

RESEARCH ARTICLE

Food habits of *Pterygoplichthys disjunctivus* (Vermiculated sailfin cat fish) and coexisting fish species in Victoria and Kalawewa reservoirs, Sri Lanka

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ABSTRACT

Pterygoplichthys disjunctivus is now recognized as an invasive alien species (IAS) in Sri Lanka. This species has established populations in local water bodies including Victoria and Kalawewa reservoirs. Current study aims to find out food habits of *P. disjunctivus*. Fish samples of *P. disjunctivus* and coexisting fish species were collected from Victoria and Kalawewa reservoirs in the months of August and September in 2018, respectively, with prior permission and their total length, standard length and weight were recorded to the nearest 0.1 cm and 0.1 g, respectively. Relative importance of food items, Pianka's food niche overlapping index values were analyzed in the study. Relative importance of food items of *P. disjunctivus*, *Oreochromis niloticus* and *Etioplos suratensis* show similar values for both reservoirs illustrating similar food preferences and omnivorous feeding habit. Diets of *Rasbora daniconius*, *Glossogobius guiris*, *Mystus vittatus* and *Heteropneustes fossilis* consisted of more insects and fish particles in both reservoirs indicating a carnivorous feeding habit including *Mastecembelus armatus*. Diets of *Puntius filamentosus* (*Dawkinsia filamentosa*) and *Puntius chola* consisted mainly with plant particles showing that these species are macrophyte feeders which were caught from Victoria and Kalawewa reservoirs. Pianka's food niche overlapping index values for the diets of *O. niloticus*, *E. suratensis*, with *P. disjunctivus* in both reservoirs showed high overlapping values indicating high dietary overlap but *G. guiris*, *M. vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, *P. dorsalis* and *P. chola* with *P. disjunctivus* in Victoria reservoir showed low overlapping values indicating relaxed dietary overlap. Pianka's food niche overlapping index values for the diets of *G. guiris*, *M. vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, and *P. chola* with *P. disjunctivus* showed low overlapping values indicating low dietary overlap in Kalawewa reservoir. Pianka's food niche overlapping index values revealed *P. disjunctivus* is in competition with food habits with *O. niloticus* and *E. suratensis*. Therefore, suitable fishing gear or trap should be identified for effective controlling of *P. disjunctivus* in Sri Lankan water bodies.

Keywords: *Pterygoplichthys disjunctivus*, invasive species, food overlapping

INTRODUCTION

Pterygoplichthys disjunctivus (vermiculated sailfin cat fish) is accidentally introduced to the natural water bodies of Sri Lanka (Gunawardane, 2002; Marambe *et. al.*, 2011). Its common threat to freshwater ichthyofauna is habitat degradation (MENR 2007; IUCN, 2011). *Pterygoplichthys* spp. (sucker mouth armoured catfishes) are invasive and has well established populations and

continuing spread in most of the freshwater ecosystems in the Mexico (Mendoza-Alfaro *et al.*, 2009). According to Martínez-Palacios *et al.* (2010) and Sandoval-Huerta *et al.* (2012), sucker mouth armored catfishes compete with native fish species mainly for food and space in Mexico. In the Philippines, *P. disjunctivus* and *P. pardalis* species consume algae from submerged surfaces (Jumawan *et al.*, 2016) which in turn may compete with aquatic species which feed on algae. Hoover *et al.* (2004) also mentioned that they graze heavy amounts of algae. Phelps and Walsh (2006) mentioned that *P. disjunctivus* has rapidly expanded its distribution. According to Özdilek (2007), the rapid invasive characters of *P. disjunctivus* are a threat to fish fauna of Middle East.

However, a little is known about the feeding biology of exotic species in freshwater habitats in Sri Lanka. Marambe *et al.* (2011) stated that tank cleaner (*Hypostomus plecostomus*) fed on plankton, plant particles and invertebrates and can compete with native biota. Wijethunga and Epa (2008) mentioned that sucker mouth armored catfish has become a threat to Sri Lankan freshwaters. Further, Sumanasinghe and Amarasinghe (2014) observed that accidentally introduced exotic fish species, *P. pardalis*, is established in most of the Sri Lanka inland waters. Analysis of food and feeding habits of such species is important to investigate the impact of introduced species on indigenous fish biodiversity. Competition for food resources with native species may create imbalance in the trophic relationships due to invasion of *P. disjunctivus*. As such, this study tried to identify the food item overlapping of *P. disjunctivus* with other fish species occupying in same habitats.

MATERIALS AND METHODS

Fish samples of *P. disjunctivus* and coexisting fish species were collected from Victoria and Kalawewa reservoirs (Plate 1 and 2) in the months of August and September in 2018, respectively, from 4.00 hours with four hourly intervals for 24 h (twenty five fishes for each species irrespective of size) with prior permission and their total length, standard length and weight were recorded to the nearest 0.1 cm and 0.1 g, respectively. Gill nets were set in shallower areas of 2 m depth of the sampling sites of the two reservoirs. Small fish species were injected with 10% buffered formalin and stored in bottles with same concentration of buffered formalin (25 fishes for each species). Guts of the larger fish species including *P. disjunctivus* were stored individually in containers with 10% buffered formalin (25 fishes for each species). In the laboratory the digestive track was uncoiled and anterior one third of gut of fish species were separated to analyze undigested food items because the latter gut had digested food items. The species with prominent stomach, stomachs were also separated. All fishes were grouped into 2 cm length classes for convenience. The anterior one third of gut and stomachs were weighed to the nearest 0.001g using analytical balance. In *P. disjunctivus* the stomach was always empty so the total gut was weighted and anterior one third of the gut was considered. Then, the anterior one third of gut or stomach contents were removed and remaining

empty gut or stomach was weighted to the nearest 0.001g. The difference in weight between the full anterior one third of gut or stomach and the empty anterior one third of gut or stomach from which contents were extracted gave the wet weight of the stomach contents (Getachew, 1989). Stomach/gut contents were diluted to form a suspension in a beaker with known volume.

