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Dietary Notes on the Red-eared Slider (*Trachemys scripta*) and River Cooter (*Pseudemys concinna*) from Southern Illinois

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ABSTRACT

The primary focus of this study was to ascertain the presence of sexual, seasonal, or ontogenetic differences in the diets of *Trachemys scripta* and *Pseudemys concinna* captured at Round Pond, Gallatin County, Illinois, between 17 May 1994 and 30 August 1995. I collected feces from *T. scripta* and *P. concinna* and separated the contents into eleven dietary categories for *T. scripta* and two for *P. concinna*. I quantified fecal volume by water cc displacement, then described each dietary category by frequency of occurrence, percent volume, and relative percent volume. Juvenile *T. scripta* fecal contents comprised >70% plant matter, while adult males and females had equal proportions of plant and animal matter in their feces. Percent volume and relative percent volume for *T. scripta* fecal samples did not differ between males and females, or between females and juveniles; however, I detected significant differences between males and juveniles and early (May-June) and late (July-August) samples. Overall the diversity of food items in the diet of *T. scripta* was large (Shannon index = 2.50) and the diversity of items expanded from early (Shannon index = 1.19) to late season (Shannon index = 2.72). Females consumed more mollusks than males, and males and females consumed more bryozoans than juveniles. I found Mollusks and bryozoans only in late season samples. *Pseudemys concinna* was herbivorous, specializing on epiphytic filamentous algae of the genera *Cladophora* and *Oedogonium,* with no differences in the frequencies of occurrence between males, females, and juveniles.

Keywords. *Trachemys scripta, Pseudemys concinna*, feeding biology, ontogenetic shift, seasonal shift.

INTRODUCTION

Research on feeding ecology elucidates how an organism meets its bio-energetic demands and allows insight into feeding niches. The primary focus of this study was to determine if there are any sexual, seasonal, or ontogenetic differences in the diets of *T. scripta* and *P. concinna*. Two types of dietary shift may occur during an organism's life, ontogenetic and seasonal. Ontogenetic dietary shifts have been described for three species of North American freshwater turtles: *Graptemys pseudogeographica* (Moll, 1976), *Chrysemys picta* (Marchand, 1942; Moll, 1977), and *Trachemys scripta* (Minyard, 1947; Cagle, 1950; Clark and Gibbons, 1969; Moll and Legler, 1971; Moll, 1977; Hart, 1983). Juvenile turtles tend to consume small invertebrates and adults meet their metabolic demands by consuming readily available plant material (Marchand, 1942; Parmenter, 1980); further, such size-based shifts in prey size have been described for kinosternid species (Mahmoud, 1968), *Emydura kreftii* (Georges, 1982), and *Hydromedusa maximiliani* (Souza and Shinya, 1998). There are few reports of seasonal dietary shifts. In Belize, Moll (1990) found that *Kinosternon leucostomum* and *K. scorpioides* became more specialized as the season progressed and *Staurotypus triporcatus* became more generalized despite no change in abundance of potential prey; thus, these seasonal dietary shifts remain unexplained. However, the diet of *S. triporcatus* shifted to include the consumption of more *Kinosternon* species as *Kinosternon* species abundance increased during the season. Moll (1990) suggested that *S. triporcatus* is an opportunistic predator of other turtles, encountering and consuming more turtles in the later, drier seasons. First-year *T. scripta* decreased in carnivory through the summer in three ponds located on the Savannah River Plant site, Aiken, South Carolina (Clark and Gibbons, 1969). The investigators hypothesized that insects were either more difficult to capture or less abundant later in the summer, or easily obtainable plant matter met dietary requirements.

The red-eared slider, *Trachemys scripta*, is reported to be an opportunistic omnivore (see Moll and Legler, 1971; Moll, 1990 for reviews) and the river cooter, *Pseudemys concinna*, is mainly herbivorous but juveniles occasionally consume crayfish (Buhlmann and Vaughan, 1991; Marchand, 1942; Thomas et al., 1994). I report on the diets of *T. scripta* and *P. concinna* captured during a long-term mark-recapture program of the latter.

