FEEDING BIOLOGY OF THE TESSELLATED DARTER

(*ETHEOSTOMA OLMSTEDI ATROMACULATUM*)

AT

TIVOLI NORTH BAY, HUDSON RIVER, NY

by

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Abstract

The feeding habits of tessellated darters were examined in Tivoli North Bay, Hudson River National Estuarine Research Reserve during July and August, 1986. The most significant food items were Chironomidae larvae, Cladocera, and Copepoda with a variety of invertebrates of lesser importance. The relative importance of the three major food items changed with increasing size of darters such that midges (Chironomidae) became more significant as darters grew.

Darters inhabiting the tidal marsh were almost all young of the year. Older individuals may be inhabiting the main Hudson River estuary during the summer. This possible movement of darters out of the marsh as they mature represents an export of biomass from the marshes to the main Hudson estuary.

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Introduction

The dominant species in the summer fish community in Tivoli North Bay includes tessellated darters (Schmidt, 1986). Their abundance suggests that they are significant to the ecosystem but little is known about the biology of the Hudson River populations.

Age, growth and feeding habits have been described (Tsai, 1972; Cole, 1967; Lavzer and Reed, 1978; Raney and Lachner, 1943). These studies, however, all examined populations of the subspecies E. o. olmstedi. The tessellated darters in the main Hudson River estuary are probably E. o. atromaculatum (Cole, 1967), a subspecies found in large tidal rivers, distinguished by the extent of scalation on the nape, cheek, breast, and belly. To our knowledge, there are no published studies on the biology of this latter subspecies.

The purposes of this study were to determine the subspecies status of the tessellated darter population in Tivoli North Bay and to elucidate its feeding habits.

Methods

Study Area

This study was done in Tivoli North Bay, a tidal freshwater marsh on the Hudson River Estuary (river mile 99), New York. Tivoli North Bay is part of the Hudson River National Estuarine Research Reserve and has been designated as an Experimental Ecological Reserve.

Tivoli North Bay is a high marsh dominated by narrowleaf cattail (Typha angustifolia). Stable winding channels are found throughout the marsh which, with a tidal range of about 1.2 m (4 feet), vary in depth from about 2.6-3 m (5-6 feet) at low tide to 3.1 m (10 feet). Substrates ranged from scoured clay in the main channels to deep silt in backwaters.

The site chosen for this study was in the shallow end of a channel leading out of a large pool in the middle of the marsh (Figure 1). The pool is virtually dry at low tide. The substrate is mucky on the channel margins and firmer clay in the center. Typical emergent vegetation in the vicinity was Arrow arum (Peltandra virginica), Arrowhead (Saggitaria sp.), Pickerelweed (Pontedaria cordata), Burr-marigold (Bidens sp.), Dotted smartweed (Polyganum sp.), and Narrowleaf cattail.

Prodecure

Sampling was done at or near low tide during the day. Fishes were collected with a 3/16-inch Ace knotless nylon mesh 3-m (10-ft) seine. Occasionally, when water levels were exceptionally high (after heavy rains), we used a 17.5-m (50-ft) bag seine with the same mesh. We collected approximately twice a week from July 6 through August 23, 1986. We collected until 20-25 specimens were captured on a given day. Darters were preserved in 10% formalin in the field.

