

RESEARCH ARTICLE

Trophic status and diversity of fish species in selected tributaries of Bentota River.

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Abstract: Present study was carried out to investigate the, abundance and trophic status of fishes inhabiting tributaries of the Bentota River. Fish were sampled using gill nets, seine nets, cast nets and some were also collected from fishermen's catches harvested at the tributaries of the Bentota River in Katapola, Ganegoda, Avitthawa, Yagirala and Galatara. To investigate the trophic status, stomach contents were analyzed and quantified using the Point method based on the percentage of bio volume per food category. Ten species of fish were recorded from all five sites, including two endemic species, *Clarias brachysoma*, *Channa orientalis* and one invasive alien fish *Chitala ornata*. Some indigenous species such as *Puntius vittatus* (n=400), *Rasbora daniconius* (n=134), *Puntius dorsalis* (n = 42) and *Trichogaster pectoralis* (n=71) were also caught in reasonable number. Parts of fish (scales, fins and flesh), mollusks, adult insects, insects larvae, macrophytes and digested/detritus matters were identified as main food categories in the stomach. Based on the gut content analysis, three feeding guilds i.e. piscivorous, herbivorous and zooplanktivorous, were identified. High diet overlap values were recorded in species pairs belonged to the same feeding guild i.e. *Chitala.ornata*- *Channa orientalis* while low diet overlap values were recorded in species belonged to different feeding guilds. Remains of fins of *Channa orientalis*, and *Rasbora daniconius* and some invertebrates observed in stomach contents of *C. ornata*, indicated its negative impacts on biodiversity in study sites. Therefore urgent attention should be paid to population control of *C.ornata* and to prevent its further invasion into new habitats.

Keywords: Gut content, Bentota River, Feeding guilds, diet overlap

Introduction

Food and feeding habits of fish are important biological factors to understand the community structure and selecting fish for aquaculture (Dewan & Saha, 1979). Biological studies of fish species with respect to their diet composition is an important aspect in fish biology. Digestive system of the fish varies with their feeding habits such as carnivorous, omnivorous and herbivorous. There is a temporal variation in gut contents of fish in parallel to seasonal changes in the environment including temperature, and available food organisms Cong et al., (2017). Stomach content analysis is a better tool to predict possible predation, competition and feeding habit of animals. Accurate quantification of fish diets is an

important aspects of fisheries management (Manon et al., 2011).

The species-specific differences that allow coexistence can be considered as species' niche. According to the definition of species' niche it consist of four major axes: resources, predators, space and time (Chesson, 2000). Coexistence thus requires niche partitioning between species that increases the strength of intraspecific competition relative to that interspecific competition along at least one of those four niche axes (Amarasekara, 2003). Niche overlap measures the degree to which a niche resource is shared between individuals or population within the community. The greater the overlap between co-occurring species, more similar the

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resource use of the individuals of these two populations, and the greater the potential for competition between these two populations.

Diversity of organisms and measurement of diversity have concerned ecologist and conservationist. Biological communities vary according to species richness and evenness (relative abundance of species). A diversity index employed in ecological researches is a measure that reflects the number of different species and how evenly the individuals are distributed among those species (Negi, 2013).

Present study was carried out in Bentota River, which is one of the main rivers in the Southern region of Sri Lanka and its catchment spread in the small mountain in Elpitiya, Pitigala and Pelawatta area. This river play an important role in ecological, social and economic aspects. Fishery of this river is mainly carried out by Small- scale fishermen using non modernize fishing gears i.e. pole and line and gillnets etc..

Many studies have been carried out on the food and feeding habits, distribution pattern of many fish species inhabiting the lotic and lentic ecosystem of Sri Lanka, but detail study on the above aspects of the tributaries of Bentota River is yet to be studied. Therefore present study was carried out mainly to investigate fish diversity, food and feeding habits & size related ontogenetic diet shift in fish species found in the tributaries of Bentota River.

Materials and Methods

Five sampling sites i.e. Katapola, Ganegoda, Avitthawa, Galatara and Yagirala located in the tributaries of Bentota River were selected in the suburbs of Elpitiya area in Southern Sri Lanka (Figure 1). Bentota River is originated from mountains in Elpitiya area and emptied into the sea near Bentota, a place which has much touristic activities and attractions.



