun 14	Beaver Dam	36
84	Jul 12	Culvert	42
84	Jul 31	Beaver Dam	32
84	Aug 23	Culvert	45
84	Aug 23	Beaver Dam	24
84	Sep 29	Culvert	15
85	May 5	Culvert	5
85	May 26	Culvert	36
85	Jun 24	Culvert	22
85	Jul 4	Culvert	60
85	Jul 22	Culvert	24
85	Oct 20	Culvert	53

Table 2. Age composition of <u>Etheostoma microperca</u> from Dinner Creek, 1984 and 1985.

Year of Collection	Age in Months	No. of Fish Caught		Percentage of Total Catch	
		Males	Females	Males	Females
1984	1-12	29	29	16.3	16.3
	13-24	57	43	32.0	24.2
	25-36	7	13	3.9	7.3
	37	0	0	0.0	0.0
	Totals	93	85	52.2	47.8
1985	1-12	18	20	15.4	17.1
	13-24	32	32	27.4	27.4
	25-36	3	11	2.6	9.4
	37	0	1	0.0	0.9
	Totals	53	64	45.3	54.7

Table 3. Weighted mean total lengths and growth increments of Dinner Creek Etheostoma microperca collected May 1984 through October 1985.

No. Annuli	No. Fish	Mean TL (2 SE) at Annulus I	II	III
		Females		
1	66	30.2 (0.7)		
2	11	28.8 (1.1)	34.2 (1.2)	
3	1	28.6 (- -)	33.5 (- -)	36.3 (- -)
[Empirical		29.2 (0.8)	34.4 (0.7)	39.0 (1.8)
Method]	[N]	[44]	[26]	[2]
Weighted Mean		29.7	34.3	38.1
Average Growth Increments		29.7	4.6	3.8
		Males		
1	51	29.6 (0.7)		
2	8	28.6 (1.1)	33.9 (0.7)	
3	1	29.8 (- -)	33.6 (- -)	35.3 (- -)
[Empirical		29.3 (0.8)	34.0 (0.6)	36.0 (1 .1)
Method]	[N]	[61]	[24]	[2]
Weighted Mean		29.4	34.0	36.2
Average Growth Increments		29.4	4.6	2.2

Table 4. Comparison of the 10 longest female E. micropera with the 10 longest males.

	TL Category Midpoints (mm) 35.5	36.5	37.5	38.5	39.5	Range	Mean	2SE
Females	0	0	5	4	1	37.1-39.9	37.98	0.52
Males	2	8	0	0	0	35.7-36.9	36.30	0.25

	Age In Months 11	12	14	15	23	24	26	27	35	36	37	Mean	2SE
Females	0	0	3	0	1	1	2	1	1	0	1	25.0	5.20
Males	1	1	0	1	4	0	1	0	1	1	0	23.7	5.38

Table 5. Least-squares regression equations of body size relationships for Dinner Creek Etheostoma microperca.

Sex	Regression Equation	r	N
	Total Length (TL) on Standard Length (SL)		
Females	TL = 1.908 + 1.145 SL	0.982	105
Males	TL = 2.186 + 1.137 SL	0.989	128
	Standard Length (SL) on Total Length (TL)		
Females	SL = -0.616 + 0.841 TL	0.982	105
Males	SL = -1.325 + 0.861 TL	0.989	128
	Total Body Weight (TBW) on Total Length (TL)		
Females	log TBW = -5.453 + 3.265 log TL	0.947	105
Males	log TBW = -5.134 + 3.025 log TL	0.941	126
	Adjusted Body Weight (ABW) on Total Length (TL)		
Females	log ABW = -5.306 + 3.072 log TL	0.935	149
Males	log ABW = -5.293 + 3.068 log TL	0.919	151

Table 6. Ova counts of <u>Etheostoma microperca</u> from Dinner Creek, May 1984 and June 1985. [R = ripe, M = mature, D = developing] (mean =168.5 ± 38.2, 2SE).

