

Seasonal Variation in Feeding Behaviour of Indian Roofed Turtle, *Pangshura tectum* in Bangladesh

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Abstract

Study was conducted in nature and in captivity to observe the food contents and feeding behaviour of Indian roofed turtle, *Pangshura tectum*, in Bangladesh between January 1997 and December 2001. The species was found to be omnivore, fed on plants, dead fishes, insects and fecal matters. In nature, the food consumption of the turtle was 3.32% of the body weight per day that was the highest in summer (4.6%) and lowest in winter (1.7%). In captivity, the consumption was 5.8% of the body weight per day and it was highest in rainy season (7.5%) and lowest in winter (3.8%). The feeding frequency was higher in captivity than in nature.

Key words: Indian Roofed Turtle, Seasonal variation, feeding behaviour

Introduction

Indian roofed turtle, *Pangshura tectum* (Gray 1831), is an important biotic component of freshwater bodies of Bangladesh. The turtle meat, in general and the Indian roofed turtle in particular, is believed to have medicinal properties (Das 1995 and Daniela 2000). In the present decade, the exploitation of turtles has been increased significantly (Shrestha 1997). Turtles are consumed by a group of people for its delicacy (Rao 1987). Turtle has been considered as the major non traditional export item of Bangladesh. Huge quantities of turtles (estimated 3164.24 tons) are exported from Bangladesh (Export Promotion Bureau of Bangladesh from 1982 to 2002).

Government of Bangladesh has invited the conservation biologists to explore innovative ideas for restoration of dwindling population of important indigenous species, especially turtles. Turtle nurseries and hatcheries has been established to replenish the diminishing populations, and making them available in local markets (Barua *et al.* 1986) A scarce research has been done on the food and feeding habits of *Pangshura tectum Bangladesh*. So an attempt has been taken to study the food and feeding behaviour of this

species in nature as well as in captivity. So that the findings may help in farming of this species commercially as in different countries of the world.

Materials and Methods

Study was conducted during January 1997 and December 2001 in Chandpur, Gopalganj, Narayanganj, Manikgonj and Zoological garden of Dhaka University, Bangladesh.

Feeding behaviour in nature

Fifty *Pangshura tectum* were collected from nature to study the food habits. Of the captured turtles, 18 were collected during summer season, 16 in rainy and 16 in winter. All the specimens were collected mainly in afternoon and anesthetized instantly and their stomachs were dissected

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out and preserved in a solution of 5% formalin and 1% glycerin in airtight containers. The qualitative analysis of food items was done under microscope, and recorded into three groups: (a) plants, (b) animals, and (c) unidentified food items. The food items were identified up to species level with the help of field manuals, guides, and with the help of specialists of respective field.

Stomach contents of individual turtle were measured by quantitative analysis according to Hartley (1948). The consumed amount of food in captivity was assessed by subtracting the rejected food after 24 hrs from the supplied food. The percentage of food consumption in relation to body weight per day by each individual was calculated as -

$$\text{Percentage of food consumption} = \frac{\text{Total weight of stomach contents}}{\text{Weight of turtle}} \times 100$$

Food consumption in different seasons

Food consumption was assessed monthly for five years in captivity. Seasonal variation of food consumption was analyzed by Chi-square test:

$$\chi^2 = \frac{(O - E)^2}{E}$$

Food preference

To determine the food preferences in nature minimum 4 turtles were dissected in each month. In captivity different food items were offered to observe food preference. This practice was repeated for different weight groups of turtle in different seasons of the year. Food preferences both qualitative and quantitative measures were made by electronic balance and finally tested by statistical methods. Statistical analysis: Data were processed under computer software MS Excel, using statistical software SPSS (version 10.0), and analyzed by one way analysis of variance (ANOVA). Seasonal differences in food consumption were tested by Chi-square test. Significance was tested at the $p < 0.05$ level.