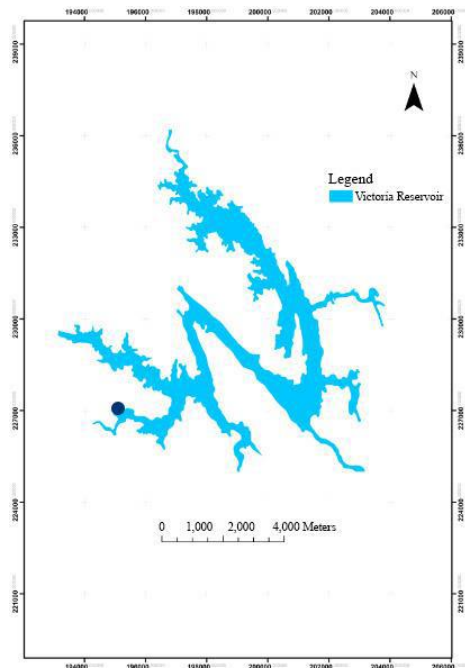


Plate 1: Sampling site in Victoria

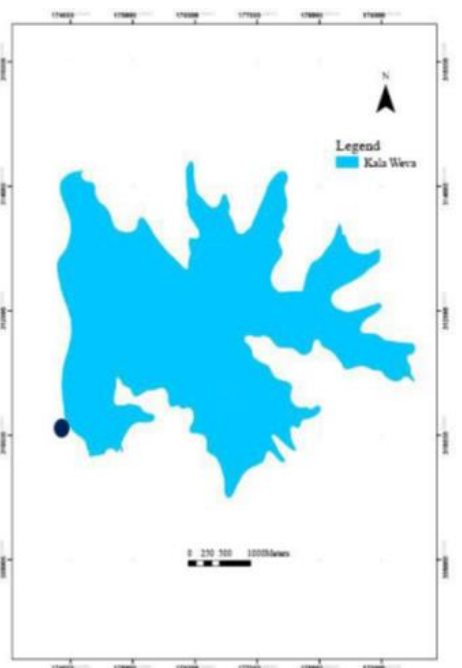


Plate 2: Sampling site in Kalawewa

From the appropriate dilution 1 ml volume was taken into a Sedgwick rafter cell and examined under light microscope (Olympus BX40) with magnification $10 \times 4/10$. Three sub samples of each suspension were analyzed. The food items were identified up to lowest possible taxa using the keys given by Prescott, (1954). The quantitative analysis of gut/stomach contents was performed by point's method as described by Hynes (1950) by estimating relative bio volumes of food items in each gut contents for each fish species using *Pinnularia* as the unit. Relative bio volumes of food items were recorded for each fish specimen for four hourly time intervals of the day. The % relative importance of major food items pooled for individual fish of each species was calculated according to the method described by Helawell and Abel, (1971), as follows.

$$\% \text{ Relative importance} = \text{Bio volume of } i^{\text{th}} \text{ food item} * 100 \quad (1)$$

The % relative importance's of major food items for each species were plotted as pie charts in order to examine the food preferences of each fish species.

Then the species dietary overlap was determined for pooled data by using Pianka's index (Pianka, 1973).

$$O_{jk} = \sum P_{ij} P_{ik} / (\sum P_{ij}^2 P_{ik}^2)^{1/2} \quad (2)$$

Where,

p_i = Proportion of prey item i in the diet of species j and k

O_{jk} = Pianka's index for species j and k

Pianka's index (O) varies between 0 (total separation) and 1 (total overlap).

The fishes which quantitative analysis of the gut/stomach contents were calculated were grouped into 2 cm length classes for convenience as mentioned. For each fish in separate length class, gut / stomach fullness was calculated as follows.

$$\text{Gut/stomach fullness} = \frac{\text{Total weight of gut / stomach content weight for a length class}}{\text{Total number of fish in that length class}} \quad (3)$$

Assuming that gut fullness is high in peak feeding hours, gut fullness for *P. disjunctivus*, *O. nilotucus* and *E. suratensis* were illustrated graphically for four-hour intervals for the 24 h to check overlapping of species wise peak feeding times.

The ten fish species collected from Victoria and Kalawewa reservoirs were clustered according to the bio volumetric proportion of categories of food items with minitab software and illustrated as similarity levels of food categories of each fish species. Pianka's food niche overlapping index was estimated to investigate the level of food niche overlapping of *P. disjunctivus* and coexisting fish species in Victoria and Kalawewa reservoirs.

RESULTS AND DISCUSSION

Coexisting fish species and different food categories in gut

Ten fish species were collected from Victoria reservoir and eleven fish species were collected from Kalawewa reservoir including *P. disjunctivus* (Table 1).

Table 1: Diversity of fishes caught during diurnal sampling in Victoria and Kalawewa.

	Fish species	Common name	Status*
Victoria	<i>Pterygoplichthys. disjunctivus</i>	Vermiculated sail fin catfish	Exotic
	<i>Oreochromis. niloticus</i>	Nile tilapia	Exotic
	<i>Etilapia suratensis</i>	Green chromid	Indigenous
	<i>Puntius filamentosus</i>	Blotched filamented barb	Indigenous
	<i>Puntius dorsalis</i>	Long snouted barb	Indigenous
	<i>Puntius chola</i>	Chola barb	Indigenous
	<i>Rasbora daniconius</i>	Black line rasbora	Indigenous
	<i>Heteropneustes fossilis</i>	Stinging catfish	Indigenous
	<i>Mystus vittatus</i>	Striped dwarf catfish	Indigenous
	<i>Glossigobius guiris</i>	Goby	Indigenous
	Kalawewa	<i>P. disjunctivus</i>	Vermiculated sail fin catfish
<i>O. niloticus</i>		Nile tilapia	Exotic
<i>E. suratensis</i>		Green chromid	Indigenous
<i>P. filamentosus</i>		Blotched filamented barb	Endemic
<i>P. dorsalis</i>		Long snouted barb	Indigenous
<i>P. chola</i>		Chola barb	Indigenous
<i>R. daniconius</i>		Black line rasbora	Indigenous
<i>H. fossilis</i>		Stinging cat fish	Indigenous
<i>M. vittatus</i>		Striped dwarf cat fish	Indigenous
<i>G. guiris</i>		Goby	Indigenous
<i>Mastacembelus armatus</i>		Zig zag eel	Indigenous

*De Silva (1989); Marambe *et al.* (2011)

Different food types available in the gut contents were identified under eleven categories. Different food categories observed in gut contents of fish species were given in Table 2 and checklist of different categories of food items in gut contents of fish species sampled in Victoria and Kalawewa reservoirs in table 3.

