Food, Age and Growth of the Tessellated Darter, *Etheostoma olmstedi*, in Massachusetts[1]

ABSTRACT: Tessellated darters (*Etheostoma olmstedi*) fed primarily on tendipedid larvae in the Connecticut and Mill rivers from June to September, but by October shifted to a diet of Trichoptera larvae in the Mill River. Feeding in the Mill River on 8-9 July 1970 occurred throughout daylight hours but was heaviest between 0600 and 1200. Back-calculated lengths varied within age groups and the length ranges overlapped between age groups in the five darter populations studied. In the Mill River, young darters appeared to remain near a spawning area until they reached about 30 mm TL.

INTRODUCTION

The tessellated darter (*Etheostoma olmstedi*) occurs throughout eastern United States from southern New Hampshire to northern Florida, frequenting a variety of habitats but preferring quiet stream pools with sand or mud substrates (Cole, 1967). In some areas, it is an important forage species for smallmouth bass (*Micropterus dolomieui*), walleye (*Stizostedion v. vitreum*) and American eel (*Anguilla rostrata*) (Raney and Lachner, 1942, 1943; Ogden, 1970).

Although various aspects of the tessellated darter's life history have been documented by Adams and Hankinson (1928), Atz (1940), Raney and Lachner (1943) and Tsai (1972), no detailed study of its feeding habits has been made. The present paper describes seasonal food, daily feeding periodicity, age and growth of the tessellated darter in Massachusetts.

MATERIALS AND METHODS

We used an electric shocker, seines and rotenone to sample darters from five areas in Massachusetts: Mill River, Amherst; Connecticut River, Hatfield; Holyoke Canal, Holyoke (20 October 1970); West Branch of the Swift River, New Salem (17 July 1967); and Wading River, Mansfield (24 July 1970). Specimens were preserved in 10% formalin immediately after collection. Later, total length was recorded to the nearest millimeter and weight to the nearest 0.01 g; and sex was determined. To determine seasonal food habits, darters were collected in the Connecticut River biweekly from the 1st week in June through September 1970; and in the Mill River through October 1970. On 8 and 9 July 1970, we made four collections at 6-hr intervals to determine darter feeding periodicity in the Mill River. Stomach contents were examined with a dissecting microscope at 15-45X. Since preliminary examination of stomach contents indicated that darters fed almost exclusively on tendipedids from June to August, we estimated visually the volumes of food items.

Scales were removed from an area below the lateral line at the posterior tip of the pectoral fin (when extended posteriorly along the body), dry-mounted between two glass slides, and examined with a Bausch and Lomb tri-simplex projector (50X). Computer programs developed by Mawson and Reed (1970) were used for most age and growth calculations on a 3600 CDC computer at the University of Massachusetts.

RESULTS AND DISCUSSION

Food.—Tessellated darters in the Mill and Connecticut rivers fed primarily on tendipedid larvae throughout the summer (Fig. 1). Other dipterans made up less than 5% of the total food volume. Incidental food items in the two streams were annelids, cladocerans, fish eggs and Ephemeroptera nymphs ("D" in Fig. 1). In the Mill River tendipedids reached peak importance in July, when they contributed nearly 98% to the total food volume. Trichoptera larvae became important in August and dominated the diet in October. In the Connecticut River, tendipedid larvae were also by far the most important food from June to September. Levesque (1970) reported that the abundance of midge larvae in the Connecticut River benthos was cyclical in 1969, and these fluctuations were reflected directly in the food of juvenile American shad (*Alosa sapidissima*). However, we did not observe cyclical fluctuations in the diet of darters in the present study.

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Darters collected from the Mill River on 8 and 9 July fed throughout the day but principally between 0600 and 1200 hr (Table 1). The percentage of undigested food in the stomachs was smallest at 2400 hr; at this time most of the stomach contents were in a late stage of digestion and only the sclerotized head capsules of tendipedid larvae were identifiable. The