Figure 1: Map of sampling sites

Gill nets, seine nets, and cast nets were used as fishing gears to catch fish. In addition, data on fish diversity and abundance were collected from fishermen. Maximum number of 10 individual of fish caught at each sampling were preserved in Formaldehyde solution in order to carry out gut

content analysis. Fishes larger than 10 cm were preserved by injecting 10% formalin into the body cavity immediately after capturing in order to preserve gut contents. All collected samples were kept in formaldehyde bath until analysis.

Prior to fixing the fish for gut content analysis, total length and body weight of each individual of each species were measured using meter ruler and top loading balance respectively as soon as possible after sampling them. For gut content analysis, the point method based on the percentage of bio volume per food category was used (Hynes, 1950). Diet overlaps were calculated on the basis of the gut contents of species concerned. Diet overlap (S) between each pair of species was determined using the formula of Schoener's index (1970) ; $S = 1 - 0.5 (\sum_{aj}^n [pxi - pyi])$, where S= the dietary overlap coefficient of fish species x and y: Pxi = proportion of food category "i" in the diet of species "x": Pyi = proportion of food category "i" in the diet of species "y": n = number of food categories.

Shannon-Wiener Index of diversity, Evenness and Species richness values were calculated for each site. Shannon-Wiener Index of diversity was calculated by using following equation: $H' = \sum_{i=1}^s pi \ln pi$ where pi= proportion of total sample represented by species, S = number of species, H= Maximum diversity. Evenness of the respective sites was calculated by dividing Shannon's diversity index (H) by natural logarithm of species richness. Species richness was determined by counting the number of fish species present in each site.

The values for this similarity index ranged from 0.00 to 1.00, with 1.00 indicating complete overlap and 0.00 indicating no overlap. To calculate the Jaccard similarity index, following equation was used; $Sj = \frac{a}{(a+b+c)}$ where Sj is the Jaccard similarity index, a=number of species in both sites, b= number of species in second site only, c= number of species in first site only. Coefficient of community for the study sites computed by the equation: $CC = \frac{2a}{(2a + b + c)}$

where CC= Coefficient of community, a=number of species in both sites, b= number of species in second site only, c= number of species in first site only. Percentage similarity index was calculated using equation: $j = \frac{200 \sum \min(yki, ykj)}{\sum yki + \sum ykj}$, where, yki is the abundance of the kth species at site i.

For the data that exhibited normal distribution, One-way Analysis of variance (ANOVA) was carried out

to statistically compare food items among and between the different fish species using SPSS ver 17 statistical package.

Results and Discussion

Relatively high fish species richness was recorded in all the five selected sites along the tributaries of Bentota River (Table 1). Ten fish species were recorded irrespective to different sites including some endemic species such as *Clarias brachysoma*, *Channa orientalis*. Some indigenous species such as *Puntius vittatus* (n=400), *Rasbora daniconius* (n=134), *Puntius dorsalis* (n=42) and *Trichogaster pectoralis* (n=71) were also caught in reasonable numbers. *Chitala ornata* an invasive alien fish species was also recorded in reasonably high number (Table 01). Fish abundance was high in Katapola site (315) while Yagirala site recorded the lowest abundance (96). During study period researcher observed high microhabitat diversity in Katapola site and this can be attributed to high fish abundance of Katapola site. The highest abundance of *C. ornata* was recorded in Katapola site. Total length ranged from 6.8 cm to 42.0 cm individuals of *C. ornata* were found in the fish sample giving some clue of successful reproduction in the tributaries of Bentota River, and thus, fulfilling one of the characteristic feature to consider *C. ornata* as invasive species.

Table 1: Species richness and total number of fish caught (abundance) in study period in the five selected sites

Fish species	Sampling sites					Total abundance
	Katapola	Ganegoda	Avitthawa	Yagirala	Galatara	
<i>Chitala ornata</i>	10	04	05	06	04	29
<i>Puntius vittatus</i>	192	98	52	26	32	400
<i>Rasbora daniconius</i>	29	24	24	28	29	134
<i>Puntius dorsalis</i>	12	10	08	-	12	42
<i>Trichogaster pectoralis</i>	19	08	12	16	16	71
<i>Osphronemus goramy</i>	29	27	21	14	14	105
<i>Clarias brachysoma</i>	06	-	02	-	01	9
<i>Channa orientalis</i>	10	02	07	-		19
<i>Mastacembulus armatus</i>	02	04	-	04		10
<i>Mystus vittatus</i>	06	-	-	02	05	13
Species richness	10	08	08	07	08	

Some diversity indices computed for study sites are given in table 2. Katapola sites showed the highest species richness and lowest evenness. The reason for the lowest evenness could be attributed to the highest number of one particular species i.e. *Puntius vittatus*

(n=192) and lowest number (n= 02) of one particular species i.e. *Mastacembulus armatus*. Lowest Sorenson diversity index is recorded by Ganegoda site.