Table 2: Different food categories and food items in the gut contents of each category.

Food Category	Food items
Diatoms (DI)	<i>Navicula, Nitzschia, Stauroneis, Pinnularia</i>
Green algae (GA)	<i>Pediastrum, Cosmarium,</i>
Filamentous algae (FA)	Algae forms with filaments or threadlike shapes
Macrophytes (MP)	Plant particles
Rotifers(RO)	<i>Brachionus</i>
Cladocerans (CC)	Body parts of <i>Daphnia</i> sp. and other cladocerans
Insect parts (IN)	Body parts of insects
Worms (WO)	Nematodes
Fish parts (FP)	Scales and other body parts
Detritus (DT)	Organic particulate matter partially digested and difficult to particularly distinguished as animal or plant origin
Unknown particles (UI)	Items which were difficult to identify due to digestion

Percentage importance of food items

Percentage importance of food items (percentage of food items were given in bio volumetric proportions) of fish species were given in a series of pie charts in Figure 1 and 2 for Victoria and Kalawewa reservoirs respectively. Gut contents of *P. disjunctivus* was consisted with food items in nine categories. Detritus was the most prevailing category of food items and represented 41 and 37% of the total food items of gut contents of *P. disjunctivus* in Victoria and Kalawewa reservoirs respectively (Figure 1 (a) and Figure 2 (a)). The next prevailing category of food was filamentous algae and represented 28% and 38% of the food items in the gut contents of *P. disjunctivus* in Victoria and Kalawewa reservoirs, respectively. The majority of the food items in gut content of *P. disjunctivus* in both reservoirs can clearly categorized into plant origin. The relative importance of diatoms, green algae, filamentous algae and plant parts were 51 and 57% in the gut contents of *P. disjunctivus* sampled from Victoria and Kalawewa reservoirs respectively. Identification of the origin of detritus was difficult in present analysis.

Table 3 provides a checklist of different categories of food items in gut contents of fish species sampled in Victoria and Kalawewa reservoirs.

Table 3: Checklist of different categories of food items in gut contents of fish species sampled in Victoria and Kalawewa reservoirs.

Reservoir	Fish Species	Different categories of food items											
		DI	GA	FA	MP	RO	CC	IN	WO	FP	DT	UI	
Victoria	<i>P. disjunctivus</i>	+	+	+	+	+	+	+	+	+	NA	+	
	<i>O. niloticus</i>	+	+	+	+	+	+	+	+	+	NA	+	
	<i>E. suratensis</i>	+	+	+	+	+	+	+	NA	+	NA	+	
	<i>P. filamentosus</i>	NA	NA	+	+	NA	+	+	+	+	+	+	
	<i>P. dorsalis</i>	NA	NA	+	+	NA	+	+	+	+	+	+	
	<i>P. chola</i>	NA	NA	+	+	NA	+	+	+	+	+	+	
	<i>R. daniconius</i>	NA	NA	NA	+	NA	+	+	+	+	+	+	
	<i>H. fossilis</i>	NA	NA	NA	+	NA	NA	+	NA	+	+	+	
	<i>M. vittatus</i>	NA	NA	NA	+	NA	NA	+	NA	+	+	+	
	<i>G. guiris</i>	NA	NA	NA	+	NA	NA	+	NA	+	+	+	
	Kalawewa	<i>P. disjunctivus</i>	+	+	+	+	+	+	+	+	+	NA	+
		<i>O. niloticus</i>	+	+	+	+	+	+	+	+	+	NA	+
		<i>E. suratensis</i>	+	+	+	+	+	+	+	+	+	NA	+
<i>P. filamentosus</i>		NA	NA	+	+	+	+	+	+	+	NA	+	
<i>P. dorsalis</i>		NA	NA	+	+	NA	+	+	+	+	+	NA	
<i>P. chola</i>		NA	NA	+	+	NA	+	+	+	+	+	NA	
<i>R. daniconius</i>		NA	NA	NA	+	NA	+	+	+	+	+	+	
<i>H. fossilis</i>		NA	NA	NA	NA	+	+	+	+	+	+	+	
<i>M. vittatus</i>		+	NA	NA	+	NA	+	+	+	+	NA	NA	
<i>G. guiris</i>		NA	NA	NA	+	NA	+	+	+	+	NA	NA	
<i>M. armetus</i>		NA	NA	NA	NA	NA	+	+	+	+	+	+	

