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Sexual Dietary Differences in a Population of *Trionyx muticus*

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ABSTRACT—The stomachs of 105 *Trionyx muticus* contained mainly various invertebrates (primarily insects), fruits, and fish carrion. The diet of males was more diverse and was significantly different from that of females. About 71% by volume of the prey of females was aquatic items (especially *Hydropsyche* larvae), whereas about 67% of the prey of males was terrestrial items. No significant relationship could be found between comparisons of prey size and turtle size and of prey size and sex of turtle.

Sexual differences in diet are related to different microhabitat preferences. Females forage primarily in stable microhabitats in deep water whereas males forage at the shallower interface between terrestrial and aquatic environments.

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INTRODUCTION

In reptiles the most frequently reported intraspecific niche dimension that separates age classes is food type (Schoener, 1977). In freshwater turtles females of many species are larger than males (Ernst and Barbour, 1972), but the reported intrapopulational dietary differences have been related to differences in body size (= different ages) (Mahmoud, 1968; Clark and Gibbons, 1969; Moll, 1976; Dalrymple, 1977) as opposed to strict sexual differences at similar ages. The explanations offered for these differences include the possible different dietary requirements of the various age classes (Clark and Gibbons, 1969) and to the need for large predators to generalize more in their diet because of the relative rarity of large prey (Schoener, 1977).

We examined the stomach contents of *Trionyx muticus* from a population inhabiting the Kansas River near Lawrence, Douglas County, Kansas, and studied diet in relation to body size and sex. Mature males in this population are smaller (Plummer, 1977a) and prefer different microhabitats (Plummer, 1977b) than mature females.

METHODS

Turtles (51 males; 54 females) were collected from May through September in 1973 and in 1974. The monthly distribution of captured males (females) was 7(4), 18(21), 10(11), 8(11), 8(7), respectively. Turtles were killed immediately and preserved in 10% formalin and stored in 50% isopropyl alcohol. Stomachs were removed, tagged, and stored in alcohol. Volumes of stomach contents were measured by volumetric displacement in a narrow-necked graduated cylinder. Stomach contents were sorted, identified and counted. For stomachs with large numbers of cottonwood seeds or trichopterans an estimated 50% by volume of the items were counted and then doubled in order to obtain the total number. Approximate percentage composition by volume of each prey item category in each stomach was estimated by visual inspection (Pianka and Pianka, 1976). Foraging behavior of turtles in shallow water was observed through binoculars from a blind. One meter-square plots in shallow water near sandbars were dredged to a depth of approximately 10 cm and sifted in search for potential aquatic prey items.

Shannon-Wiener diversity indices were calculated using percent of total volume of prey items. All statistical tests follow Sokal and Rohlf (1969).

RESULTS

Turtles appeared to be primarily active, aquatic, visual predators but perhaps olfactory as well as tactile senses were involved in locating prey. They were observed feeding on floating cottonwood seeds, investigating small floating and submersed objects and frequently rooting in the substrate with their attenuate snouts. Inanimate objects such as small pieces of wood were taken in to the mouth and then expelled. Turtles were occasionally observed feeding on dead fish near the shoreline on sandbars or in shallow water.

Stomach contents of male and female *T. muticus* are summarized in Table 1. Ranked numbers of prey items found in males and females are uncorrelated ($\rho = .29$, $P > .05$, Spearman rank correlation) and the proportions are highly dependent upon sex ($G = 1286.7$, $P < .001$, $R \times C$ test of independence). A few items are represented by large numbers and/or volumes, and many are items with small representation. Notable among the former are large nos./volumes of trichopteran larvae and pupae, coleopterans, adult dipterans, fish, mulberries and cottonwood seeds. Most, if not all, fish probably were ingested as carrion. No fins or cranial bones were found in stomachs. The sizes of fish scales and vertebral centra (both >5 mm in diameter), and ribs in stomachs suggest that portions of large fish were ingested. Trichopterans (mostly *Hydropsyche*), which constituted about 63% of all prey items and were found in 62% of all stomachs examined, were common in stomachs throughout the season as were terrestrial coleopterans and dipterans. Fruits were more seasonal in the diet, cottonwood seeds occurred from mid-May through mid-August and peaked in early June, and mulberries occurred from early June through early August. The comprehensive food list is similar to that of Webb (1962) who examined stomach contents of 11 *T. muticus* from the same population but did not separate the sexes.