Table 2: Some diversity indices computed for study sites

Site	Shannon-Wiener Index	Evenness	Species richness
Katapola	1.44	0.63	10
Ganegoda	1.41	0.68	08
Avitthawa	1.71	0.82	08
Yagirala	1.68	0.86	07
Galatara	1.79	0.86	08

The highest Shannon-Wiener diversity index and evenness was observed in Galatara site. Compared to rest of the sites, in Galatara site, it is not recorded dominant fish species (with high abundance) and this

could be attributed to high Shannon-Wiener Index in this site. Jaccard similarity index and Coefficient of community computed for different sites was shown in Table 3.

Table 3: Jaccard similarity index and Coefficient of community values in sampling sites

		Sampling site/ Jaccard similarity index				
Sampling site/ Coefficient of community values		Katapola	Ganegoda	Avittawa	Yagirala	Galatara
	Katapola	-	0.80	0.80	0.70	0.80
	Ganegoda	0.89	-	0.78	0.67	0.60
	Avitthawa	0.89	0.82	-	0.50	0.78
	Yagirala	0.82	0.80	0.67	-	0.75
	Galatara	0.89	0.75	0.86	0.80	-

Note: Data above the diagonal axis are Jaccard similarity index values and data below the diagonal axis are Coefficient of community values.

For both indices, higher values indicate more ecologically similar sites. Accordingly, Katapola-Avittawa, Katapola-Ganegoda and Katapola-Galatara sites are more ecologically similar than other sites. Habitat composition of above sites are more similar and hence exhibit high similarity values. The Lowest Jaccard similarity index and Coefficient of community values (0.50) displayed by site

combination of Avittawa and Yagirala attributed to two sites are remote and dissimilar.

Percentage similarity index (Gauch, 1982) is another index that can be used to evaluate the similarity and dissimilarity between sites taking in to account, not only the numbers of similar and dissimilar species present in the two respective sites, but also incorporate their abundance.

Table 4: Percentage similarity index (Gauch, 1982) values in sampling sites

	Katapola	Ganegoda	Avittawa	Yagirala	Galatara
Katapola	-	0.69	0.37	0.19	0.23
	Ganegoda	-	0.74	0.40	0.49
		Avitthawa	-	0.74	0.84
			Yagirala	-	0.91
				Galatara	-

The highest Percentage similarity index value was exhibited by site combination of Yagirala and Galatara (Table 4). Since the Percentage similarity index also consider the abundance of species found in two sites, less deviation in abundance values of species recorded in the two sites, Yagirala and Galatara (Table 1) could also be attribute for the

highest percentage similarity index value between these two sites. Contrary, the lowest percentage similarity index value between Kotapala and Yagirala can be attributed to the higher difference in abundance of species between the two sites Kotapala and Yagirala (Table 1).

Results of the gut content analysis of fish species recorded irrespective of the sampling sites are shown in table 5.

Table 5: Percentage Bio-volume of food categories in the gut content of fish species collected (Irrespective to sampling sites)

Food Item	Fish species						
	PV	RD	PD	TP	OG	CHO	CO
Parts of the fish*	-	-	-	0	1.28	52.8	38.65
Mollusk	-	0.10	15.85	1.25	0	6.25	9.67
Adult insects*	0.25	32.8	14.5	8.25	0	15.2	13
Insects larvae	0.31	12.6	12.2	12	3.25	9.5	5.21
Macrophytes	12.15	2.1	1.28	16.5	48.2	1.25	12.16
Zooplankton*	6.28	21.6	6.27	32	9.8	5.25	10.15
Algae	42.8	-	-	6.25	16.2	-	-
Microbenthos	0.21	2.9	16.8	0	0	-	-
digested/detritus matters	38.0	27.9	33.1	23.75	21.27	9.75	11.16

Note: PV- *Puntius vittatus* RD- *Rasbora daniconius* PD- *Puntius dorsalis* TP- *Trichogaster pectoralis* OG- *Osporonemus goramy* CHO- *Channa orientalis* CO- *Chitala ornata*. Significantly different food categories between species denoted by *.