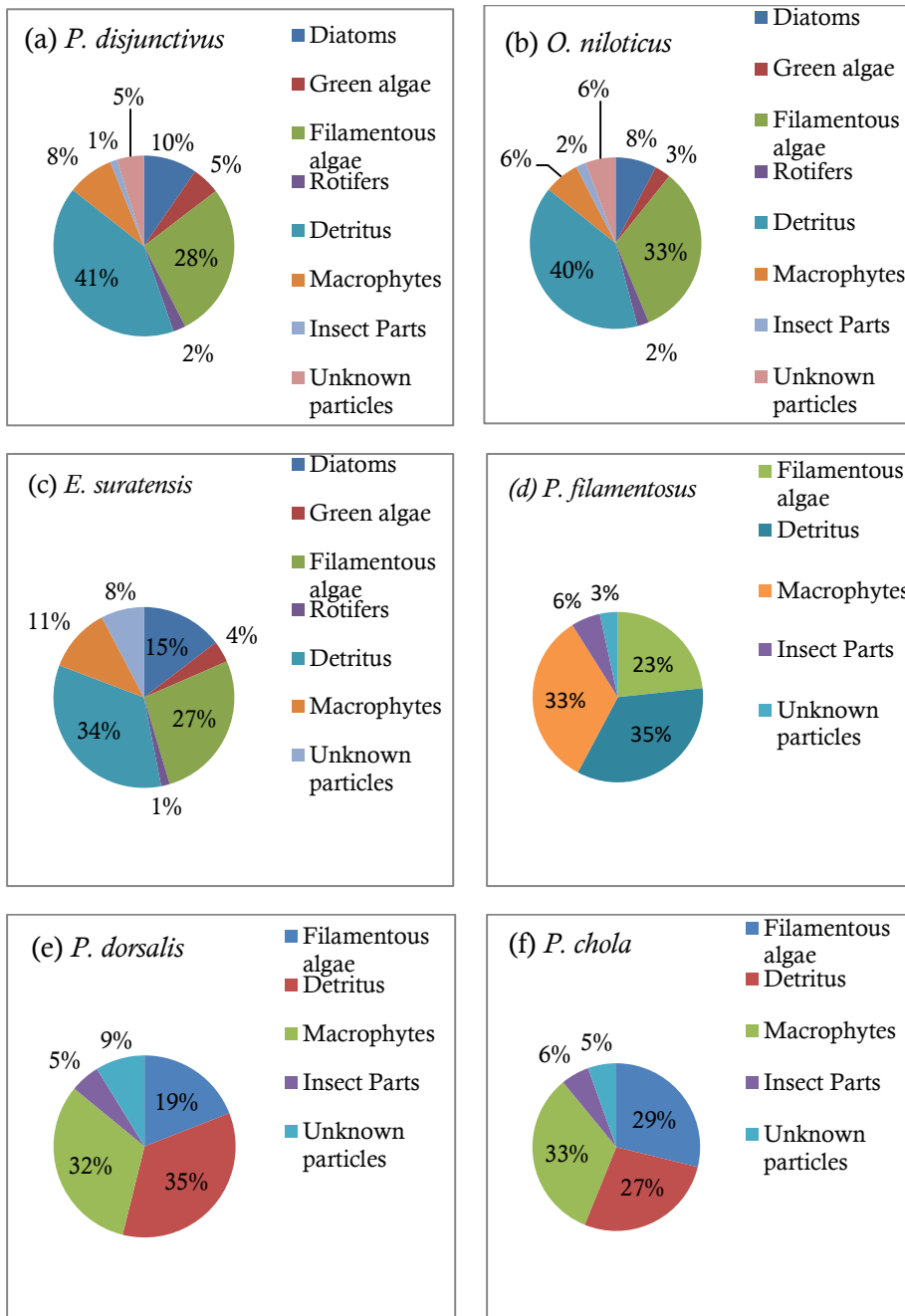


Figure 1: Percentage importance of food items of (a). *P. disjunctivus*, (b). *O. niloticus*, (c) *E. suratensis*, (d) *P. filamentosus*, (e) *P. dorsalis*, (f) *P. chola* caught from Victoria reservoir

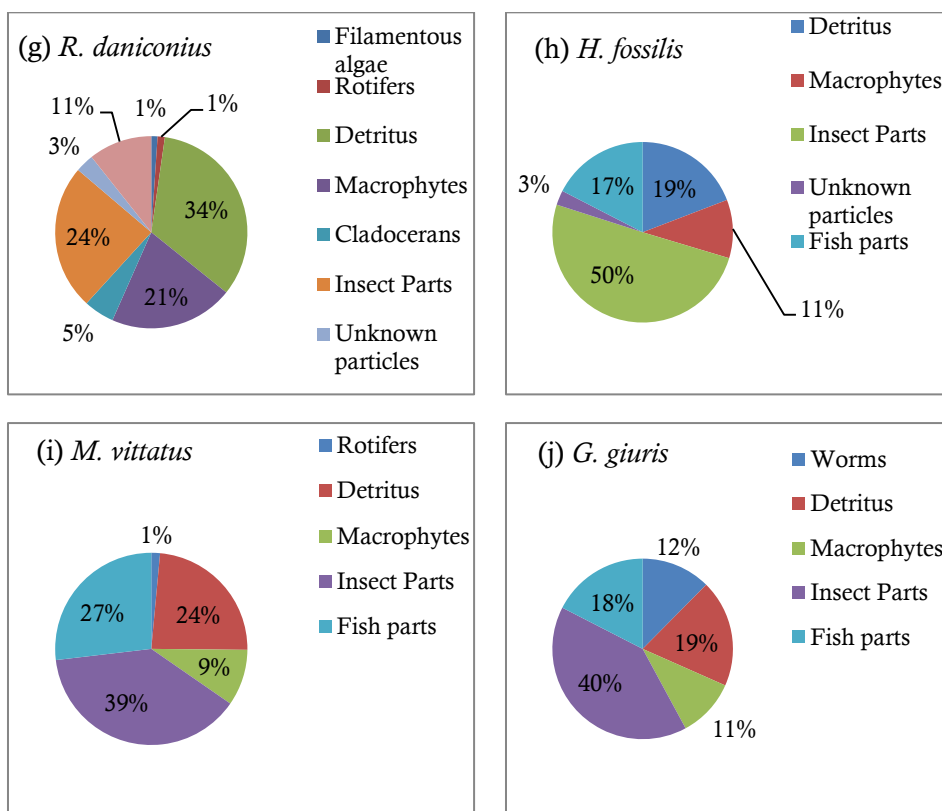


Figure 1 (contd.): Percentage importance of food items of (g) *R. daniconius*, (h) *H. fossilis*, (i) *M. vittatus* and (j) *G. giuris* caught from Victoria reservoir