MATERIAL AND METHODS

<u>Study Site</u>

Located about 4 km west of the Ohio River, Round Pond is a relatively small member (ca. 30 ha) of a chain of floodplain lakes in southeastern Gallatin County, Illinois. During annual spring floods these lakes connect, directly or through a system of sloughs, to the Ohio River. Small cabins and trailers occupy the west shoreline, a man-made beach encompasses the southern shore, and the remaining shoreline is bordered by floodplain forest. Several shallow coves less than 1.5 m deep contain numerous basking sites (fallen trees).

<u>Data Collection</u>

I collected data at Round Pond between 17 May 1994 and 30 August 1995. I captured turtles by hand, fyke net, baited hoop trap, dip net, and trammel net and released them onsite. I held approximately fifteen individuals in buckets, in shallow water to retain feces, each night then released them the next day regardless of whether they had defecated. Although fecal samples may be biased because of differential digestion of prey items, most soft tissues may be fully digested leaving little or no trace in the feces, I used them over stomach flushing because 1) *Pseudemys concinna* is listed as state endangered in Illinois by the Illinois Endangered Species Protection Board of the Illinois Department of Natural Resources, and stomach flushing is occasionally fatal, 2) to maintain comparability between the species, I had to take fecal samples from *Trachemys scripta,* and 3) fecal samples indicate dietary items consumed over a longer period than stomach samples. I sieved individual fecal samples, then preserved them in 10% formalin. I identified the fecal contents under an ocular light or dissecting microscope, depending on size, separated the contents into food categories, and quantified the volume of food categories by water displacement in cc's (Moll and Legler, 1971). I grouped food items into eleven categories: 1) nuts, seeds, and fruits (NSF); 2) leaves, stems, roots, and bark (LSRB); 3) vascular plant material (predominately aquatic grasses); 4) algae; 5) miscellaneous plant material; 6) insects; 7) crustaceans; 8) mollusks; 9) fish; 10) bryozoans; and 11) unidentified material and detritus.

Data Analysis

Dietary categories are presented by:

$$\text{Frequency of Occurrence} = \frac{\text{Number of individuals with diet category x}}{\text{Number of individuals sampled}}$$

$$\text{Percent Volume} = \frac{\Sigma \text{ of the volume (cc) of diet category x over all individuals}}{\Sigma \text{ of the volume (cc) of all diet categories over all individuals}}$$

$$\text{Percent Relative Volume} = \frac{\Sigma \text{ (individual relative volumes) of diet category x}}{\Sigma \text{ of the relative volume of all dietary categories}}$$

where:

$$\text{individual relative volume} = \frac{\text{Percent volume of diet category x for individual n}}{\text{CL of individual n}}$$

I pooled comparison groups for *Trachemys scripta* and *Pseudemys concinna* across years because of small sample sizes, then I partitioned the samples by species into three age/sex categories: males, females and juveniles. I then partitioned the total *T. scripta* data set into early (May-June) and late seasons (July-August). Because of small sample sizes, I could not analyze seasonal variation in the fecal contents of *P. concinna*. I analyzed frequency of occurrence data for sex/age using Kruskal-Wallis H-tests and seasonal data for *T. scripta* using a Mann-Whitney U-test. Because percent volume and relative percent volume data were scaled to one, I used two-sample Kolmogorov-Smirnov cumulative probability tests; however, again due to small sample sizes, I could not analyze *P. concinna* in a similar manner. I set all nominal alpha values at 0.05, and analyzed all data in SPSS for Windows ver. 6.1® or in Microsoft Excel® spreadsheets. I calculated niche breadth using Shannon's H' (Shannon, 1949).