An examination of Table 1 suggests that males feed on a greater proportion of terrestrial items than do females. The data in Table 2 confirm this difference. Males eat a wide variety of terrestrial prey and occasionally gorge on such typically shoreline animals as heterocerid beetles. The only aquatic group eaten substantially more by males than by females are the corixids and notonectids (Table 1), which typically inhabit calm water near the shoreline. Male diets are more diverse than those of females and their stomachs contain more unidentifiable material (Table 1).

In comparisons of males and male-sized (small) females, males and large females, and males and all females according to the volume of the largest prey item and to the mean volume of the five largest prey items in each stomach, all t-values were insignificant ($P > .05$). Also insignificant were correlations between plastron length and maximum prey volume ($r = -.04$, $P > .05$) and between plastron length and mean volume of the five largest prey items ($r = .10$, $P > .05$). In these comparisons carrion categories (fish, mammals) were deleted from the analyses.

Dredging was discontinued after 15 plots were sampled because no living macroscopic animals were found.

DISCUSSION

Although male and female *T. muticus* are both aquatic predators, the sexes have significantly different diets. Males rely primarily on terrestrial prey, whereas females rely primarily on aquatic prey. Substrate samples in shallow water were devoid of prey items perhaps due to the moderate to high water velocity which continuously scours the sandy substrate. Donald G. Huggins (pers. comm.) found that trichopterans at this locality are clumped on submerged logs and other such stable substrates. Such microhabitats are relatively scarce and widely distributed. However,

TABLE 1. Stomach contents of *Trionyx muticus*: Total number, frequency of occurrence, percent of total number, and percent of total volume of prey items.

Prey category	Habitat[1]	Males (n=51) No.	Frequency	% no.	% volume	Females (n=54) No.	Frequency	% no.	% volume
Ephemeroptera									
larvae, pupae	A	27	13.7	1.39	.58	59	28.3	2.29	1.92
Odonata									
larvae	A	3	5.9	.15	.51	4	7.5	.16	.26
adults	T	5	5.9	.26	.80	2	3.8	.07	.14
Orthoptera	T	2	3.9	.10	.71	2	3.8	.07	.19
Isoptera	T	1	2.0	.05	<.01	0	0	0	0
Plecoptera									
larvae	A	1	2.0	.05	.09	7	7.5	.27	.09
Hemiptera	T	12	13.7	.62	.52	0	0	0	0
corixids and notonectids	A	9	17.6	.46	.03	2	1.9	.07	.02
Homoptera	T	12	9.8	.62	.21	6	9.4	.23	.05
Coleoptera	T	206	52.9	10.60	4.23	17	18.9	.65	2.27
Neuroptera	T	0	0	0	0	2	3.8	.07	.03
Trichoptera									
larvae, pupae	A	483	51.0	24.80	7.55	2340	71.7	90.70	43.73
adults	T	73	19.6	3.76	2.86	6	5.7	.23	.03
Lepidoptera	T	9	13.7	.46	1.18	6	9.4	.23	.54
Diptera	T	67	41.2	3.45	5.35	18	17.0	.70	.13
chironomid larvae	A	72	7.8	3.71	.96	35	3.8	1.32	.06
Hymenoptera	T	28	27.5	1.44	.77	7	7.5	.27	.02
Isopoda	A	0	0	0	0	1	1.9	.04	.01
Decapoda	A	1	2.0	.05	<.01	7	13.2	.27	4.90
Diplopoda	T	0	0	0	0	1	1.9	.04	.01
Araneae	T	0	0	0	0	1	1.9	.04	.11
Mollusca	?	1	2.0	.05	<.01	5	9.4	.19	.24
Fish	A	3	5.9	.15	1.65	9	15.1	.36	20.11
Mammalia	T	1	2.0	.05	1.10	0	0	0	0
Mulberries	T	48	23.5	2.47	34.31	28	5.7	1.09	16.29
Cottonwood seeds	T	892	27.5	45.65	15.28	33	7.5	1.27	.69
Miscellaneous[2]	—	—	52.9	—	21.29	—	30.2	—	8.16
Diversity index			H′ = 2.00				H′ = 1.65		

[1]aquatic or terrestrial
[2]unidentified chitin fragments, vegetation, rocks, sand

TABLE 2. Stomach contents of *T. muticus*: Percent volume (number) of terrestrial and aquatic prey items in males, in all females,in male-sized (small) females and in large females. The undetermined category was deleted from the numerical analysis because "number of items" was not meaningful. Considering the numerical analysis: males vs. all females ($G = 243.71$, $P < .001$); males vs. small females ($G = 179.41$, $P < .001$); males vs. large females ($G = 180.16$, $P < .001$); small females vs. large females ($G = 7.34$, $P < .05$).

