Fish Diversity in Tributaries of Bentota River and Potential Threats from *Chitala ornata* (Osteichthyes; Notopteridae), an Invasive Fish Species in Sri Lanka

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ABSTRACT

Fish from tributaries of the Benthota River were sampled from August to December 2016 using different fishing gears such as gill nets, seine nets, cast nets and fishermen's catches. Length (cm) and weight (gr) of the individuals of each fish species were recorded. To investigate the potential threats from *Chitala ornata*, its stomach contents were analyzed and quantified using the Point method. Ten species of fish were recorded from all five sites, including two endemic species, *Clarias brachysoma,*and *Channa orientalis*. Some indigenous species such as *Puntius vittatus*, *Rasbora daniconius*, *Puntius dorsalis* and *Trichogaster pectoralis* were also found. The largest individual of *Chitala ornata* was 45.0 cm in standard length and 2.0 kg in weight. The stomach contents of *Chitala ornata* larger than 15 cm in length revealed a variety of food items suggesting a voracious and carnivorous feeding habit. The highest bio volume (72%) comprised of fish scales, fins and flesh which was significantly higher ($p < 0.05$) than other food categories. Macrophytes accounted for the lowest biovolume (6.5%) which was significantly lower ($p < 0.05$) than the other food categories. The gut contents of *Chitala ornata* smaller than 10 cm comprised of a high percentage (60%) of algae and plant materials. Remains of fins of *Channa orientalis*, and *Rasbora daniconius* and some invertebrates observed in the stomach contents of *C. ornata*, indicates the negative impacts on native fish as well as on other aquatic fauna. Therefore urgent attention should be paid to population control of *C.ornata* and prevention of further invasion.

Key words: Invasive fish, *Chitala ornata*, stomach contents, biodiversity, endemic fish species, *Clarias brachysoma*, *Channa orientalis*, Sri Lanka

INTRODUCTION

Invasive Alien Species (IAS) are those native to one area or region, that have been introduced into an area outside their normal distribution, either by accident or on purpose, and which have colonized or invaded their new home, threatening biological diversity, ecosystems and habitats, and human well-being (Wittenberg and Cock, 2001). For a species to be considered invasive, it must fulfill the following criteria. Successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range (Wittenberg and Cock 2001). At present, introduction of invasive alien species is considered as one of the major direct drivers of erosion or devastation of the

biodiversity in freshwater ecosystems (Lakra et al., 2008; Singh and Lakra, 2011).*Chitala ornata* (Family: Notopteridae), is one of the major IAS in Sri Lanka, a primarily carnivorous fish species threatening biodiversity. According to Marambe *et al* (2011) in Sri Lanka, 12 IAS of animals are nationally listed, among them 10 being vertebrates with seven being freshwater fishes including *Chitala ornata*.

It is believed that introduction of *Chitala ornata* which is native to the Mekong Basin in Laos, Thailand, Cambodia and Viet Nam (Froese and Pauly, 2015) is due to negligence of aquarists and ornamental fish traders (Bambaradeniya, 2002). This IAS is now found in Diyawanna Oya and the Bolgoda Lake in the Western Province (Amarasinghe *et al.* 2006) as well as in Bentota River in the Southern Province. Bentota River is the one of the main rivers in the southern region which originates from the mountain range in Elpitiya, Pitigala and Pelawatta area.

C. ornata is popularly consumed, fished at large and small scales, and found in aquaculture. Juveniles are popular in the aquarium trade and large fish are popular for public aquaria. Most of the countries around the world, it is often used in food products (Vidthayanon, 2012). Processed meal from *C. ornata* is used to replace fishmeal in diet production (Sherilyn, 2017).

So far no detailed ecological and biological studies on possible impacts of *C. ornata* in freshwater bodies of the southern region have been carried out, but some studies on ecological, biological and reproductive aspects of this species have been conducted in the Western Province of Sri Lanka (Kumudinie 2004; Kumudinie and Wijeyaratne 2005; Amarasinghe et al, 2006).