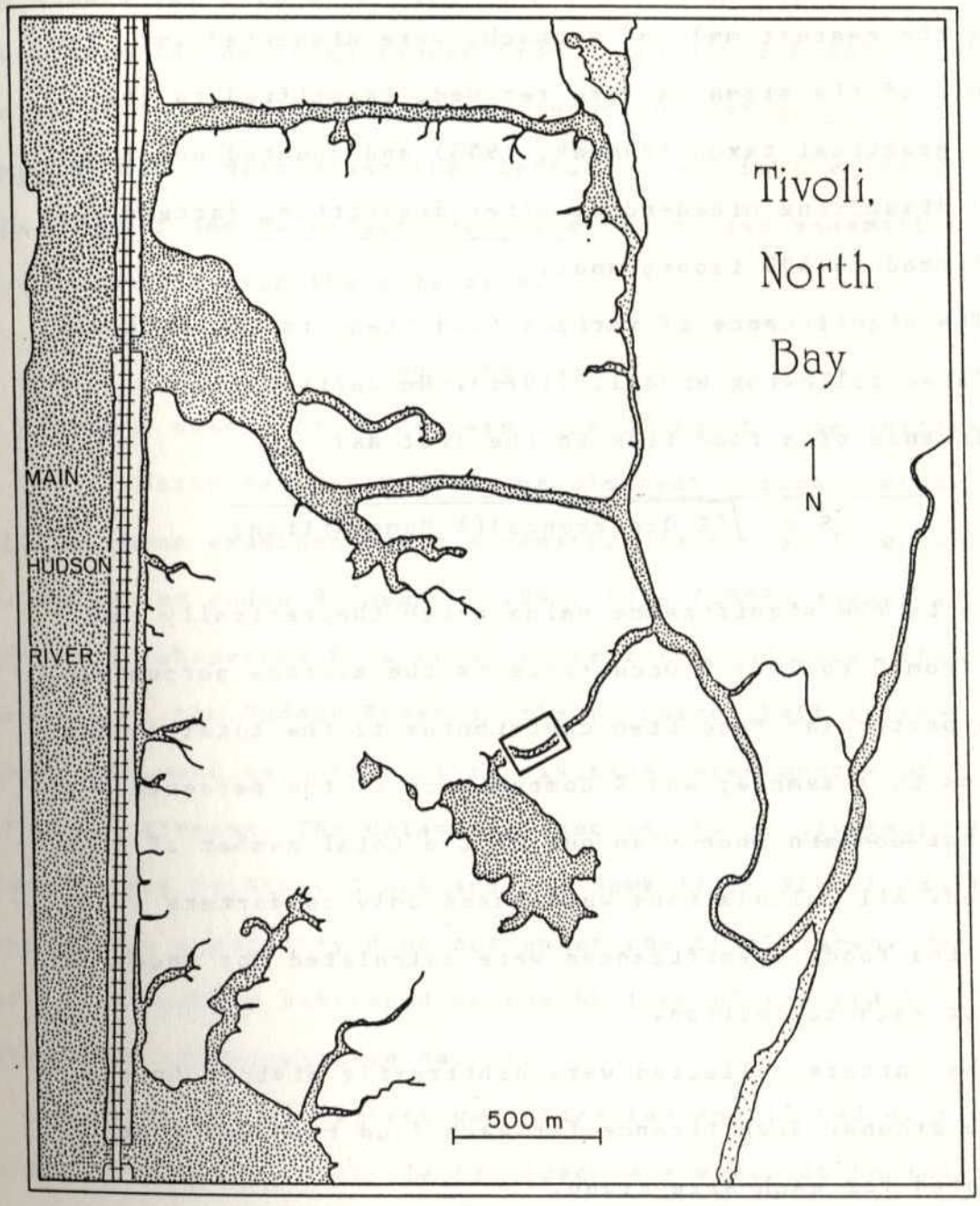

Figure 1. Sample area (outlined) in Tivoli North Bay, Hudson River, NY.

In the laboratory, darters were measured (total length, TL, to the nearest mm) and stomachs were dissected out. The contents of the stomachs were removed, identified to the lowest practical taxon (Pennak, 1953) and counted under a stereo dissecting microscope. After dissection, darters were transferred to 50% isopropanol.

The significance of various food items in the diet was calculated following Windell (1971). He defined the significance of a food item in the diet as:

$$S = \sqrt{(\%\ \text{Occurrence})(\%\ \text{Composition})}$$

where S is the significance value which theoretically can range from 0 to 100; % Occurrence is the average percentage that a particular food item contributes to the total number of items in a sample; and % Composition is the percentage of fish that contain that item out of the total number of fish examined. All calculations were based only on darters containing food. Significances were calculated for each food item for each collection.

The darters collected were arbitrarily divided into 5 mm size groups. Significance for each food item was then calculated for each size group.