Results and Discussion

Food habits in nature

Qualitative analysis: A total of 26 food items were found in the stomach contents, of which 19 (73.08%) items were of plant matters and 6 (23.08%) animal matters along with

01(3.84%) unidentified item (Table 1). So, the turtle has been identified as omnivore. The plant food items included *Eichhornia crassipes*, *Hydrilla verticillata*, *Lemna* spp., *Spirodela*, *Ipomoea aquatica*, *Vallisneria*, *Spirogyra*, *Pistia*, *Enhydra*, etc., and the animal food items were *Metaphire* spp., *Amblypharyngodon mola*, *Bellamaya* sp., crab, freshwater prawn etc. (Table 1). Fugler (1984) and Smith (1931) reported that *P. tectum* is exclusively herbivore. Shrestha (1997) stated that Indian roofed turtle is chiefly herbivore. Rashid and Swingland (1997) mentioned that the turtle is primarily herbivore but occasionally scavenges on animal matters.

Quantitative analysis

Plant matters constituted 59.2%, animal matters 25.6% and unidentified materials 15.2% in the food of this species, and these were respectively 17.3 %, 7.48% and 4.45% in relation to body weight of the dissected turtles (Table 1). Among the plant food items *E. crassipes* was the highest (13.9%) and *Spirogyra* spp. lowest (0.56%), whereas, of the animal items crab was the highest (7.6%) and prawn lowest (3.1%).

The mean plant food consumption per individual per day was 7.4g. The same for animal food was 3.2 g (range 19.2g to 47.5g), and unidentified materials 1.9 ± 0.23 g (Table 1).

Aquatic vegetation was 43.9%, terrestrial plant matters and cereal 7.2%, animal matters 26%, rotten matters and carcasses 22.9% (Table 1). Among the plant foods, *E. crassipes* was found in maximum number of stomach (n = 45), and of the animal foods, carapace of prawn was found in maximum number of stomach (n=31 stomach).

The turtle consumed various species of plants and animals (Shrestha 1997). Indian roofed turtle fed on all sorts of aquatic vegetation, parts of plants, live and dead leaves, flower of trees, grass roots, fruit seed (watermelon, tamarind), cereals, small fish, insects, earthworms, fecal matters and animal fragments (Ernst and Barbour 1989).

One individual was captured in a hook trap baited with chicken entrails (Moll 1987). It was inferred, in this present research, that *P. tectum* acted as scavenger because it fed on animal fragments, dead leaves and fecal matters in nature. Hossain (1984) stated that *P. tectum* fed on a variety of aquatic vegetation, and slow moving aquatic animals i.e. earthworm, waterbug, *Notonecta*, baits, etc. dead animals, and fragments of dead bodies, thus reduce

Table 1. Stomach contents of *Pangshura tectum* collected from nature

Sl No	Food items	Frequency of occurrence (n = 50)	Occurrence to the total (% no. of stomach)	Total weight of .(food (g	Occurrence to the (%) consumed food
Plant foods					
1.	Bark of banana	14	28	8.4	1.34
2.	Bread	05	10	4.5	0.72
3.	Dead leaves	22	44	29.5	4.69
4.	<i>Eichhornia crassipes</i>	45	90	87.6	13.92
5.	<i>.Enhydra sp</i>	17	34	20.4	3.24
6.	Fig	18	36	9.0	1.43
7.	Flower of grass & trees	24	48	6.3	1.00
8.	Grass roots	11	22	4.6	0.74
9.	<i>Hydrilla verticillata</i>	20	40	32.3	5.14
10.	<i>Ipomoea aquatica</i>	19	38	19.6	3.11
11.	Leaf of <i>Cynodon dactylon</i>	09	18	6.1	0.97
12.	<i>.Lemna spp</i>	37	74	45.2	7.17
13.	<i>Oryza sativa</i>	23	46	10.2	1.63
14.	<i>Pistia strattos</i>	07	14	16.4	2.62
15.	Skin of tamarind	12	24	8.1	1.28
16.	<i>Spirodela polyrhiza</i>	24	48	20.6	3.28
17.	<i>.Spirogyra spp</i>	11	22	3.6	0.56
18.	<i>Triticum aestivum</i>	08	16	9.2	1.45
19.	<i>Vallisneria spiralis</i>	21	42	30.6	4.86
Animal foods					
20.	<i>Amblypharyngodon mola</i>	08	16	28.3	4.50
21.	<i>.Bellamaya sp</i>	06	12	19.5	3.10
22.	Carapace of prawn	31	62	19.2	3.05
23.	Egg shell	08	16	21.8	3.47
24.	Legs of crab	15	30	47.5	7.55
25.	<i>.Metaphire spp</i>	09	18	25.2	4.00
26.	Unidentified materials	50	100	95.5	15.18

the water pollution. They also feed on debris, and therefore, may reduce the pollution in lotic and lentic water (Hossain 2000).