RESULTS

Trachemys scripta

I analyzed a total of 27 fecal samples (13 female, 6 juvenile, and 8 male). I collected seven during May-June (early) and 20 during July-August (late). Plant material made up >40% of the total relative volume of feces in male and female *T. scripta* and >70% in juveniles; the relative volume of animal matter was approximately the same for sexes (Table 1). There was no significant difference in the frequency of occurrence of dietary categories among sex/age grouping ($\chi^2 = 0.048$, d.f. = 2, p = 0.9763). Juvenile percent volume and percent relative volume of fecal contents were significantly different from those of males (percent volume: $D_{max} = 0.666$, $0.05 > p > 0.01$, $n_1 = 11$, $n_2 = 11$; percent relative volume: $D_{max} = 0.679$, $0.05>p>0.01$, $n_1 = 11$, $n_2 = 11$) but not from those of females (percent volume: $D_{max} = 0.560$, $p > 0.05$, $n_1 = 11$, $n_2 = 11$; percent relative volume: $D_{max} = 0.467$, $p > 0.05$, $n_1 = 11$, $n_2 = 11$). The higher percent relative volume of LSRB markedly increased the total percent relative volume of plant material in juvenile feces. Juvenile feces never contained bryozoans. Male percent volume and percent relative volume of fecal contents did not differ significantly from those of females (percent volume: $D_{max} = 0.166$, $p > 0.05$, $n_1 = 11$, $n_2 = 11$; percent relative volume: $D_{max} = 0.185$, $p > 0.05$, $n_1 = 11$, $n_2 = 11$); however, there were a few noteworthy qualitative differences. Bryozoans and aquatic grasses predominated in the feces of males. Female feces contained slightly more bryozoans and mollusks, and lesser amounts of aquatic grasses (Table 1).

The niche breadth of *T. scripta* at Round Pond was 2.5 and expanded from early (H'=1.19) to late season (H'=2.72). The expansion was accompanied by a non-significant difference in frequency of occurrence of dietary items (U = 34, $n_1 = 11$, $n_2 = 11$, z = -1.759, p = 0.0785), and a significant seasonal difference in percent volume ($D_{max} = 0.8366$, $0.01> p > 0.001$, $n_1 = 11$, $n_2 = 11$) and relative percent volume ($D_{max} = 0.827$, $0.01> p > 0.001$, $n_1 = 11$, $n_2 = 11$). Early in the season, feces contained more LSRB, and later, more bryozoans and aquatic grasses (Table 1).

Pseudemys concinna

I collected 16 fecal samples, four males, six females, and six juveniles. Because it was impossible to separate algal species from each other and from *Sagitaria* for volumetric analyses, I could only use two categories, aquatic grasses, and *Sagitaria* and algae (Lower Plants) in the analysis. I expressed data as frequency of occurrence and percent volume. Lower plants comprised 98% of the fecal volume of *P. concinna* sampled (Table 2). Filamentous algae of the genera *Cladophora* and *Oedogonium* predominated the samples (Table 2). The numerous species of unicellular algae and diatoms present, though probably eaten incidentally along with algal mats, may have nutritive value. Feces of only two juveniles and one female contained aquatic grasses (Table 2). Frequency of occurrence data did not differ significantly ($\chi^2 = 0.4795$, d.f. = 2, p = 0.7868) among age/sex categories and *P. concinna*'s niche breadth was 0.14.

DISCUSSION

Trachemys scripta

Data for adults are somewhat different from those of other reports in that both sexes consumed approximately equal amounts of plant and animal matter and the diets of juveniles contained over 70% plant matter. Illinois specimens collected in July contained equal amounts of fish and plant matter (Smith, 1961). Cahn (1937) reported that Illinois *T. scripta* consumed amphibians, mollusks, crustaceans, insects, fish, and plant material. In Reelfoot Lake, Tennessee, *T. scripta* stomachs contained mostly plant matter (Parker, 1939). Range-wide, much of the data supporting *T. scripta*'s carnivorous habits are based on captive individuals (Carr, 1952). Diets of adults from Florida were reported to consist of 89% plant matter and 9% animal matter and diets of immatures 30% plant matter and 52% animal matter (Marchand, 1942). In the Neotropics *T. scripta* adults and juveniles consumed similar proportions of plant matter (Moll and Legler, 1971).