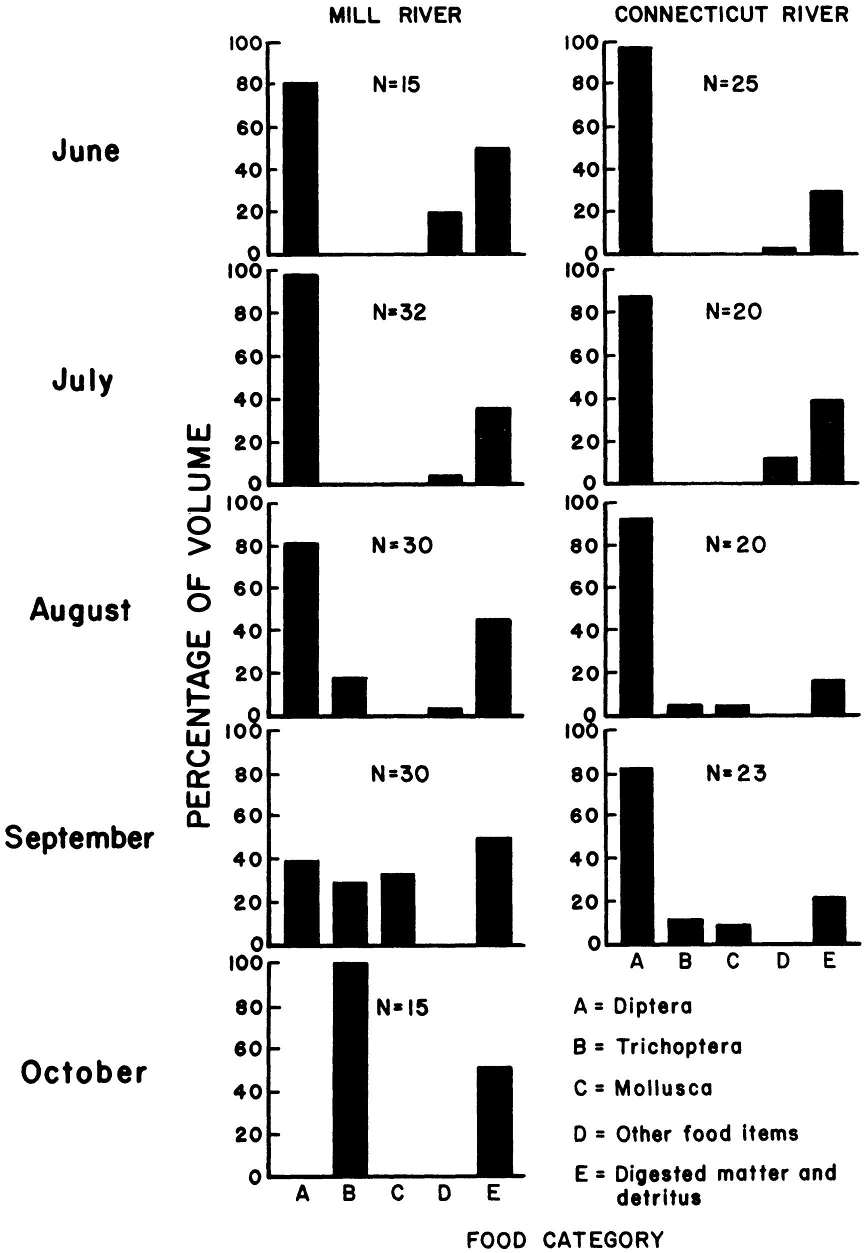

Fig. 1.—Seasonal food habits of the tessellated darter in the Mill and Connecticut rivers in 1970

slight increase in undigested food in the 0600-hr sample was a result of the presence of a few recently ingested larvae, indicating the initiation of feeding. The samples at 1200 and 1800 hr contained by far the largest percentage of undigested food. The 8 and 9 July samples appeared to be representative of feeding throughout the season. In other collections from the Mill River, made between 1800 and 1900 hr, the percentages of undigested food were similar to those in the 1800-hr sample of 8 July, ranging from 50 to 65%. Stomach contents from the Connecticut River, collected between 0900 and 1500 hr, contained 62-84% undigested food similar to the sample collected 9 July at 1200 hr.

Age and growth.—Raney and Lachner (1943) reported that in tessellated darters annuli form only in the anterior field and are identified by differences in the spacing of circuli. In addition to the criteria used by these authors to designate an annulus, we found that when growth resumes in the spring new radii often form or existing ones develop a break or curvature. This characteristic was useful in locating annuli on scales that did not show a clear differential spacing of the circuli. Although these new radii usually are associated with annulus formation, they are formed also at other times, particularly in late summer just before the autumn decline in growth rate. Therefore, new or deformed radii cannot be used as the sole criterion of an annulus.