The subspecies of the darters from Tivoli North Bay was determined following Cole (1967). The percent squamation (area covered by scales) of the nape, cheek, opercle, breast, and belly was visually estimated. Percent squamation

was summed for each individual and then coded into a squamation factor which ranged from 1 (total of 0-40%) to 10 (total of 450-500%). Cole (1967) reported that E. o. olmstedi had a mean squamation factor of 4.2 in the lower Hudson River and E. o. atromaculatum had a mean squamation factor of 9.37 from the same area.

Results

From a sample of 24 darters over 30 mm TL, the darters in Tivoli North Bay are Etheostoma olmstedi atromaculatum. All specimens examined had a squamation factor of 10 except one which was coded 8 (mean = 9.99). Cole (1967) suggested that this subspecies is a tidal river form, indicated its presence in the Hudson River as the northern limit of the subspecies, and said that it rarely penetrates mouths of tributary streams. The upland subspecies, E. o. olmstedi, is found nearby in Stony Creek and the Sawkill in Tivoli South Bay, but it apparently does not enter the tidal marsh. We know of no papers published on the biology of the tidal subspecies of tessellated darter.

A total of 243 darters was dissected and 13 had no food in their stomachs. These latter specimens were not included in the analyses. The darters were collected in 11 samples from July 7 through August 22, 1986. Between 18-25 darters were examined from each sample. Except for one individual (76 mm TL), all darters were in one age class (Figure 2).

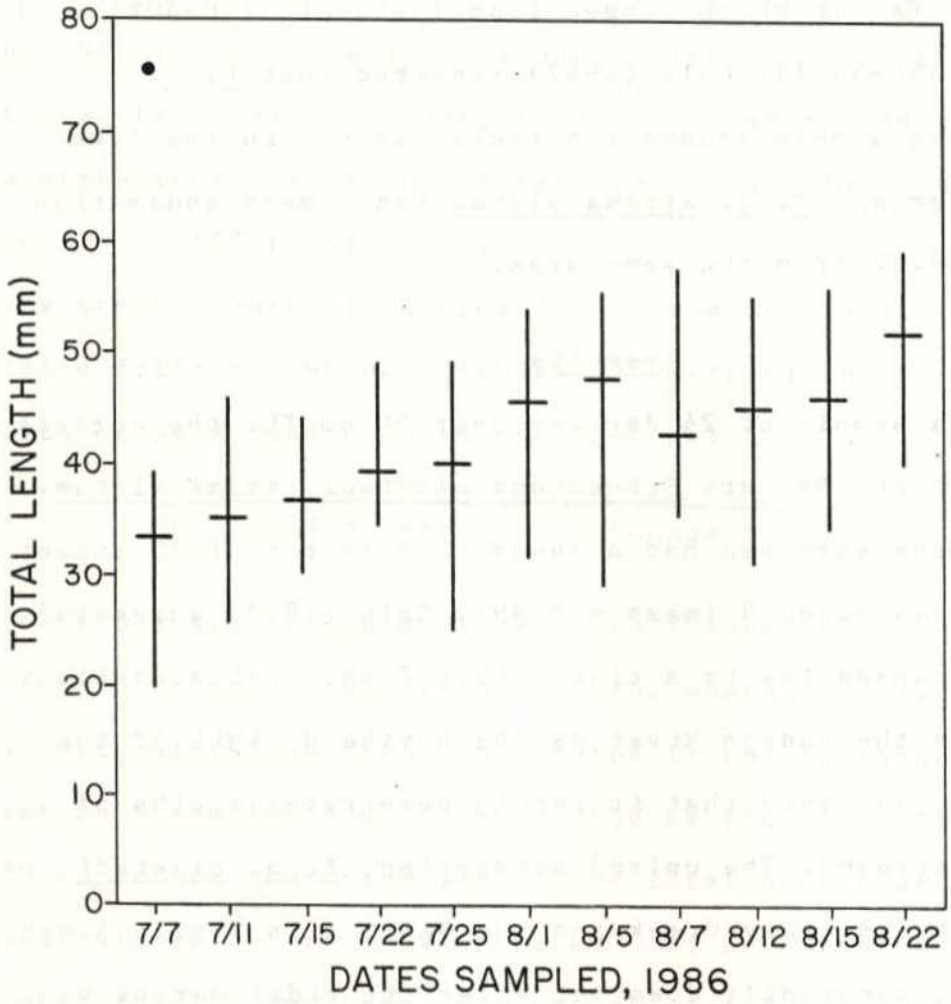

Figure 2. Mean (horizontal bar) and range (vertical bar) of total lengths of tessellated darters for each collection made in Tivoli North Bay, Hudson River, NY. One large specimen (the filled circle on July 7) was not included in the mean or in any of the analyses.