Juveniles are reported as carnivorous (reviewed by Moll and Legler, 1971). However, at Round Pond, feces of juveniles lacked bryozoans and fish but contained large amounts of nuts, seeds and fruits, and insects, as Parker (1939) reported at Reelfoot Lake, Tennessee. Juvenile *T. scripta* on the Savannah River Site, Aiken, South Carolina, had a more varied and carnivorous diet than adults. Moreover carnivory, specifically insectivory, decreased in first-year turtles during the summer (Clark and Gibbons, 1969). They attributed the decrease in insectivory to a decreased abundance of insects, greater difficulty in obtaining insects later in the season, or the satisfaction of nutritional requirements with plant matter alone (Clark and Gibbons, 1969). A Louisiana population exhibited a gradual shift from carnivory to herbivory as individual size increased, and this dietary shift with size paralleled a habitat shift related to body size (Hart, 1983). Because of sample size limitations the effects, if any, of season on the diet of Round Pond *T. scripta* age/sex categories remain unresolved. Moll and Legler (1971) found a similar proportion of insect matter (16.3%) and a lack of fish in the stomachs of neotropical *T. scripta*. Moll (1990) found juvenile *T. scripta* at Chan Chen, Belize, to be almost entirely insectivorous.

Although diets of adult males and females in Illinois were not significantly different, there are some apparent qualitative differences. The feces of only females contained mollusks and then only after the nesting season (July and August). In contrast, in the Neotropics, Moll and Legler (1971) found consumption of gastropods greatest before nesting. They hypothesized that females in this way acquired calcium for egg production. Females in temperate regions may lack the time required to acquire calcium before nesting. Instead, they may mobilize calcium from their skeletons, then replace the calcium when mollusks are at higher abundance.

The proportion of leaves, stems, roots and bark (LSRB), algae, and bryozoans consumed varied between seasons. The increased consumption of bryozoans later in the year may indicate anticipated energetic demands of hibernation. Early in the year, LSRB composed 74% of the fecal volume, whereas later LSRB accounted for 9% of the fecal volume. Although a population of *T. s. elegans* inhabiting a roadside ditch was reported to subsist on leaves alone (Cagle, 1950), the majority of the LSRB samples in this study consisted of roots and bark. Because bryozoans and algae found in the feces were epiphytic, this dietary category might be considered incidentally consumed; however, when bryozoan intake was highest, proportional intake of LSRB was lowest, suggesting the more credible alternative that *T. scripta* at Round Pond cue on substrates such as submerged logs and rocks even when bryozoan and algal epiphytes are not at peak abundance. My data indicate dietary shifts; however, further analysis and more data need to be collected on the periodicity, timing and composition of the shifts.

<u>*Pseudemys concinna*</u>

At Round Pond, *P. concinna* specialized on filamentous algae, which also predominated in the diets of cooter populations in Florida (Lagueux et al., 1995), Missouri (Thomas et al., 1994), and North Carolina (Brimley, 1943; in Ernst et al., 1994). New River, West Virginia, cooters consumed filamentous algae until macrophytes appeared in the spring (Buhlmann and Vaughan, 1991). Studies throughout the range of *P. concinna* show it to be chiefly herbivorous (Allen, 1938; Parker, 1939; Marchand, 1942; and Lagueux et al., 1995) and are supported by the finding of symbiotic cellulolytic bacteria in the gut by Thomas et al. (1994). Symbiotic microflora have also been found in other herbivorous and omnivorous species: *Chelonia mydas* (Bjorndal, 1979), *Gopherus polyphemus* (Bjorndal, 1987), and *Trachemys scripta* (Bjorndal and Bolten, 1990). However, reports contradicting the typical herbivorous diet of *P. concinna* exist. Illinois *P. concinna* were reported as largely carnivorous (Cahn, 1937) and in the New River, West Virginia, adults occasionally consumed crayfish, whereas juveniles were omnivorous (Buhlmann and Vaughan, 1991).

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Table 1: Dietary items taken from fecal samples of *Trachemys scripta* captured at Round Pond, Gallatin County, Illinois during the summers of 1994 and 1995. Data are expressed as frequency of occurrence, percent relative volume (in brackets) and percent volume (in parentheses). LSRB = Leaves, stems, roots, and bark.