Seasonal variation

During summer 15 types of food items were noted in the stomach (n = 18) contents, of which 71% food items were of plant matters and 29% of animal matters. *E. crassipes* and animal fragments were found to be the major food items. The average food consumption was 16.5g per day (range 12 g to 22 g) that was 4.6% of the body weight (Table 2). Consumed food constituted plant and animal items, which were 3.45% and 1.15% in relation to the body weight respectively. The highest consumption was in June (19.8g) followed by May (16.8g), April (16g), and the lowest in March (13.4g) (Table 2).

In rainy season, 24 food items were found in 16 stomach contents. Of the food items, 83% was of plant items and 17% animal and their fragments. The average consumption

was less than summer months with a variation between 9 g and 14g (Table 2). Plant items was 6.8g and animal 4.1g. The major food items were *Hydrilla*, *Vallisneria*, *Lemna* spp. and *Spirodella*. The food consumption was 3.3% of the mean body weight of dissected turtles. The highest food consumption was in the month of July (12g) followed by August (10.8g), September (10.5g), and the lowest in October (10.3g) (Table 2 and Fig. 2).

During winter months, 16 stomachs were dissected and found 14 food items. Of the food items, 57% were plant and plant materials, and 43% animal foods. The average food consumption was less than rainy season (range between 5g and 14g), plant foods was 5.6g and animal food 4.3g, of which grass roots and leaves, fruit skin, seeds and prawn, were the major food items. The food consumption was 1.7% in relation to the mean body weight. The highest food consumption was in the month of February (11.8g) followed by January (11g), November (8.5g) and the least in December (8.3g) (Table 2 and Fig.2). There was

a significant difference of food consumption of different months of the year in nature ($\chi^2=10.71$, $df=11$, $p<0.05$) but no significant difference among the three seasons ($\chi^2=2.03$, $df=2$, $p>0.05$).

Food habits in captivity

Qualitative analysis: Naturally available food items were supplied to the Indian roofed turtle in captivity through out the year. The turtle consumed a total of 14 items, of which 11 (78.5%) were plant foods and 3 (21.5%) animal foods. The plant food items were floating and submerged vegetation which were available throughout the year. The animal food items were dead and weak fishes, fragments of animals and earthworms (Table 3). Other than the mentioned items were also supplied but always it was noted these refused foods by the turtle. The turtles fed on small live shrimps, crabs, aquatic insects, etc., in captivity (Khan 1987).

Quantitative analysis

The food consumption of *P. tectum* per day was 27.4g (range 3.5 g to 108.8g) that was 5.8% in relation to body weight. *E. crassipes* was the highest consumed (108.8g) food among the plant items, while among the animal foods *Macrobrachium* spp. was the highest (62g) (Table 3).

Seasonal variation

In summer, the average daily food consumption of *P. tectum* was 28.2g (ranged 6 g to 65 g) that was 6.1% in relation to the mean body weight. Of the plant foods, the highest consumption was *E. crassipes* (65g) and of the animal matters was *Metaphire* sp. 57g was the highest (Table 3). In rainy season, daily food consumption was 37.1g (range 7.0 g to 108.8g) that was 7.5% of the mean body weight. Mean consumption of plant food was 34.8g and animal

Table 2. Food habits of *Pangshura tectum* studied in different season in nature.

Season (Months)	Sample size (n = 50)	Wt. of stomach contents (g)	Mean weight of turtles (g)	Food consumption per individual	
				Mean \pm SD	% relation to body wt.
Summer (Mar. – June)	18	297	360.7 \pm 88.3	16.5 \pm 3.2	4.6
Rainy (July - Oct.)	16	174	328.9 \pm 97.7	10.9 \pm 1.5	3.3
Winter (Nov. – Feb.)	16	158	580.6 \pm 36.1	9.9 \pm 2.6	1.7

Table 3. Seasonal variation of food consumption of *Pangshura tectum* in captivity.

