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Food resource partitioning of accidentally introduced sucker mouth catfish, *Pterygoplychthys multiradiatus* with some of the indigenous and intentionally introduced fish species in Sri Lanka

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Abstract

Invasive alien species (IAS) have been one of the major causes responsible for extinction of native species in island ecosystems. Sri Lanka being an island, it is very much essential to identify the effects of invasive alien fish species at the initial stages of infestations in order to apply control measures whenever necessary. ·

Ptrygoplychthys multiradiatus, is one of the accidentally introduced fish species that occurs mainly around Anuradapura, Colombo, Gampaha, Kandy, Kalutara and Kurunegala districts. The present study investigated the food resource partitioning of *P. multiradiatus* with several alien and indigenous fish species found in aquatic habitats of Sri Lanka. The gut/stomach contents of *Oreochromis mossambicus*, *Etroplus suratensis*, *Etroplus maculatus*, *Puntius dorsalis*, *Puntius filamentosus*, *Rasbora daniconius* and *Mystus gulio* was volumetrically analysed and food particles were identified. Gut/stomach content analysis data of *Mystus vittatus*, *Labeo rohita*, *O. niloticus*, *Anabas testudineus*, *Danio malabaricus*, *Glossogobius giuris*, *Catla catla*, *Trichogaster pectoralis* was obtained from secondary sources and are also considered in analysis.

According to the Shoener Index high dietary overlaps were observed between *P. multiradiatus* with *O. mossambicus* (S = 87%), *P. dorsalis* (S = 67.6%) and *T. pectoralis* (S = 66%). *E. suratensis*, *E. maculatus*, *P. filamentosus*, *R. daniconius*, *M. gulio*, *M. vittatus*, *C. catla*, *L. rohita* and *O. niloticus* had a moderate dietary overlap (33% < S < 66%) with *P. multiradiatus*. A low dietary overlap (33% < S) was observed between *A. testudineus*, *D. malabaricus*, *G. giuris* with *P. multiradiatus*.

Diet of the *P. multiradiatus* reflects characteristics of its omnivorous feeding habit or high feeding plasticity by consumption of a wide spectrum of food items ranging from plankton, plant matter to invertebrates. According to the results the range expansion of *P. multiradiatus* into the inland reservoirs mainly affects food availability of three intentionally introduced fish species, namely *O. mossambicus*, *O. niloticus* and *T. pectoralis* and one indigenous species, *P. dorsalis*. Further, invasion of *P. multiradiatus* in to inland freshwaters may pose a threat to the existence of number of endemic, indigenous and alien fish species that have similar feeding habits.

Key words: Tank cleaner, *Pterygoplychthys*, invasive, aquatic, dietary overlap

Introduction

One of the major threats to native biological diversity is now acknowledged to be the biological invasions caused by invasive alien species. Invasive alien species are found in all taxonomic groups and their impact on biodiversity is enormous (IUCN, 2000). According to Rainbow (1998) intentional and accidental introduction of exotic species have severely effected the native species composition in many countries during the past decades. It has been well documented that invasive alien species (IAS) have resulted in massive and rapid losses of biodiversity, especially in island communities (Clout, 1995).

According to historical evidence, many species of alien biota (especially plants) have been introduced to Sri Lanka during the past 500 years. Most of these deliberate introduction were carried out for agro-economic and forestry purpose (Bambaradeniya *et al.*, 1998). As far as the current situation in Sri Lanka is concerned, agricultural organizations, agencies responsible for inland fisheries development and ornamental fish industry clearly standout as major sources that contributed to the introduction of alien biota to Sri Lanka.

Pterygoplychthys multiradiatus, the Sucker mouth cat fish is one of the fish species that has accidentally introduced to the natural water bodies of Sri Lanka. Presence of this fish species in Sri Lankan fresh waters was reported by Gunawardena (2001), Marambe *et al.* (2003). It has now well established in water bodies around Anuradhapura, Colombo, Gampaha, Kalutara, Kandy and Kurunegala districts. In all instances, it is believed the presumed mechanism of introduction was aquarium release or escape from aquaculture farms.