TL	Age (mo.)	GSI	R	(mm)	M	(mm)	D	(mm)	Total Yolked Count
			Ovum Category and Mean Diameter						
23.0	12	16.4	0		66	0.72	40	0.54	106
23.5	12	19.8	0		78	0.81	45	0.56	123
23.6	12	28.2	73	0.99	62	0.65	0		135
23.8	12	14.5	0		59	0.71	39	0.59	98
24.1	12	22.7	0		86	0.79	48	0.56	103
24.4	12	21.4	44	1.03	0		0		44
25.4	12	27.5	29	1.06	83	0.85	0		112
25.8	12	19.2	0		79	0.87	61	0.60	140
26.4	12	14.1	0		67	0.75	48	0.59	115
26.6	12	29.5	97	1.03	105	0.65	0		202
26.7	12	16.5	0		79	0.81	0		79
27.5	12	15.0	1	0.91	79	0.76	63	0.57	143
27.7	24	35.2	122	1.10	53	0.81	0		175
28.7	24	24.6	82	1.00	96	0.68	0		178
29.0	24	24.4	91	0.95	103	0.71	0		194
29.2	12	17.4	0		95	0.89	0		95
29.5	24	29.1	109	1.01	103	0.73	0		212
29.7	24	20.5	106	0.91	104	0.70	0		210
30.4	12	11.4	1	0.91	71	0.86	41	0.56	113
June 85									
30.6	25	25.2	136	0.90	147	0.68	35	0.52	318
30.6	25	20.4	0		151	0.81	72	0.55	223

Table 7. Least-square regression analysis of fecundity and body size (N =17) for <u>Etheostoma microperca</u> from Dinner Creek. [ABW = adjusted body weight; GSI = gonadosomatic index; GWT = wet gonad weight; SL = standard length; TO = total ova count; WTO = weighted total ova count (count/ABW)].

	Regression Equation	R	Probability Level for T-test
log TO	= -1.037 + 2.257 log SL	0.694	0.002*
log TO	= 2.682 + 0.687 log ABW	0.605	0.010*
log GWT	= -5.637 + 2.968 log SL	0.714	0.001*
log GWT	= -0.735 + 0.915 log ABW	0.631	0.007*
log WTO	= 3.536 - 0.438 log SL	-0.160	0.540
log WTO	= 2.682 - 0.313 log ABW	-0.328	0.199
log GSI	= 0.937 + 0.274 log SL	0.085	0.747
log GSI	= 1.265 - 0.085 log ABW	-0.075	0.775

*Denotes significant correlations

Table 8. Mean number of food items per stomach and in parentheses () number of stomachs out of ten in which the item occurred for Etheostoma microperca collected from Dinner Creek, 1985.

Food Item	May 26	Jun 24	Jul 04	Jul 22	Oct* 20
Crustacea	67.1 (10)	5.0 (10)	7.8 (10)	6.4 (9)	19.7 (10)
Amphipoda					
Hyalella	1.1 (5)	0.4 (2)	0.1 (1)	0.1 (1)	0.3 (2)
Cladocera					
Acroperus	0.4 (4)			0.5 (2)	6.7 (10)
Chydorus	29.0 (8)	0.4 (4)	4.8 (9)	1.0 (6)	1.3 (5)
Other [a]	0.3 (2)	0.2 (2)	0.7 (3)	1.3 (7)	0.1 (1)
Copepoda	35.7 (10)	3.8 (9)	2.2 (7)	3.4 (7)	11.0 (10)
Ostracoda	0.9 (4)	0.2 (1)			0.3 (3)
Insecta	2.5 (6)	19.0 (10)	15.2 (10)	17.6 (10)	10.5 (10)
Diptera					
Chironomidae	1.6 (5)	17.6 (10)	14.2 (10)	14.9 (10)	10.0 (10)
Other [b]	0.2 (1)	1.0 (5)		0.2 (2)	0.3 (3)
Ephemeroptera					
Baetis	0.8 (2)	0.3 (2)	0.6 (4)	2.5 (6)	0.0
Trichoptera					
Hydropyschidae [c]	0.1 (1)	0.1 (1)	0.4 (3)		0.1 (1)
Other Food [d]		0.2 (1)		0.2 (2)	
Total Food	69.6 (10)	24.2 (10)	23.0 (10)	24.2 (10)	30.2 (10)
Index of Fullness	4.4 [2.0]e	2.1 [0.8J	1.5 [1.0]	1.8 [1.1]	2.2 [0.8]