Food type	Males (n=51)	All females (n=54)	Small females (n=17)	Large females (n=37)
Terrestrial	67.3 (69.8)	20.0 (5.0)	7.8 (2.1)	22.5 (5.7)
Aquatic	11.4 (30.2)	71.1 (95.0)	88.0 (97.9)	68.6 (94.3)
Undetermined	21.3	8.9	4.2	8.9

trichopterans apparently attain high densities at these sites judging from the large quantities found in stomachs of females.

In a study of diet and the feeding apparatus of *T. ferox,* Dalrymple (1977) concluded that much of the great variation in both parameters could be accounted for by size of turtle alone. In all North

TABLE 3. Stomach contents of 17 male-sized female (<120 mm PL) *T. muticus*: Total number, frequency of occurrence, percent of total number, and percent of total volume of prey items.

Prey category	Habitat[1]	No.	Frequency	% no.	% volume
Ephemeroptera					
larvae, pupae	A	45	29.4	4.62	2.91
Odonata					
larvae	A	1	5.9	.10	.02
adults	T	1	5.9	.10	.17
Orthoptera	T	1	5.9	.10	.93
Plecoptera					
larvae	A	1	5.9	.10	.14
Hemiptera					
corixids and notonectids	A	2	5.9	.21	.01
Homoptera	T	3	17.6	.31	.23
Coleoptera	T	2	11.8	.21	.14
Trichoptera					
larvae, pupae	A	867	76.5	89.11	62.80
adults	T	1	5.9	.10	.01
Lepidoptera	T	1	5.9	.10	.02
Diptera	T	2	5.9	.21	.12
chironomid larvae	A	34	5.9	3.49	.24
Hymenoptera	T	5	17.6	.51	.11
Decapoda	A	3	17.6	.31	21.95
Mulberries	T	4	11.8	.41	5.98
Miscellaneous[2]	—	—	23.5	—	4.21
Diversity index			$H' = 1.15$		

[1]aquatic or terrestrial
[2]unidentified chitin fragments, vegetation, rocks, sand

American species of *Trionyx*, females are larger than males (Webb, 1962). In our population of *T. muticus* the mean plastron length of mature males is about 64% that of females because of sexually different growth patterns (Plummer, 1977a). If sexual differences in diet were primarily due to size differences then male-sized females ought to have diets similar to those of males. However, male diet is significantly different from the diet of male-sized females (Table 3, $G = 683.8$, $P < .001$, $R \times C$ test of independence; Table 2). Small females seemed more inclined to take aquatic prey than large females except that small females did not eat as much fish. A similar ontogenetic shift to fish-eating occurs in *T. ferox* (Dalrymple, 1977).

Because optimal prey size for large animals is greater than that for small animals (Schoener, 1977), females may select larger prey which fortuitously are in different taxa than the prey of males. The insignificant correlation coefficients between plastron length and the two measures of prey size suggest, however, that this is not the case. In both correlations less than 1% of the variation in prey size is explained by body size of turtles. This analysis assumes isometric growth of the feeding apparatus and plastron length, a relationship found to be true in at least some *Trionyx* spp. (Dalrymple, 1977). Additionally, mean prey sizes of males, small females and large females are not significantly different. It appears that large turtles, as highly mobile predators (MacArthur and Pianka, 1966), can afford to seek small prey when such prey are abundant and spatially and temporally predictable (such as trichopterans). However, the shift to fish-eating in large females suggests that search and/or handling time involved with large numbers of small prey becomes a cost factor. Cahn (1937) indicated that living fish were caught and ingested by *T. muticus* in Illinois.

The present analysis suggests that sexual differences in diet exist but are unrelated to size dimorphism. Rather, these differences are correlated with sexual differences in habitat selection. Plummer (1977b) and Plummer and Shirer (1975) documented that males prefer the shallow water near emergent sandbars and are less mobile, whereas females prefer deeper water associated with steep mud banks, are highly mobile, and spend more time in open water. Intersexual dietary differences might follow from such habitat separation. Both sexes probably feed in a "fine-grained" manner (*sensu* MacArthur and Levins, 1964), females forage primarily in stable microhabitats in deep water and males forage at the shallower interface between terrestrial and aquatic environments. Whether different sexual dietary preferences are a result of different habitat selection patterns, or perhaps vice versa is unknown. Microhabitat difference is the most frequently reported niche dimension that separates the sexes in reptiles (Schoener, 1977).

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