Food items	Summer (Mar. – June)		Rainy (July – October)		Winter (Nov. – Feb.)	
	Consumption / day (g)	% to body wt.	Consumption / day (g)	% to body wt.	Consumption / day (g)	% to body wt.
Plant foods						
<i>Eichhornia crassipes</i>	65.0 \pm 45.1	12.15	108.8 \pm 11.4	20.33	12.0 \pm 1.9	2.24
<i>Enhydra</i> sp.	6.0 \pm 1.6	1.12	7.0 \pm 1.0	1.31	5.0 \pm 1.9	0.93
<i>Hydrilla verticillata</i>	25.0 \pm 8.6	4.67	25.3 \pm 3.3	4.73	17.0 \pm 2.1	3.17
<i>Ipomoea aquatica</i>	24.0 \pm 4.3	4.49	23.3 \pm 4.6	4.36	4.7 \pm 0.5	0.87
<i>Lemna</i> spp.	31.3 \pm 6.5	5.84	40.5 \pm 7.2	7.57	35.8 \pm 8.6	6.70
<i>Oryza sativa</i>	32.2 \pm 5.3	6.02	43.0 \pm 6.0	8.04	16.4 \pm 2.1	3.07
<i>Pistia stratiotes</i>	18.0 \pm 5.9	3.33	36.7 \pm 4.7	6.87	22.5 \pm 3.6	4.21
<i>Spirodela polyrrhiza</i>	35.0 \pm 6.3	6.54	42.1 \pm 12.9	7.78	25.0 \pm 5.4	4.67
<i>Spirogyra</i> spp.	7.0 \pm 2.4	1.31	11.0 \pm 1.6	2.04	3.5 \pm 1.1	0.65
<i>Triticum aestivum</i>	14.5 \pm 3.5	2.66	22.4 \pm 3.3	4.19	8.0 \pm 2.3	1.50
<i>Vallisneria spiralis</i>	11.5 \pm 3.5	2.13	22.3 \pm 2.7	4.16	7.0 \pm 1.9	1.31
Animal foods						
<i>Amblypharyngodon</i> sp.	13.5 \pm 2.9	2.52	15.0 \pm 2.4	2.80	5.0 \pm 1.9	0.93
<i>Macrobrachium</i> spp.	55.0 \pm 14.7	10.71	62.0 \pm 4.4	11.6	41.6 \pm 12.9	7.85
<i>Metaphire</i> spp.	57.0 \pm 18.0	9.51	60.0 \pm 7.1	11.2	32.4 \pm 4.5	6.06

food 45.7g. The highest consumption was *E. crassipes* (108.8 g) in the plant food and *Macrobrachium* spp. (62g) in animal foods (Table 3). In winter, the average daily food consumption was 16.9g, variation between 5 g and 41.6g that was 3.8% of the mean body weight. The mean plant food 14.3g and animal food was 26.3g.

The highest consumption was *Lemna* spp. (35.8 ± 8.6 g) in the plant foods and *Macrobrachium* sp. (41.6g) in the animal foods (Table 3). The food consumption of different season was statistically significant ($\chi^2 = 7.48$, $p < 0.05$) i.e. there was a significant difference in consumption of food in different seasons. The mean food consumption was the highest in summer in nature and in rainy season in captivity. The least consumption was in winter both in nature and captivity (Tables 2 & 3).

Comparison of food habits

In nature, the plant food consumption was 17.3% and animal food 6.5% in relation to body weight. The highest food consumption was recorded in summer followed by rainy and winter seasons. *E. crassipes* was the most favoured food item in summer, *Hydrilla* sp. in rainy season and prawn in winter. Percentage of plant and animal food consumption in relation to body weight in different seasons was significantly different ($F=0.24$, $p<0.05$) (Tables 4 and 5).

In captivity, plant food was 4.6 % and animal food 7% in relation to body weight. The food consumption was the highest in rainy season followed by summer and winter months (Fig 2). Among the plant food items, *E. crassipes*

was the most favoured food in summer and rainy season, and *Lemna* spp. in winter season. The *Metaphire* spp. was the highest in summer and *Macrobrachium* sp. was in rainy and winter season. The percentage of plant and animal food consumption in relation to body weight in different seasons was significant ($F = 2.427$, $df=3/2$, $p<0.05$) (Table 5). Indian roofed turtle was mainly vegetarian, however occasionally they become obligatory carnivore (Das 1991).