a lncludes *Alona, Ceriodaphnia, Eurycercus,* and *Simocephalus*
b lncludes Heleidae and Simuliidae *(Simulium)*
c lncludes *Chemafopsyche* and *Hydropsyche*
d lncludes 1 Coleoptera, 2 fish eggs and 1 mesolarval cyprinid
e Values in brackets 0 are 2SE

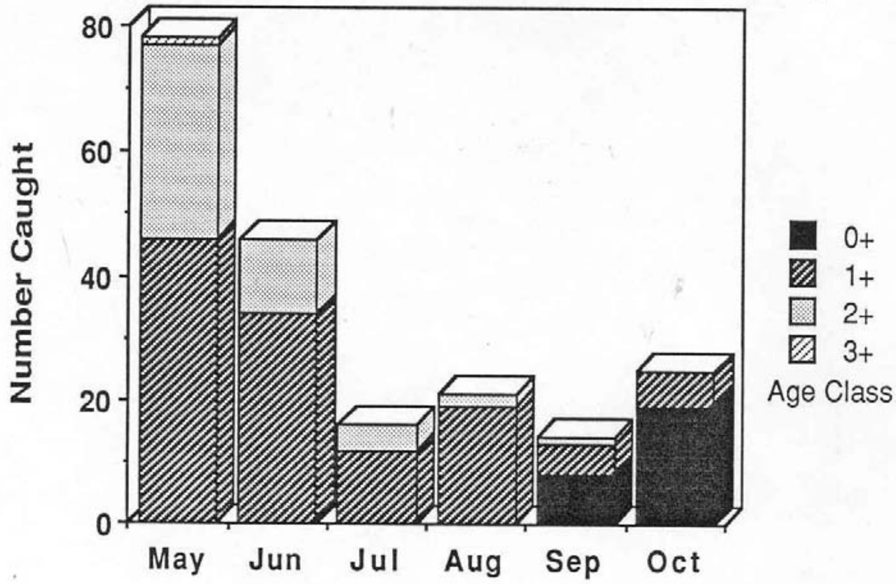

Figure 2. Age composition of monthly least darter catch from Dinner Creek May-September, 1984 and October 1985. Sexes combined.