The sucker mouth catfish (Plate 1) belongs to Family Lorricaridae and are endemic to south America and Panama. They are characterized by having large bony plated and a ventral mouth (Page *et al.*, 2006). Sucker mouth cat fish is dorso-ventrally flattened with under slung sucking mouth surrounding fleshy lips bearing reduced barbles and spiny body armour. This fish bears more than 10 dorsal fin rays and 1 dorsal fin spine. Its pectoral fins have thick, toothed, spines. Body is short and robust. These characteristics are used to identify this species from other Loricariidians. *Pterygoplychthys multiradiatus* is a bottom dweller and likes warm water at the temperature range of 23-27 °C and pH range of 6.5-7.8. It is believed that the destructive feeding habit of this fish and reproductive behavior coupled with large size and population densities constitutes significant threats to native fish communities and to aquatic habitats (Hoover, 2004).

Plate 1. Sucker mouth catfish, *P. multiradiatus* collected from Polgaha Wewa, Ragama

According to Hoover (2004) there may also be other environmental impacts caused by this exotic fish species such as, impacts to native fish species, mortality of endangered show birds, change in aquatic plant communities, disruption of aquatic food chains and bank erosion. The destruction caused to the fish diversity of African lakes by the introduction of Nile Perch, *Lates niloticus* is well documented (Latini and Petrere, 2004). These introductions not only modify local ecological conditions but alter the reproduction, growth and development of indigenous species. It is believed that destruction of aquatic food chains is the most common threat due to this IAS and therefore, it is important to find out the effects of accidentally introduced *P. multiradiatus* on food partitioning with indigenous and other alien fish species in Sri Lanka. Therefore in the present study an attempt was made to quantify food resource partitioning and dietary overlap between *P. multiradiatus* with some of the other fish species inhabit in Sri Lankan fresh waters.

Methodology

A man made lake where an established population of *P. multiradiatus* was found at Polgaha Wewa, Ragama (7^0 01'-57.69" N, 79^0 55' 48.77" E), Western province was selected as the sampling site. It is located 842 feet above mean sea level and according to the records of Meteorological Department, Sri Lanka the average annual temperature and rain fall of the area were 27^0C and 2000-2500 mm, respectively. The approximate surface water area of the lake is 08 ha.

Sampling of fish were carried out using the cast net (mesh size of 1.3 cm) once a month up to four months from June to September 2007. The fish sampled and preserved in 5% buffered formaldehyde and fish were dissected with a lateral cut after capture to facilitate the penetration of preservative. Fish were taken to the laboratory for further examination. The sampled fish were identified up to the species level.

In order to determine the stomach/gut content of fish, fish were dissected in the laboratory. *P. multiradiatus* had a long coiled gut without a prominent stomach. Anterior one third of the guts of the cyprinids (Family Cyprinidae), *P. multiradiatus* and stomachs of other fish species were taken for the food analysis. Specimens with empty guts were excluded in the analysis. The stomachs or guts of fish were teased and pooled in to a measuring cylinder to form a suspension of known volume. From this suspension with an appropriate dilution 1.0 ml was taken out to Sedgwick rafter cell and was examined under a light microscope. Likewise three sub samples were examined from each suspention. The food items were identified to the lowest possible taxon using Needam & Needam, (1972). Food items identified were categorized in to seven categories (Table 1). The volume of each food item was estimated taking a *Pinnularia* cell as a standard, and expressed this as percentage of the total food items in the gut content.

The dietary data for *Labio rohita*, *Oreochromis niloticus*, *Mystus vittatus*, *Danio malabaricus*, *Anabas testudineus*, *Catla catla*, *Glossogobius guirius* and *Trichogaster pectoralis* were obtain from secondary sources [Amarasinghe *et al.*, (2003); Wijeratne and Perera (2001)]. These fish species were found in inland fresh water lakes and reservoirs of the country.