Stomach content analysis is a satisfactory tool to predict possible predation, competition and feeding habit of particular species. Several studies on food and feeding habit of *Chitala ornata* revealed its carnivorous feeding habits (Shirantha 2014; Kumudinie and Wijeyaratne 2005).

The main objective of this present study was to investigate the possible competition for food between the *Chitala* spp. and other indigenous fish species inhabiting the Bentota River. Sub objectives are to investigate ontogenetic diet shift in *Chitala ornata,* and to assess fish diversity in selected tributaries of the Bentota river.

MATERIALS AND METHODS

Five sampling sites i.e. Katapola, Ganegoda, Avitthawa. Galatara and Yagirala close to Elpitiya area and associated with the tributaries of the Bentota river were selected for this study (Figure 1). Fish were sampled using different fishing gears such as gill nets, seine nets, and cast nets. In addition some *Chitala ornata* were collected from fishermen. The period of sampling was August to December 2016.

A maximum of 10 individuals from different length classes of *C. ornata* were preserved in formalin 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 capture to prevent deterioration of stomach contents and then were put in a formalin bath. Prior to gut content analysis, total length and body weight of each individual were measured. For gut content analysis, the Point

method based on the percentage of bio volume per food category was used (Hynes, 1950). Gut contents of *Chitala ornata* were analyzed according to different length classes i.e. below 15 cm, 15-30 cm and larger than 30 cm, in order to assess ontogenetic diet shift.

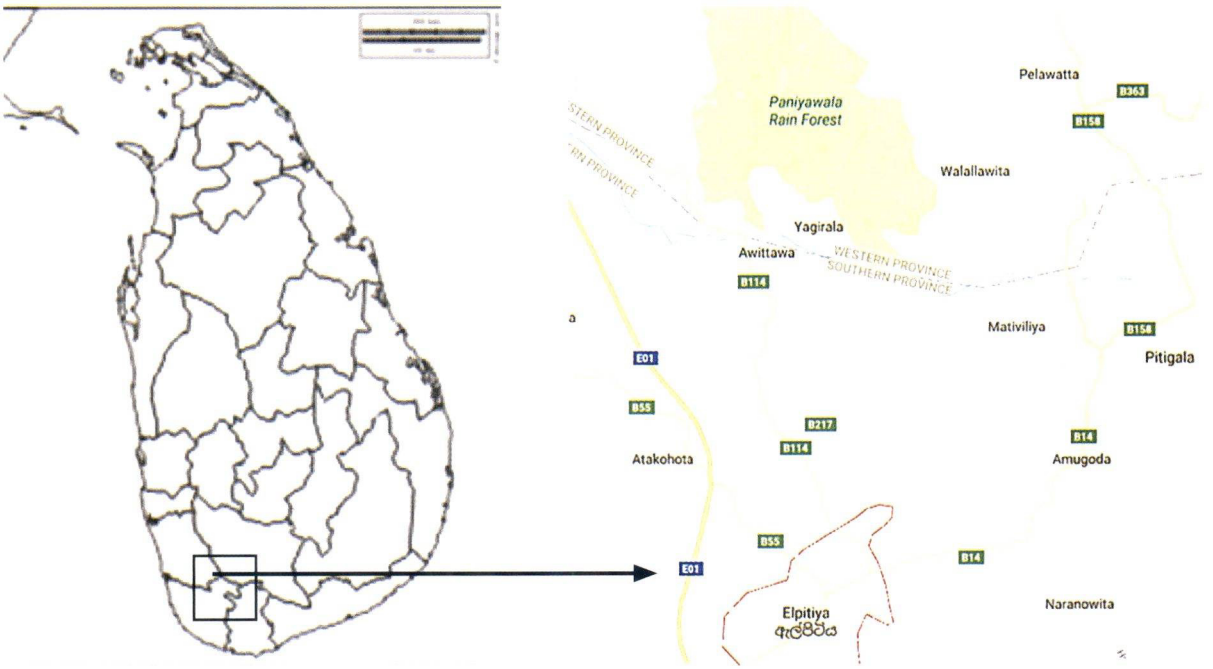


Figure 1-Map of the sampling sites.