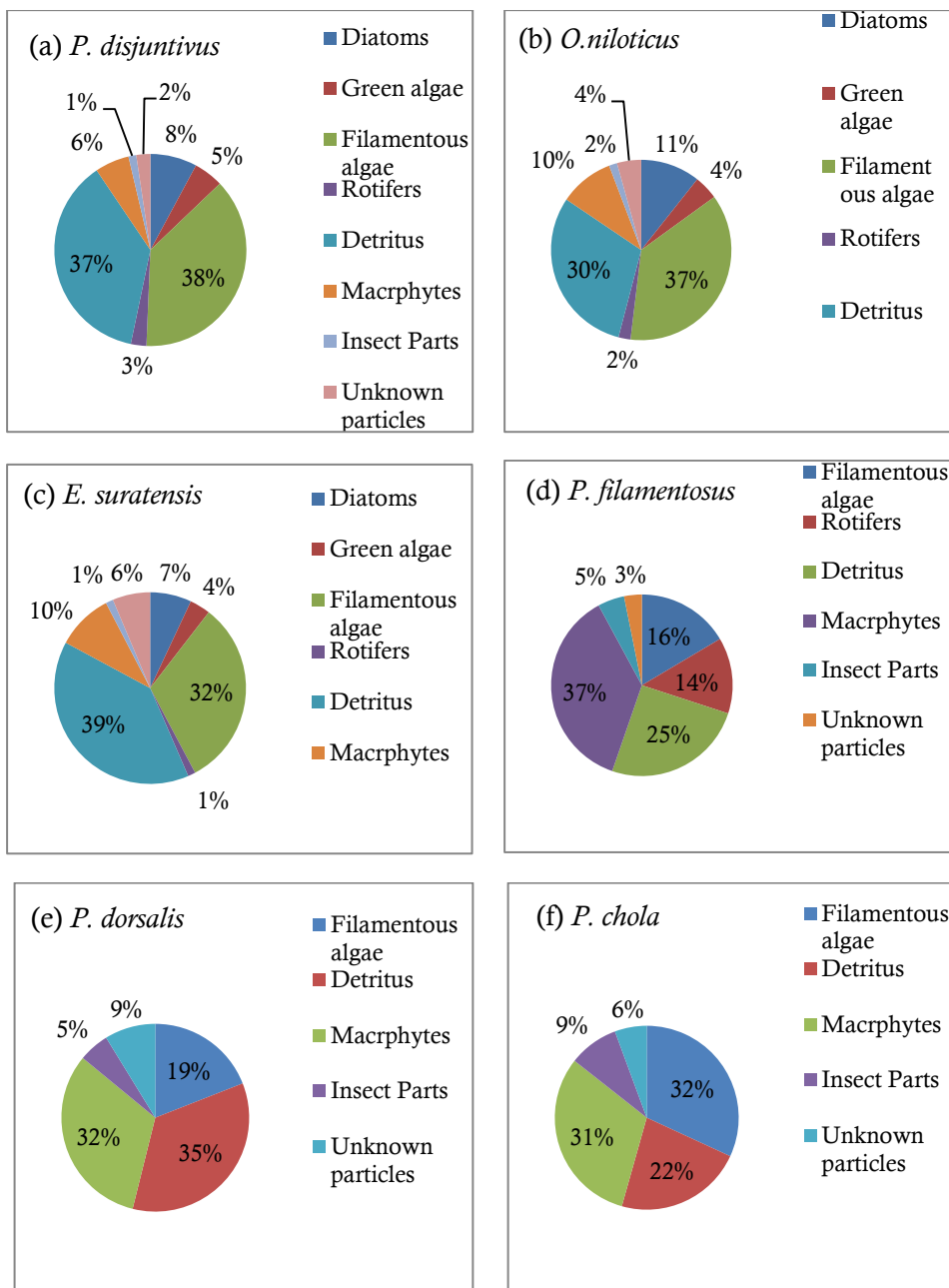


Figure 2: Percentage importance of food items of (a). *P. disjunctives*, (b). *O. niloticus*, (c) *E. suratensis*, (d) *P. filamentosus*, (e) *P. dorsalis*, (f) *P. chola* caught from Kalawewa