Table 1. Seven food categories identified in the study

Food category	Abbreviation	Main food component
Green algae	GAL	*Spirogyra, Closterium, Cosmarium, Cladophora*
Diatoms	DIT	*Pinnularia, Nittschia, Navicula*
Blue green algae	BGA	*Oscillatoria, Anabaena, Lyngbia*
Macrophytes	MAC	Aquatic plants
Copepod zooplankton	COP	Cyclopoid copepods and their body parts
Insect parts	INS	Unidentified insect parts
Eggs	EGG	Unidentified eggs of aquatic organisms

For the volumetric proportions of dietary data the cluster analysis was performed to compare feeding patterns of different fish species. Data were log transformed to reduce the importance of abundant species (Field *et al.*, 1982) and to avoid biasness. A similarity matrix was constructed and cluster dendrogram was developed using the PRIMER statistical package version 5.0 (Larke & Gorley, 2001). The species dietary overlap was determined for pooled data for the sampling period and for the secondary data according to the following formula (Schoener, 1970),

$$S = 1- 0.5 \sum |P_{xi} - P_{yi}|$$

Where P_{xi} and P_{yi} are the proportions of resource category i used by species x and y respectively. The values of Shoener's index (S) range from 0.00 to 1.00 signifying no overlap to complete overlap. In the analysis, overlaps >0.66 were considered as to be high, and those < 0.33 low, and overlaps in between 0.33-0.66 were considered as moderate.

This analysis was performed for the data of diet composition of different fish species and dietary overlap was also calculated for different fish species. In the second approach to explore dietary variation among all the sixteen fish species Principal Component Analysis (PCA ; Gauch, 1982) was performed using MINITAB version 14.

Results and Discussion

Eight fish species were caught from Polgaha wewa, Ragama (Table 2). *P. multiradiatus* was observed in the Polgaha wewa and its inflow and outflow canals. *Oreochromis mossambicus, Puntius filamentosus* and *P. multiradiatus* were the most abundant species found during the study period. From the fish species found in this study *O. mossambicus* and *P. multiradaitus* were alien species while *E. maculatus*, *E. suratensis*, *R. daniconius* , *P. filamentosus, M. gulio* were indigenous. The dietary data for *L. rohita*, *O. niloticus, M. vittatus*, *D. malabaricus*, *A. testudineus*, *C. catla*, *G. guirius* and *T. pectoralis* were obtained through secondary sources.

The gut content of fish species consisted with blue green algae, green algae, detritus, diatom, macrophytes and crustacean and insects particles. According to the volumetric proportions of food *R. daniconius* was mainly feeding on detritus and insects parts. *P. filamentosus* and *P. dorsalis* had mainly fed on detritus, higher plants, and algae. The Fish species namely, *E. maculatus*, *E. suratensis* and *O. mossambicus* belonged to the family Cichlidae were omnivorous and had depended mainly upon low trophic levels. The tank cleaner, *P. multiradiatus,* was an omnivore that fed on more than one trophic level while *P. multiradiatus* mainly fed upon detritus, green algae and blue green algae. It had also fed on eggs of aquatic organisms, diatoms, insects and copepods. The volumetric proportions of food items identified in the stomach content of the fish species found in the Polgaha wewa and volumetric proportions of food items of fish species recorded from the secondary sources were given in the Tables 3 and 4, respectively.

Figure 1 exhibits dietary variation among all the sixteen fish species as given by Principal Component Analysis (PCA; Gauch, 1982). According to the PCA *P. multiradiatus, T. pectoralis, O. mossambicus* and *P. filamentosus* could be grouped into one square showing their relative similarity in food habits.

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Table 2. Fish species considered in the present study, their common names and status

Family/Species	Status	Common names (Sinhala/ English)
Bagridae		
Mystus gulio (MG)	Indigenous	Long whiskers catfish, anguluwa
Mystus vittatus (MV)	Indigenous	Striped dwarf catfish, anguluwa
Cichilidae		
Etroplus maculatus (EM)	Indigenous	Orange chromide, Kaha korallia
Etroplus suratensis (ES)	Indigenous	Greenchromide, Iri korallia
Oreochromis mossambicus (OM)	Alien (In)	Mozambique tilapia
Oreochromis niloticus (ON)	Alien (In)	Nile tilapia
Cyprinidae		
Puntius filamentosus (PF)	Indigenous	Dankola pethiya
Puntius dorsalis (PD)	Indigenous	Katu kooriya
Rasborra daniconius (RD)	Indigenous	Dandiya
Catla catla (CC)	Alien (In)	Catla
Danio malabaricus (DM)	Indigenous	Malabar danio
Labio rohita (LR)	Alien (In)	Rohu
Lorricaridae		
Pterygoplychthys multiradiatus (PM)	Alien (Ac)	Sucker mouth catfish , Tank cleaner
Gobiidae		
Glossogobius giuris (GG)	Indigenous	Tank goby
Osphronemidae		
Trichogaster pectoralis (TP)	Alien (In)	Snakeskin gourami
Anabantidae		
Anabas testudineus (AT)	Indigenous	Climbing perch, Kawaiiya