Calculation of diet/niche breadth

The diet/niche breadth was calculated for each fish species using the niche breadth coefficient, Bi (Levins, 1968).

$B_i = -\Sigma^n_{j=1} P_j * \log Pj$

Where Pj = the proportion of food category "j" consumed by species "i".

Bi = the niche breadth coefficient of a fish species "i"

n = the number of resource states available

For the data that exhibit normal distribution, One-way ANOVA was carried out to observe the significantly different food items among and between the different size classes using SPSS version 17 statistical package.

RESULTS

Fish species richness is high in Katapola site (10). Irrespective to sites ten fish species were collected and among these there are two endemic species recorded i.e. *Clarias brachysoma, Channa orientalis* (Figure 1). Highest abundance of *Chitala ornata* was recorded in Katapola compared to *Chitala ornata* in other four sites. Highest abundance of *Puntius vittatus* was recorded in Katapola site while lowest abundance was in Yagirala. *Mystus vittatus* was recorded only from Katapola and Galatara sites. *Clarias brachysoma* was found only in Katapola site but in low abundance (n=5) (Table 1). The length of the smallest *Chitala ornata* recorded is 7.2 cm while largest one measured 42 cm during this study.



Figure 1: Some fish species recorded from sampling sites. A; *Chitala ornata* B: *Channa orientalis* C: *Clarias brachysoma*

Table 1: Species richness and relative abundance of fish species in selected sites

Fish species	Sampling sites				
	Katapola	Ganegoda	Avitthawa	Yagirala	Galatara
Chitala ornata	08	04	05	04	04
Puntius vittatus	185	95	42	24	25
Rasbora daniconius	26	21	18	26	29
Puntius dorsalis	08	05	08	-	12
Trichogaster pectoralis	16	08	10	14	14
Osphronemus goramy	26	24	14	12	12
Clarias brachysoma	05	-	-	-	-
Channa orientalis	08	02	05	-	-
Mastacembulus armatus	1	04	-	04	-
Mystus vittatus	04	-	-	-	05

Diversity indices computed for study sites are given in Table 2. Katapola site showed high species richness and lowest evenness and Simpson and Sorenson diversity indices. Galatara site recorded high Sorenson diversity index, Simpson diversity index and evenness.

Table 2: Some diversity indices from the study sites

Site	Sorenson diversity index	Simpson diversity index	Evenness	Species richness
Katapola	1.33	0.56	0.58	10
Ganegoda	1.35	0.62	0.65	08
Avitthawa	1.67	0.76	0.86	07
Yagirala	1.59	0.77	0.86	06
Galatara	1.76	0.80	0.98	07

Results of the gut content analysis of *Chitala ornata* are shown in Table 3. The main food items recorded in *Chitala ornata* irrespective of sites are parts of the fish (flesh, scales, parts of fins and bones), mollusk, adult insects, insect larvae, macrophytes, and digested/detritus matter.

These data clearly reveals an ontogenic diet shift. Consumption of adult insects and macrophytes was shown to gradually decrease with increasing body size while consumption of parts of fish gradually increase with body size increasing. Some undigested fish remains were identified as parts of small cyprinids like *Puntius vittatus, Rasbora daniconius* and the endemic fish, *Channa orientalis.*

Table 3: Mean Bio volume (SE) of food category present in the gut contents of *Chitala ornat*a of different size classes collected from all the sampling sites

Food item	Size classes (cm)		
	0-10	10-15	> 15
Parts of the fish	05± 1.02	32* 2.68	72* 3.21
Mollusk	04± 0.91	18± 1.09	07± 0.98
Adult insects	17± 2.15	12± 2.08	04± 1.98
Insect larvae	02± 0.65	09± 0.85	03± 0.72
Macrophytes	60* 4.12	15± 1.12	6± 0.62
Digested/detritus matter	12± 1.65	14± 1.24	8± 1.06

Results of the one way ANOVA reveals significant difference ($P< 0.05$) of food items such as parts of the fish and macrophytes among different size classes of this invasive species. In the present study fishes larger than 15 cm exhibited piscivorous food habit while small fish (< 10 cm) exhibited insectivorous/herbivorous feeding habit.