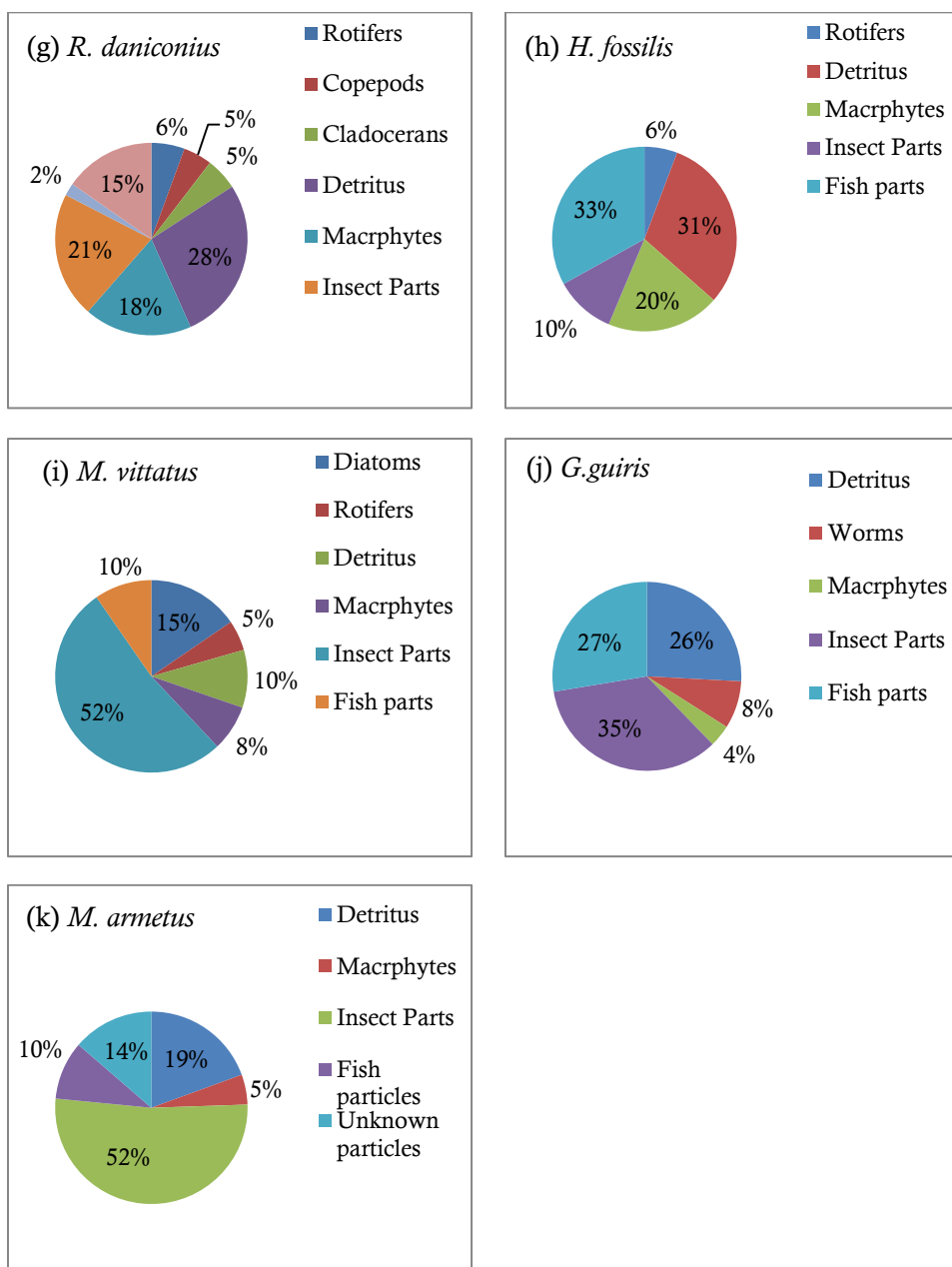


Figure 2 (contd.): Percentage importance of food items of (g) *R. daniconius* (h) *H. fossilis*, (i) *M. vittatus*, (j) *G. guiris* (k) *M. arnetus* caught from Kalawewa.

Among exotic fish species gut content similarity was observed in two reservoirs. Also, it indicated the availability of similar food items in both environments Percentage importance of food items identified in gut contents of *P. disjunctivus*,

O. niloticus, and *E. suratensis* were similar in both reservoirs (Figure. 1 a, b and c and Figure 2 a, b, and c).

It indicates the dependency of these three species on same food resources in the two reservoirs. Detritus and filamentous algae were two of the main food components of these three fish species. Percentage importance of food items identified in gut contents of *P. filamentosus*, *P. dorsalis* and *P. chola*, were also similar and they shared similar type of food resources in the two reservoirs. The most common food item of *P. disjunctivus* with *P. filamentosus*, *P. dorsalis* and *P. chola* was detritus (Figure 1 and 2 a, d, e, and f).

Cluster analysis of fish species according to food habits

The ten fish species caught from Victoria and Kalawewa reservoirs were clustered according to the bio volumetric proportion of categories of food items and illustrated as similarity levels of food categories of each fish species. The ten fish species caught from Victoria reservoir were clustered into two broad clusters at the similarity level of 36.20% (Figure 2). The first cluster formed with *P. disjunctivus*, *O. niloticus*, *E. suratensis*, *P. filamentosus*, *P. dorsalis* and *P. chola* and the other cluster were formed with *R. daniconius*, *G. guiris*, *M. vittatus* and *H. fossilis*. Then, at the similarity level 68.68% *P. disjunctivus* was separated into a new cluster from *O. niloticus* and *E. suratensis*. At the similarity level 54.63% *P. filamentosus*, *P. dorsalis* and *P. chola* were grouped into anew cluster from *R. daniconius*, *G. guiris*, *M. vittatus* and *H. fossilis*.

Fish species caught from Kalawewa were also clustered into two broad clusters at the similarity level of 38.45% (figure 3). The first cluster formed with *P. disjunctivus*, *O. niloticus*, *E. suratensis*, *P. filamentosus*, *P. dorsalis* and *P. chola* and the other cluster were formed with *R. daniconius*, *G. guiris*, *M. vittatus* and *H. fossilis*. Then, at the similarity level 65.37% *P. disjunctivus* separated from *O. niloticus*, *E. suratensis*. Again at similarity level 67.92% *P. filamentosus*, *P. dorsalis* and *P. chola* were separated into a new cluster from *R. daniconius*, *G. guiris*, *M. vittatus* and *H. fossilis*. Then at the similarity level 69.44 *P. disjunctivus* was separated into a new cluster from *O. niloticus* and *E. suratensis*. Then, at the similarity level 69.63 *P. filamentosus*, *P. dorsalis* and *P. chola* were separated from *G. guiris*, *M. vittatus*, *H. fossilis* and *R. daniconius* caught from Kalawewa reservoir. According to cluster analysis *P. disjunctivus* showed closer similarity levels of bio volumes of food categories with *O. niloticus* and *E. suratensis*.

Figure 3 and 4 shows cluster diagram of the similarity levels of each fish species caught from Victoria and Kalawewa reservoirs according to food categories, respectively.

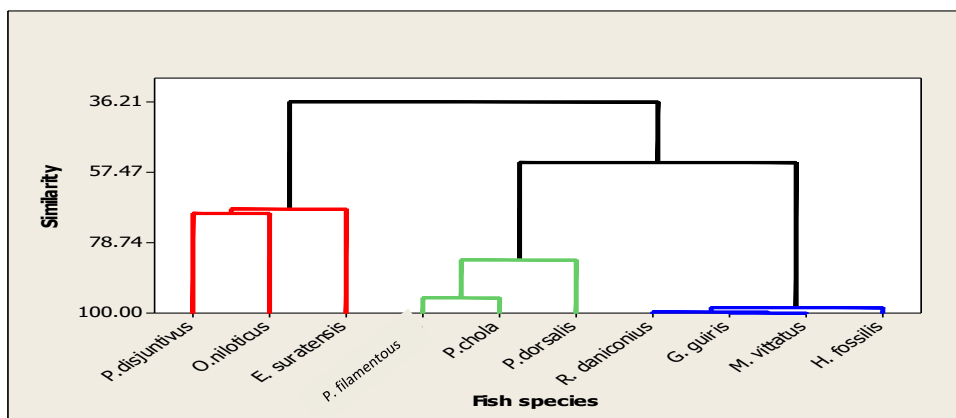


Figure 3: Cluster diagram of the similarity levels of each fish species caught from Victoria reservoir according to their food categories.