Data for 603 fish from the five populations were combined to establish the following scale radius-total length (TL) relationship:

$$TL = 22.98 = 0.891\ SR$$

where SR = scale radius in mm (50X).

Growth data for fish from the main stem of the Connecticut River and the Holyoke Canal system are presented separately (Table 2) because of the significant difference between back-calculated lengths from the two areas at age I (t-test, males, $p < .001$; females, $p < .02$). This difference was present even though darters in the canal must originate from the main stem, because part of the river is diverted through the canal system and semiannual drawdowns for inspection and maintenance of hydroelectric facilities probably eliminate most fish in the canal.

TABLE 1.—Feeding periodicity of tessellated darters in the Mill River on 8 and 9 July 1970. The collection of 1800 hr was made on 8 July 1970, and the rest on 9 July

Time (hours)	Number of fish	Percentage of food volume identifiable
0000 - 0100	15	17
0600 - 0700	9	21
1200 - 1300	15	71
1800 - 1900	15	61

TABLE 2.—Back-calculated total length (mm) for tessellated darters in Massachusetts

			Male				Female		
	Age		Year of life				Year of life		
Area	group	No.	1	2	3	No.	1	2	3
Mill River, Amherst	I	22	42	....	....	39	43	....	....
	II	47	43	57	....	36	41	51	....
	III	3	46	58	67	1	45	55	64
Wading River, Mansfield	I	16	42	....	....	18	39	....	....
	II	34	43	56	....	28	41	53	....
	III	6	44	58	67	2	42	56	65
Swift River, New Salem	I	11	40	....	....	27	40	....	....
	II	16	41	56	....	19	40	55	....
	III	3	40	60	66	6	42	61	71
Connecticut River, Hatfield	I	40	45	....	....	35	45	....	....
	II	2	46	53	....	....	....	....	....
	III	....	....	....	....	....	....	....	....
Connecticut River, Holyoke Canal	I	24	48	....	....	41	46	....	....
	II	22	50	62	....	10	48	60	....
	III	2	54	70	80	....	....	....	....

The ages of darters collected ranged from I-III. Apparently few, if any, of the fish in the populations studied attained age IV; and only 23 (4.5%) of 510 fish aged had completed 3 years of life.

Back-calculated lengths at a given age varied considerably, and the lengths of fish of different age groups overlapped. For example, the length range of males from the Mill River was 35-55 mm at age I and 46-71 mm at age II. Raney and Lachner (1943) indicated similar variations within and between age groups. They also determined that males grew at a significantly faster rate than females. Although the difference was not significant, males grew faster than females in the five populations we studied (Table 2).

All five darter populations showed the reverse effect of Lee's Phenomenon in both sexes between most age groups (Table 2). Lee's Phenomenon is the occurrence of back-calculated lengths being smaller in older fish than they are in younger fish for the same years of life. The most likely cause of this phenomenon in tessellated darters is differential mortality favoring the survival of faster-growing individuals. Individual growth histories indicate that growth compensation did not occur. Fish, with total lengths below average at age I, were also smaller than average at age II.

The length distribution of tessellated darters, collected or seen in the Mill River in 1970, suggested that the young remain near the spawning area during much of their first growing season until they exceed 30 mm TL. In a section of Mill River 550 m long that had mostly a sand substrate and few submerged rocks or other objects suitable for spawning, and which contained the principal collection sites, we collected no darters less than 30 mm TL, nor saw any during underwater observations with a snorkel and face plate. Upstream from this area, where underwater objects suitable for spawning were numerous, we collected (by applying rotenone) 94 young-of-the-year, 20-46 mm long, on 27 August 1970. Numerous small darters had been observed previously throughout this upstream area. The significance of the observed distribution of small darters is unclear. Perhaps there is a greater tendency for dispersal of the faster-growing young. If this tendency persisted, it could explain the observed faster growth rates of the temporary adult population in the Holyoke Canal. Furthermore, if differential mortality favors the survival of faster-growing darters as we suggested, the tendency for dispersal of faster-growing fish may be related to their greater survival.

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