The diet/niche breadth values of the species considered in shown in Table 4.

Rasbora daniconus, Puntius dorsalis and *Trichogaster pectoralis* showed a relatively large niche breadth based on food resources and therefore are more general feeders. In contrast, *Chitala ornata* recorded a narrow niche breadth value ($B_i< 2.75$) indicating a specialised feeder.

Table 4: Diet/niche breadth values of fish species considered.

Fish species	Overall
Chitala ornata	2.67
Puntius vittatus	2.88
Rasbora daniconius	4.02
Puntius dorsalis	4.93
Trichogaster pectoralis	4.73
Osphronemus goramy	3.18
Channa orientalis	2.96

Puntius vitatus, Osphronemus goramy and Channa orientalis moderately specialised feeders shown by the values of diet breadth from this study.

DISCUSSION

Considering computed diversity indices, Katapola sites showed high species richness and lowest evenness and Simpson and Sorenson diversity indices. The reason for these lowest values could be attributed to highest number of one particular species i.e. *Puntius vittatus* and lowest number of one particular species i.e. *Mastacembulus armatus*. This situation leads to the low evenness and hence low biodiversity.

Galatara site recorded high Sorenson diversity index, Simpson diversity index and evenness. Relatively more or less similar number of individual fish species in Galatara site resulted in high evenness, Sorenson and Simpson diversity indices

High species diversity and species richness of some of the study sites i.e Katapola and Ganegoda reveals needs of conservation measures for small tributaries of Bentota river. Because these sites are located in near to paddy field and tea cultivated land application of fertilizers and pesticides will affect to the survival of some of pollutant sensitive species in these tributaries.

Considering feeding ecology, small *Chitala ornata* (less than 10 cm) mainly depend on macrophytes and adult insects, but when they attain large size (more than 15 cm) their food habits shifted to carnivory from herbivory, as they fed mainly on parts of the fish and mollusks. Results of the one way ANOVA reveals significant difference ($P< 0.05$) of food items such as parts of the fish and macrophytes among different size classes. Shirantha (2016) recorded a similar situation in a study carried out on Size-dependent dietary shifts in *Chitala ornata* in Bolgoda Lake, Western province. Their results based on stomach content analysis revealed clear ontogenetic variations of relative abundance of different food categories. It showed strong ontogenetic diet shifts from omnivory in fish of 30-35 cm length to carnivory in fish larger than 35 cm and exclusive piscivory when it was larger than 50 cm.

According to findings of another research study on distribution patterns, feeding behavior and invasiveness of the *C. ornata* in the sub water ways of Attanagalu Oya Sri Lanka, gut content analysis indicated that *C. ornata* feeds on significant number of native fish species. Five major prey fish species, consisting *Labeo dussumeri*, *Puntius kelumi*, *Mystuss vittatus*, *Ompok bimaculatus* and *Megalops cyprinoides* were found to make up the diet of 28 adults and 05 juveniles of *C. ornata*(Perera 2016).

Remains of body parts of the endemic fish *C. orientalis* in the gut contents of *C. ornata*, indicates threats to the endemic fish fauna. 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. Size distribution of *C. ornata* ranging from 7.2 cm to 42 cm indicates reproduction and successful colonization within the introduced habitat. Therefore urgent attention should be paid to population control of *C.ornata* and to prevent its further invasion

The present study reports the size-dependent dietary shift of *C. ornata* as a contribution to the existing knowledge about biological aspects of this exotic species.

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