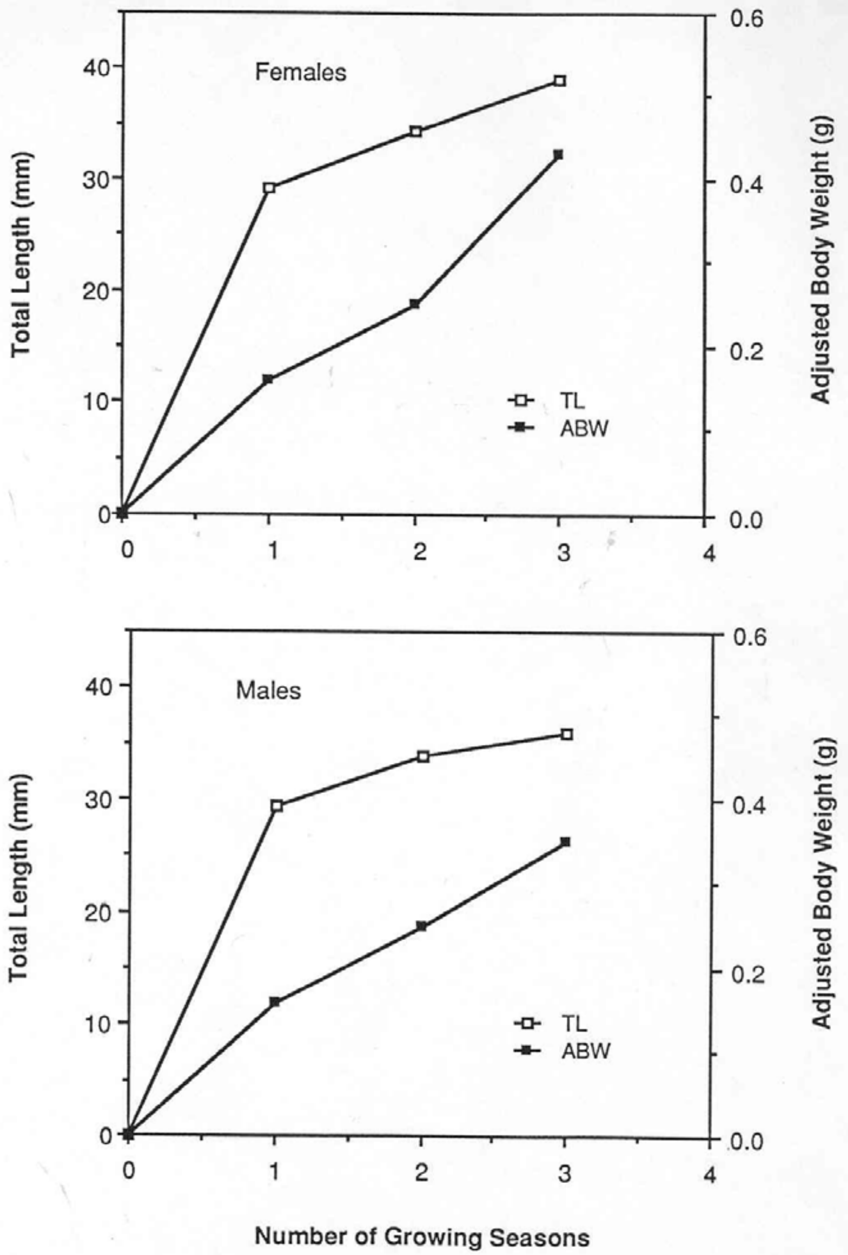

Figure 3. Growth of least darters in Dinner Creek based on mean annual total lengths and adjusted body weights (1984-1985 catches).