Schmidt (1986), using length frequency and scale annuli data on tessellated darters from the same locality, indicated that this age class is young of the year. As in Schmidt's (1986) study, few adults were encountered in the marsh in July and August.

E. o. atromaculatum from the Hudson River has a higher growth rate than E. o. olmstedi (Raney and Lachner, 1943; Tsai, 1972; Layzer and Reed, 1978). The Hudson River tidal subspecies attains a size at the end of the first summer equivalent to the upland subspecies at the end of its second summer.

Food items were lumped into 12 descriptive categories (Table 1). Four taxa were consistantly present in darters from all samples: Chironomidae, Copepoda, Cladocera, and Ostracoda. The ostracods had a generally low significance, but the other three taxa had significances greater than 20 at least some of the time. Layzer and Reed (1978) in one of the few papers written on the diet of tessellated darters reported that they fed primarily on chironomids in the summer. Their study concentrated on the upland subspecies in Massachusetts.

Plant material (filamentous green algae) appeared in over half of the stomachs examined but in small amounts compared to the invertebrates. We are inclined to believe that algae was swallowed incidentally and did not contribute to the nutrition of the darters.

Table 1. Significance values (Windell, 1971) of food items in the diet of Etheostoma olmstedi atromaculatum from Tivoli North Bay, New York. Food items are A= Chironomidae, B= Copepoda, C= Cladocera, D= Ostracoda, E= Isopoda, F= Trichoptera, G= chironomid pupae, H= Cirripedia, I= Amphipoda, J= Ceratopogonidae, K= Sphaeriidae, L= Oligochaeta, and M= total fish examined.

Date	Food Items												
1986	A	B	C	D	E	F	G	H	I	J	K	L	M
7/7	73	22	34	7	2	1						5	22
7/11	58	68	26	10				2					19
7/15	80	23	35	19		2	2		1				21
7/22	66	63	18	4			3		9	3			21
7/25	50	76	20	8			1		2	2			20
8/1	91	12	11	9	2	2			3	3			18
8/5	84	7	10	10		3			14		3		22
8/7	84	37	11	16		1	2		8	4			24
8/12	69	44	13	14		2	2		12	2			17
8/15	81	23	16	15		<1	1		12	13			22
8/22	88	22	6	8			2		17	6			20

The importance of chironomids, cladocerans, and copepods changed relative to size of the fish (Figure 3). The significance of chironomids increased with increasing fish size and copepods and cladocerans became less important. This phenomenon is probably related to the increased ability of larger darters to handle the larger individual chironomids. Amphipods increased in significance in the latter part of the summer (Table 1), probably also because of increased size of darters and consequent increased ability of the fish to handle larger food items.

Discussion

Schmidt (1986) considered the tessellated darter as one of the dominant species in Tivoli North Bay because of its numerical abundance and consistant occurrence in seine collections. This study suggests that the role that darters play in the marsh ecosystem is converting benthic and planktonic invertebrate biomass to fish biomass. This may be a significant process to the Hudson River since the darters do not remain in the marsh but apparently spend much of the year in the main estuary. Few data are available on the ecology of tessellated darters in the Hudson estuary, but we hypothesize that they are an important link in the food web because of their small size and abundance. Thus this species may be an important link between invertebrate productivity in the marsh and fish biomass in the Hudson estuary.