The main food items recorded in this study parts of the fish (flesh, scales, parts of fins and bones), mollusk, adult insects, insects larvae, macrophytes, algae and digested/detritus matters. *Puntius vittatus* and *Osporonemus goramy* are herbivorous fish, mainly feeding on macrophytes and algae. *Rasbora daniconius* is insectivorous zooplanktivorous fish mainly feed on adult insects, insect larvae and zooplankton (Table 5) by volume of food particles. Similar to present study, Amarasinghe and Ariyaratna (2002), reported same food items of *R. daniconius* in Minneriya, Udawalawa and Victoria reservoirs. *Channa orientalis* and *Chitala ornata* are piscivorous fish mainly feeding on fish (evident by parts of fish in stomach contents), which account

52.8 and 38.65 percent by volume respectively. Some fresh fish remains that are not digested, found in gut content of *C.ornata* were identified as small cyprinids like *Puntius vittatus*, *Rasbora daniconius* and endemic fish *Channa orientalis*. Research carried out in sub ways of Attanagalu oya, Sri Lanka, (Perera & Weerakoon, 2016), recorded that *C. ornata* feeds on significant number of native fish species inhabiting in Attanagalu Oya. Results of the one way ANOVA reveals significant difference (P< 0.05) of food items such as parts of the fish, adult insects, and zooplankton among different fish species.

Diet overlap values calculated using Schoenner's index are given in Table 6.

Table 6: Diet overlap values based on Schoenner's index

Fish species	PV	RD	PD	TP	OG	CHO	CO
PV	-	0.37	0.41	0.49	0.56	0.17	0.30
	RD	-	0.65	0.68	0.36	0.41	0.42
		PD	-	0.53	0.32	0.47	0.47
			TP	-	0.57	0.35	0.48
				OG	-	0.21	0.38
					CHO		0.79
						CO	-

Note: CO- *Chitala ornata* PV- *Puntius vittatus* RD- *Rasbora daniconius* PD- *Puntius dorsalis* TP- *Trichogaster pectoralis* OG- *Osporonemus goramy* CHO- *Channa orientalis*

Diet overlap between two fish species quantifies the sharing of food and habitat resource categories between two species. Fish species belong to the same feeding guild recorded high diet overlaps. In present study, very low diet overlap values were observed in fish species pairs belonged to completely different trophic states i.e herbivory and carnivory (Table 6). For examples species pair *Puntius vittatus*- *Channa orientalis* (0.17), *Osporonemus goramy*- *Channa orientalis* (0.21). *Puntius vittatus* and *Osporonemus goramy* are mainly feed on both macrophytes and algae while *Channa orientalis* is purely a carnivorous fish mainly feeding on fish. In contrast, species pair *Channa orientalis* and *Chitala ornate* recorded highest diet overlap value (0.79). This high overlap value can be attributed to their feeding pattern and trophic states. Both *Channa orientalis* and *Chitala ornate* are carnivorous and mainly feed on other fish. This gives an alarming signal for the need of conservation of biological resources because *Channa orientalis* is an endemic fish species and *Chitala ornata* is an invasive alien species. Relevant authorities and general public should take actions to control this invasive species and further distribution into other tributaries.

Conclusion

Tributaries of Bentota River exhibit comparatively high fish diversity with ten fish species including endemic, indigenous and one invasive alien species. Small minor cyprinids like *Puntius vittatus* and *Rasbora daniconius* exist with high abundance in all sampling sites. High diversity of food items were observed in gut contents of the studied fish, ranging from plant materials to animal materials. Feeding guilds of fish species in study sites are mainly piscivorous, insectivorous and herbivorous. Remains of body parts of *C. orientalis*, which is an endemic fish species found in guts of *C. ornata* indicates threats to the endemic fauna of Sri Lanka. Presence of flesh and parts of fins of *R. daniconius* and some invertebrates in the gut contents of *C. ornata*, indicates the negative impacts on native fish as well as on other aquatic fauna.

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