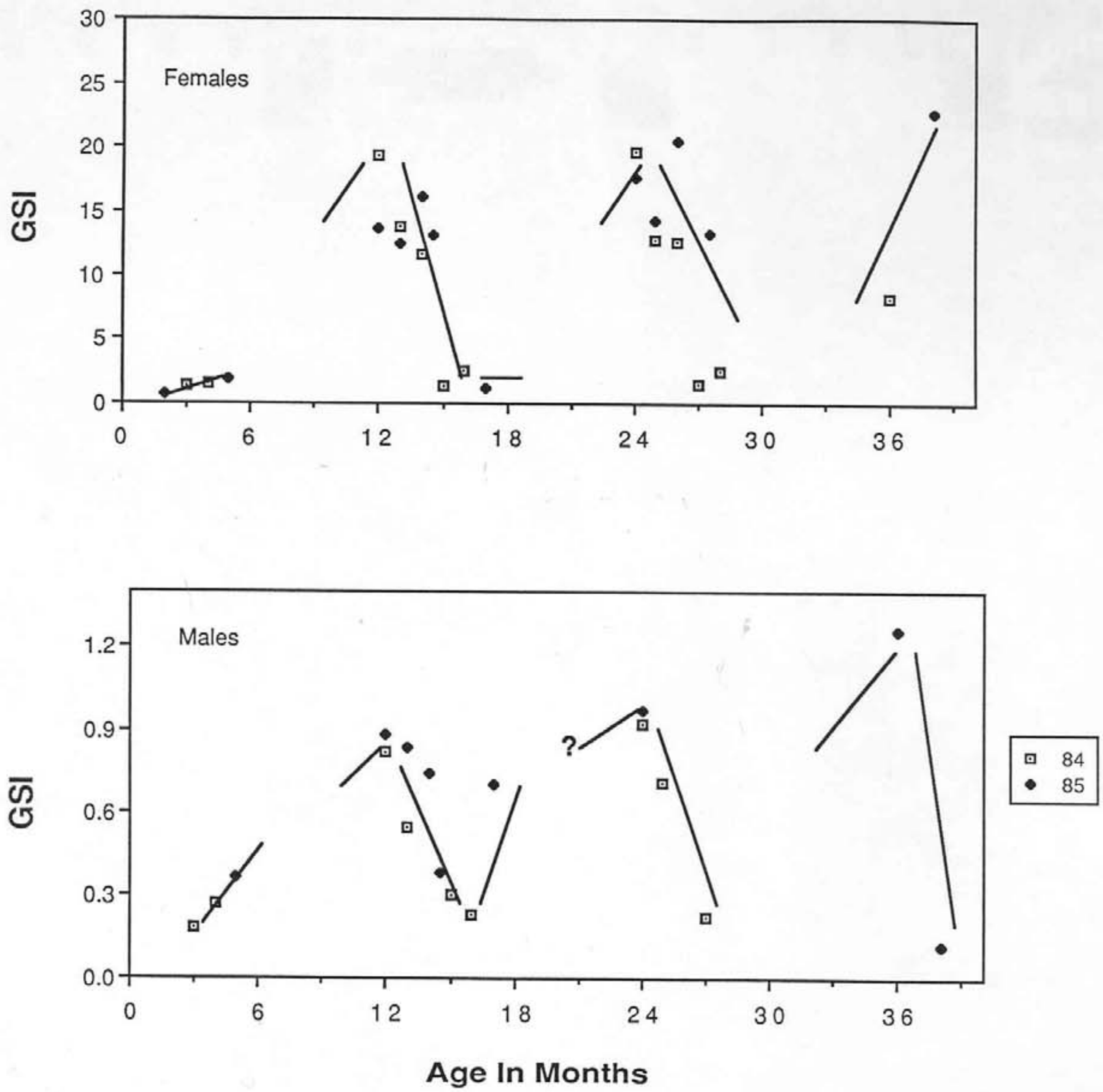

Figure 4. Gonadosomatic index cycles in least darters from Dinner Creek, Minnesota. Lines indicate inferred trends and are not intended to connect specific data points.

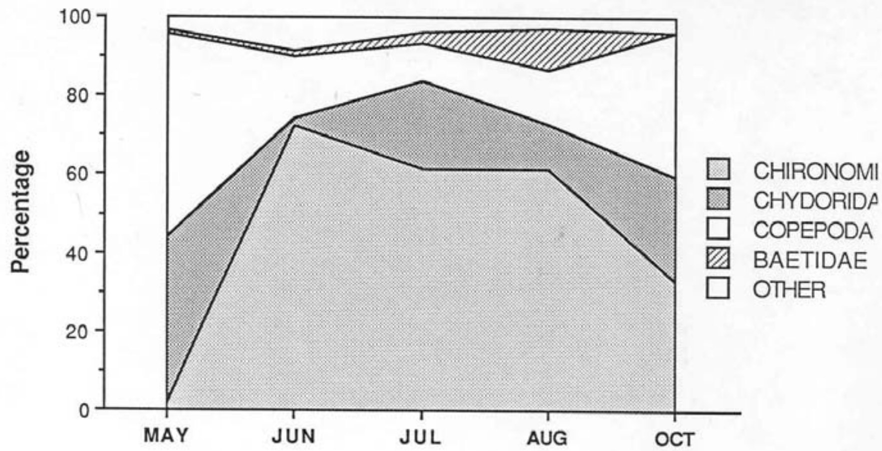

Figure 5. Seasonal composition of the diet of Dinner Creek least darters--1985.

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