Within the marsh, darters are most frequently

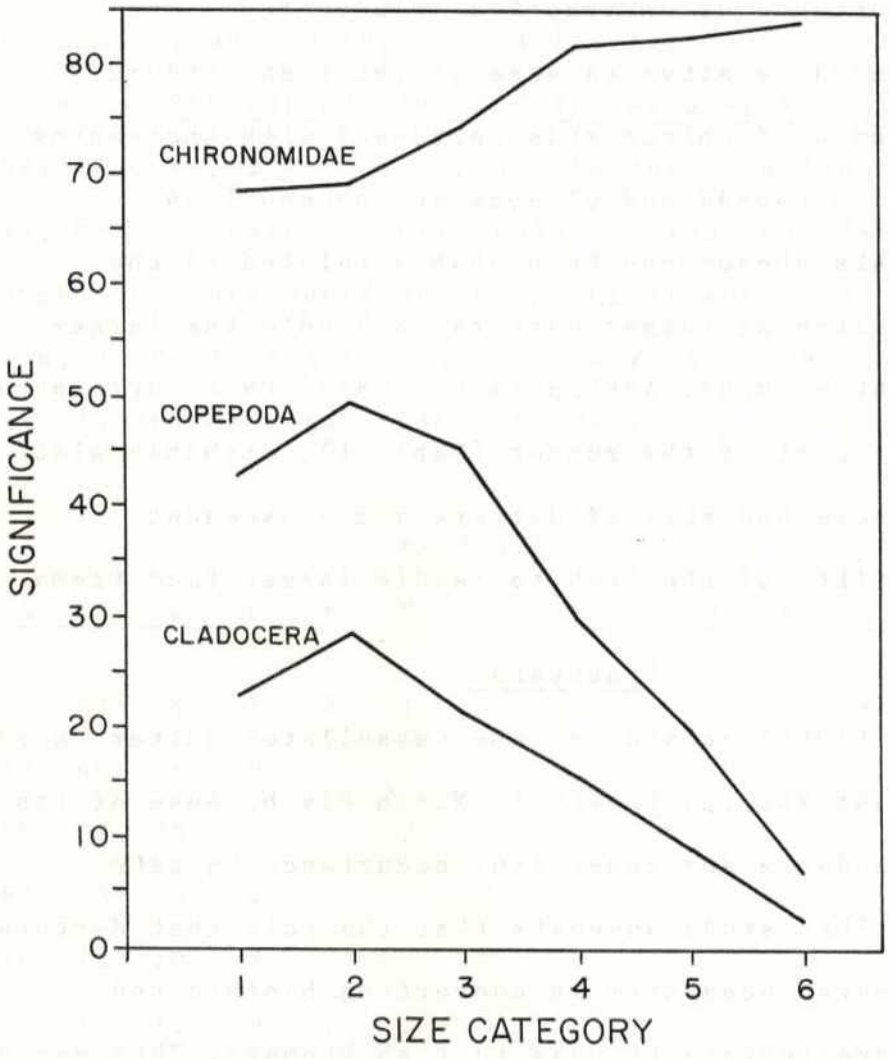

Figure 3. Significance (Windell, 1971) of three invertebrate taxa in the diet of tessellated darters from Tivoli North Bay, Hudson River, NY. Size categories of darters are (mm TL): 1= 28-32, 2= 33-37, 3= 38-42, 4= 43-47, 5= 48-52, and 6= 53-57.

encountered in the shallow channel margins usually associated with silty substrates. They are considered sight feeders (Layzer and Reed, 1978) and aquarium observations support this idea. The organisms we found in darter stomachs are consistant with visual feeding. The chironomids are sediment surface dwellers and even the Trichoptera observed (Leptoceriidae) are swimming forms.

Tessellated darters are not the only species found in the channel margins and it would be interesting to investigate possible feeding overlap that may occur in this habitat. We suggest that the chironomid, cladoceran, and copepod biomass is very large and that tessellated darter feeding habits are very similar to other fishes in the same habitat.

Conclusions

Given the abundance of tessellated darters in the Tivoli Bay freshwater tidal marsh (Schmidt, 1986), their feeding habits must affect the marsh ecosystem. Cladoceran, copepod, and chironomid biomass is being converted to darter biomass within the marsh channel margins. This darter biomass, in turn, is exported from the marsh when darters leave (presumably for the main Hudson River) in the fall.

Recommendations

We need to know much more about the biology of this important Hudson River species. Studies designed to measure

the export of darter biomass from the marsh to the main estuary would be especially valuable in light of the data presented here. Another research topic would be to document the entire life cycle of this poorly studied subspecies.

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