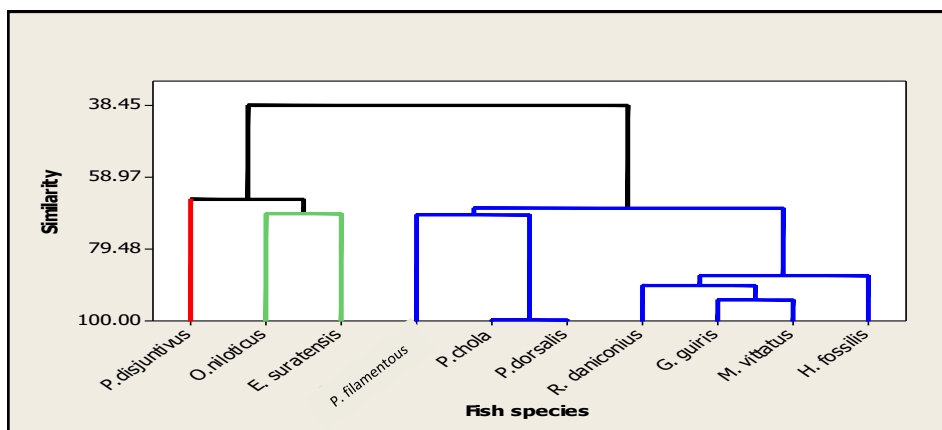


Figure 4: Cluster diagram of the similarity levels of each fish species caught from Kalawewa reservoir according to their food categories.

Pianka’s food overlapping

Table 4 shows Piyanka’s food niche overlapping index values of *O. niloticus*, *E. suratensis*, *G. guiris*, *M.vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, *P. dorsalis* and *P. disjunctivus* in Victoria and Kalawewa reservoirs.

Pianka’s food niche overlapping index values range from 0.00 to 1.00 signifying no overlap to complete overlap. According to the results in current analysis overlaps >0.66 considered as high overlaps and overlaps <0.33 considered as low overlaps. Pianka’s food niche overlapping index values showed high overlapping of *P. disjunctivus* versus *O. niloticus* and *E. suratensis* which were 0.87 and 0.79 in Victoria reservoir and 0.80 and 0.66 in Kalawewa reservoir,

respectively, (Table 4). Piyanka's food niche overlap index values of *P. disjunctivus* versus *O. niloticus* were comparatively higher than that of *E. suratensis*. Piyanka's food niche overlapping index values of *P. disjunctivus* versus *G. guiris*, *M. vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, *P. dorsalis* and *P. chola* were low or minimum in Victoria and Kalawewa reservoirs in the present analysis (Table 4).

Table 4: Piyanka's food niche overlapping index values of *O. niloticus*, *E. suratensis*, *G. guiris*, *M. vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, *P. dorsalis* and *P. chola* with *P. disjunctivus* in Victoria and Kalawewa reservoirs.

Fish species	Piyanka's food niche overlapping index with <i>P. disjunctivus</i>	
	Victoria	Kalawewa
<i>O. niloticus</i>	0.87	0.80
<i>E. suratensis</i>	0.79	0.66
<i>P. filamentosus</i>	0.28	0.22
<i>P. dorsalis</i>	0.24	0.24
<i>P. chola</i>	0.25	0.24
<i>R. daniconius</i>	0.12	0.12
<i>H. fossilis</i>	0.03	0.03
<i>M. vittatus</i>	0.06	0.05
<i>G. guiris</i>	0.04	0.08

Gutfullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis*

Figure 3 shows the temporal mean gut fullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis* in Victoria reservoir.

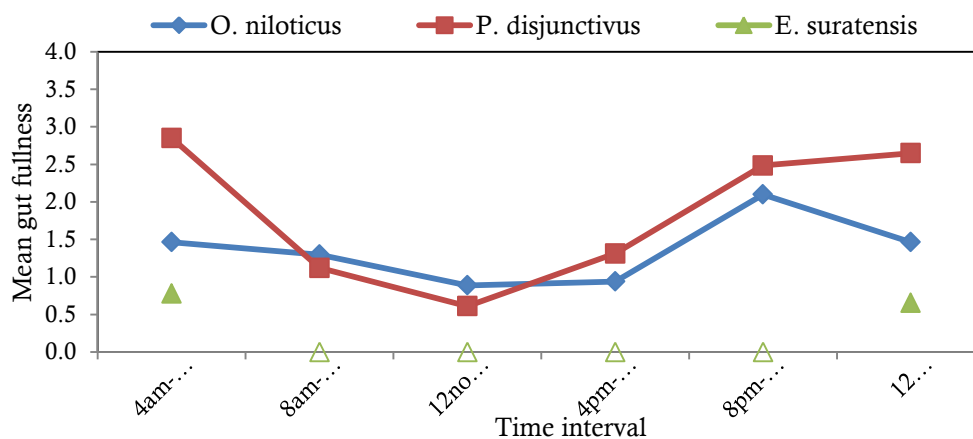


Figure 3: The temporal mean gut fullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis* in Victoria reservoir.

Figure 4 shows the temporal mean gut fullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis* in Kalawewa reservoir.

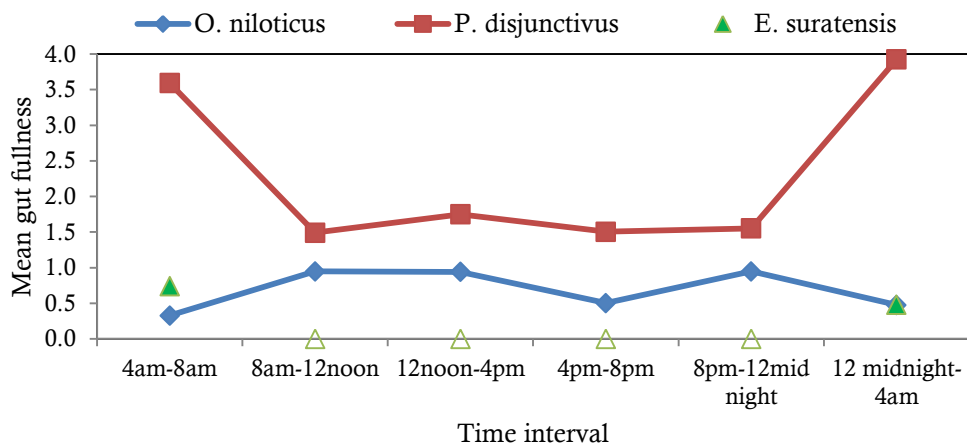


Figure 4: The temporal mean gut fullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis* in Kalawewa reservoir.