Feeding behavior in nature

The turtle fed on aquatic vegetation like water hyacinth, water cabbage, water crass, waterline weeds, duckweed, *Lemna* spp., floating leaves, and flower of trees from the surface of water by swimming. During feeding they lodged on the roots of floating vegetation by forelimbs. The turtle consumed fragments of dead animals, trash fish, and carcasses by diving and swimming. Large food particles were torn up with the help of forelimbs and sharp bony shield like jaw. They were active in whole day, even in rainy day, and parts of night to consume foods by continuous swimming. It was observed, the turtle tried to get up on floating objects to warm the body in the sunny day after feeding. The turtle was active and fed well during the warm weather.

Feeding habits in captivity

The turtle devoured the supplied food items i.e., rice, wheat, and earthworms from the bottom of the aquaria by diving. In the mini ponds and in cemented tank, the turtle consumed aquatic vegetations like *Hydrilla* sp., *Vallisneria*

Table 4. Comparison of plant and animal food consumption by *Pangshura tectum* in nature and captivity

Season	Food consumption in relation to body weight			
	Nature		Captivity	
	(%) Plant	(%) Animal	(%) Plant	(%) Animal
Summer	4.57	5.39	4.60	7.61
Rainy	3.31	4.10	6.51	8.50
Winter	1.70	0.82	2.70	4.90

Table 5. ANOVA for comparison of food consumption of *Pangshura tectum* in nature and captivity

	Source of variation	Sum of squares	df	Mean sum of squares	F Value	P (%)
Nature (1)	Between the groups (Varity)	9.127	2	9.127	0.24 ±	0.05
	Within groups (Residual)	15.239	3	3.810		
Captivity (2)	Between the groups (Varity)	8.640	2	8.640	2.43 ±	0.05
	Within groups (Residual)	14.240	3	3.560		

Insignificant at 5 % level = ±

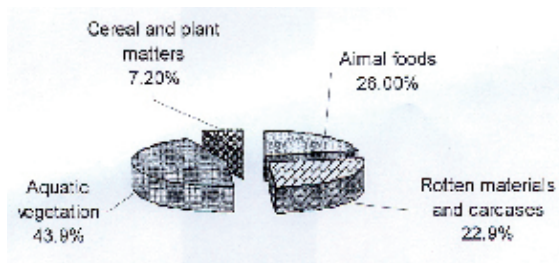


Fig 1. Food consumption of Indian Roofed Turtle, *Pangshura tectum* in nature.

sp., *Potamogeton*, *Ipomoea* sp., *Enhydra* sp., *Spirodela polyrhiza*, algae, etc. by swimming and cutting them into pieces when necessary. The turtle also fed grass blades from the pond edge. Dead crabs and fishes, and prawns were consumed by tearing with the help of limbs. Water flow was created by their limbs to drive the supplied foods at the corner of aquaria and then began feeding. After having food, the turtle remained inactive for a while at the bottom of aquaria.

Food preference

On the basis of analyses of stomach contents, *P. tectum* was found to prefer plant foods (*E. crassipes*, *Hydrilla*, *Vallisneria* etc.) other than the animal food items. Only plant matters contained in a stomach of *P. tectum* collected from nature (Moll 1987). In present study they preferred animal fragments, in captivity. The turtle preferred prawn, earthworm and crab than the aquatic vegetations when mixed food items were supplied. The turtle preferred fishes, prawns than vegetable matters (Moll 1987).

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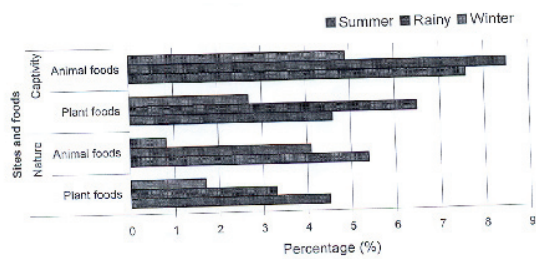


Fig 2. Seasonal food consumption of *Pangshura tectum* in relation to body weight.

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