	Males (n = 8)			Females (n = 13)			Juveniles (n = 6)			May – June (n = 7)			July – August (n = 20)		
Plant Material		**[0.50]**	**(0.50)**		**[0.44]**	**(0.42)**		**[0.72]**	**(0.72)**		**[0.93]**	**(0.93)**		**[0.41]**	**(0.40)**
Nuts, Seeds Fruits	0.00	[0.00]	(0.00)	0.15	[0.03]	(0.02)	0.33	[0.10]	(0.10)	0.00	[0.00]	(0.00)	0.20	[0.03]	(0.02)
L,S,R,B	0.63	[0.13]	(0.13)	0.38	[0.16]	(0.14)	0.67	[0.52]	(0.52)	0.71	[0.74]	(0.68)	0.45	[0.10]	(0.08)
Higher Plant Material	0.63	[0.29]	(0.28)	0.23	[0.12]	(0.14)	0.17	[0.06]	(0.06)	0.00	[0.01]	(0.01)	0.45	[0.19]	(0.20)
Algae	0.38	[0.08]	(0.09)	0.31	[0.05]	(0.06)	0.33	[0.04]	(0.04)	0.43	[0.18]	(0.24)	0.30	[0.04]	(0.05)
Misc. Plant Material	0.13	[0.003]	(0.003)	0.08	[0.08]	(0.06)	0.00	[0.00]	(0.00)	0.00	[0.00]	(0.00)	0.10	[0.06]	(0.05)
Animal Material		**[0.48]**	**(0.47)**		**[0.56]**	**(0.59)**		**[0.11]**	**(0.11)**		**[0.06]**	**(0.07)**		**[0.57]**	**(0.59)**
Insects	0.50	[0.19]	(0.002)	0.69	[0.03]	(0.03)	0.83	[0.10]	(0.10)	0.57	[0.06]	(0.06)	0.70	[0.02]	(0.02)
Crustaceans	0.00	[0.00]	(0.00)	0.00	[0.00]	(0.00)	0.17	[0.01]	(0.01)	0.00	[0.00]	(0.00)	0.05	[$1x10^{-5}$]	($5x10^{-4}$)
Mollusks	0.00	[0.00]	(0.00)	0.15	[0.05]	(0.06)	0.17	[0.004]	(0.004)	0.00	[0.00]	(0.00)	0.15	[0.04]	(0.05)
Fish	0.63	[0.03]	(0.03)	0.46	[0.02]	(0.02)	0.00	[0.00]	(0.00)	0.14	[0.01]	(0.01)	0.50	[0.02]	(0.02)
Bryozoans	0.25	[0.45]	(0.44)	0.31	[0.46]	(0.48)	0.00	[0.00]	(0.00)	0.00	[0.00]	(0.00)	0.30	[0.49]	(0.50)
Unidentified/Detritus	**0.13**	**[0.02]**	**(0.03)**	**0.00**	**[0.00]**	**(0.00)**	**0.33**	**[0.17]**	**(0.17)**	**0.14**	**[0.01]**	**(0.004)**	**0.10**	**[0.02]**	**(0.02)**

Table 2: Frequency of occurrence and percentage volume (in brackets) of dietary items found in 16 *Pseudemys concinna* fecal samples from specimens taken from Round Pond, Gallatin County, Illinois. Percentage volume encompasses only the categories of aquatic grasses and *Sagitaria* and algae. The female category includes both immature and mature females.

	Aquatic Grasses		*Sagitaria* and Algae			
	Poaceae		*Oedogonium*	*Sagitaria*	*Cladophora*	
Male (n=4)	0.00	[0.00]	0.75	0.00	0.75	[1.00]
Female (n=6)	0.17	[0.02]	0.67	0.50	1.00	[0.98]
Juvenile (n=6)	0.33	[0.03]	0.67	0.17	1.00	[0.97]
Total	0.19	[0.02]	0.69	0.25	0.94	[0.98]