Diurnal changes of mean gut fullness of *P. disjunctivus*, *O. niloticus* and *E. suratensis* were evaluated to examine whether there is a temporal difference in their feeding. Figure 3 shows temporal variation of mean gut fullness. The mean gut fullness of *P. disjunctivus* was peaked during 8.00 pm to 12 midnight until 4.00am indicating active feeding during early morning and night but day time hours in both Victoria and Kalawewa reservoirs. Mean gut fullness of *O. niloticus* was also increased from 12 mid night to 4.00 am indicating active feeding in early morning but day time hours in both Victoria and Kalawewa reservoirs. This indicated an overlap of active feeding hours of *P. disjunctivus* and *O. niloticus*. *E. suratensis* were present in the early morning catch samples in both Victoria and Kalawewa reservoirs hence the mean gut fullness was calculated for those samples and also indicated in the Figure 3 and 4. Some of the gut contents of *O. niloticus* are illustrated in Plate 3.



Plate 3: Microscopic illustration of gut contents of *O. niloticus* (10*10)

The distinctive feeding and reproductive behaviors of suckermouth catfishes, coupled with large size and high population densities, constitute significant threats to native fish communities and to aquatic habitats of the United States (Hoover *et al.*, 2004). Detailed studies about the morphology of the feeding apparatus in loricarioids are relatively rare and fragmentary compared with the commonly known trophic diversity (Adrians *et al.*, 2008; Howe *et al.*, 1997; Schaefer and Lauder, 1986; Schaefer, 2003; Geerinckx and Adriaens, 2008; Geerinckx *et al.*, 2008). According to Martínez-Palacios *et al.* (2010); Geerinckx and Adriaens (2008) and Sandoval-Huerta *et al.* (2012), sucker mouth armored catfishes compete with native fish species mainly for food and space in Mexico. In the Philippines, *P. disjunctivus* and *P. pardalis* species consume algae from submerged surfaces (Jumawan *et al.*, 2016) which in turn may compete with aquatic species which feed on algae. Hoover *et al.* (2004) also mentioned that they graze heavy amounts of algae. Similar types of negative impacts had been reported by Liang *et al.* (2005) and Chavez *et al.* (2006), such as overgrazing of algae and competition with native species. The stomach of the fish specimens of *P. disjunctivus* were always empty and were very closely associated with air bladder. Angelescu and Gneri (1949) reported empty stomachs in Loricariids. *P. disjunctivus* intestines are coiled which is a characteristic to most Loricariids (Power, 1983).

The stomach of the fish specimens of *P. disjunctivus* were always empty and were very closely associated with air bladder. Angelescu and Gneri (1949) reported empty stomachs in Loricariids. *P. disjunctivus* intestines are coiled which is a characteristic to most Loricariids (Power, 1983). There is a relationship with the quantity of detritus in diet with intestine length. *P. disjunctivus* diet mostly consisted with detritus. To ingest these fine detritus particles it possesses the lips, rake like teeth, less prominent pharyngeal teeth, fine gill rakers and long coiled intestine. Verigina (1991) and Fugi (1996) found somewhat similar characteristics for other bottom-feeding fishes that consume large quantities of detritus. The presence of considerable amount of filamentous algae in diet shows that during the scraping of substrates this food item may be ingested (Gerking, 1994). The current study relative importance of food items of *P. disjunctivus*, *O. niloticus* and *E. suratensis* show similar values for both reservoirs illustrating similar food preferences and omnivorous feeding habit. *R. daniconius*, *G. guiris*, *M. vittatus* and *H. fossilis* diet consisted with more insect and fish particles in both reservoirs indicating a carnivorous feeding habit. *M. armetus* caught from Kalawewa reservoir also showed similar results. *P. filamentosus* and *P. chola* diet consisted mainly with plant particles showing that these species are macrophyte feeders. *P. dorsalis* from Victoria reservoir also showed similar results in Victoria reservoir. Piyanka's food niche overlapping index values of *O. niloticus*, *E. suratensis*, with *P. disjunctivus* in both reservoirs showed high overlapping values indicating high dietary overlap. Piyanka's food niche overlapping index values of *G. guiris*, *M.vittatus*, *H. fossilis*, *P. srilankensis*, *R. daniconius*, *P. dorsalis* and *P. chola* with *P. disjunctivus* in Victoria reservoir

showed low overlapping values indicating relaxed dietary overlap. Also, in Kalawewa reservoir Piyanka's food niche overlapping index values of *G. guiris*, *M. vittatus*, *H. fossilis*, *P. filamentosus*, *R. daniconius*, and *P. cholera* with *P. disjunctivus* showed low overlapping values indicating low dietary overlap. *M. armetus* and *P. sarana* specimens were excluded here due to low number of fish specimens. Cluster analysis for the bio volumetric proportion of food categories of fish species considered also show high similarity of bio volumetric proportion of food categories *P. disjunctivus* with *O. niloticus* and *E. suratensis*.

Diurnal average gut fullness evaluations only considered the amount of fullness of gut for the three species considered which showed high overlapping values of Pianka's index. Study on *P. disjunctivus* food habits with coexisting fishes were carried out for the first time for Sri Lankan water bodies. Food habits clearly overlap with *O. niloticus* and *E. suratensis*. Peak feeding hours also overlapped with *O. niloticus*. There is a possibility of *P. disjunctivus* in habitat overlapping with other fishes because gillnet catch was consisted with all above mentioned fish species where gill net was set.

P. disjunctivus may accidentally swallow *O. niloticus* eggs thereby reducing its population size. Fishing in most of Sri Lanka reservoirs one of the target fish is *O. niloticus*. Hence the reduction of its population size may adversely affect the income of fishermen. Building of burrows in the banks of reservoirs may affect the stability of banks while increasing the turbidity of water. When consider the peak feeding hours it can be concluded that *P. disjunctivus* is omnivorous and nocturnally active and compete with coexisting fishes (*O. niloticus* and *E. suratensis*) for food and feeding time. There is a possibility that feeding time of *P. disjunctivus* overlaps with *O. niloticus* observing the times of fullness of guts but further research is essential in this field. Therefore, suitable fishing gear or trap should be identified for effective controlling of *P. disjunctivus* in Sri Lankan water bodies.

CONCLUSION

It can be concluded that Pianka's food niche overlapping index values revealed *P. disjunctivus* is in competition with food niche with *O. niloticus* and *E. suratensis*.

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