In – Intentionally introduced

Ac – Accidentally introduced

Table 3. Volumetric proportions (%) of food items of fish species found in Polgaha wewa (Abbreviations are given in the Tables 1 and 2)

Fish Sp	BGA	GA	DIA	MAC	INS	DET	EGG	COPE
OM	39.60	25.10	2.40	2.30	0.30	28.50	1.70	0.04
RD	4.20	6.90	0.10	2.20	17.40	68.90	0.20	0.00
EM	13.00	3.60	0.20	18.30	5.10	32.20	1.60	25.9
ES	4.00	6.60	0.10	47.80	11.10	30.20	0.00	0.00
PF	2.58	55.56	0.19	1.39	14.48	16.47	0.59	8.73
PD	15.90	8.30	0.70	15.90	5.80	39.60	3.60	10.30
MG	10.20	1.80	0.00	0.00	34.70	31.50	13.30	8.50
PM	27.00	28.40	1.90	7.50	1.90	29.70	2.00	1.60

Table 4. The volumetric proportions of food categories obtained from the secondary sources (Amarasinghe *et al.*, (2003); Wijeratne and Perera (2001)). (Abbreviations are given in the Tables 1 and 2)

Fish Sp	BGA	GA	DIA	MAC	INS	DET	EGG	COPE
ON	0.00	0.00	2.40	2.30	0.30	28.50	1.70	0.04
CC	0.00	1.00	0.00	3.00	0.00	66.00	0.00	18.00
GG	0.00	0.00	1.00	0.00	51.00	0.00	0.00	1.00
DM	0.00	0.00	0.00	1.00	91.00	3.00	0.00	0.00
MV	4.00	4.00	2.00	0.00	43.00	46.00	0.00	0.00
LR	0.00	4.00	2.00	13.00	6.00	68.00	0.00	2.00
AT	1.00	2.00	1.00	0.00	77.00	20.00	0.00	0.00
TP	13.00	12.00	6.00	10.00	3.00	58.00	0.00	0.00

The first two Principal Component values set according to the volumetric proportions of food items indicated with eigen values greater than one (2.08, 1.66) and represented 46.8%

of the cumulative variance (Table 5). PC-1 constituted with 26.1% of the variance (eigen value =2.084). Positive scores on PC-1 were associated with insect parts. The positive loading was observed had for fish species such as *G. giuris, A. testudineus, D. malabaricus, M. vittatus* and *M. gulio.* The negative scores of PC 1 were associated with blue green algae, green algae, detritus and diatom. The species such as *E. maculatus, C. catla, R. daniconius, O. niloticus* and *P. dorsalis* showed negative scores for PC-1.

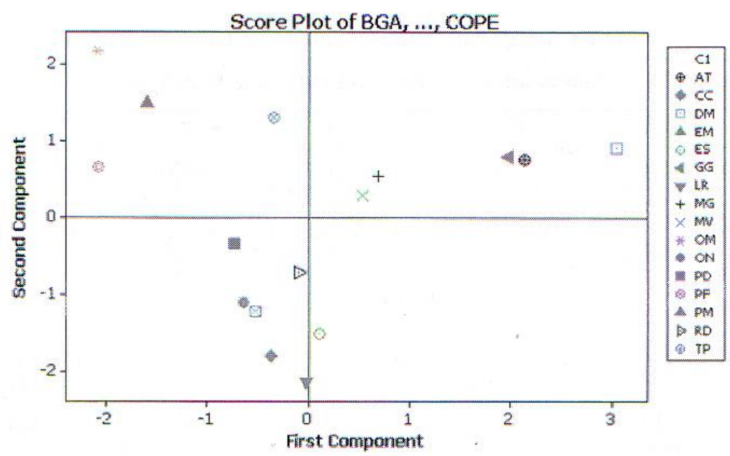

Figure 1. The plot of Principal Component Analysis of PC-1 and PC-2 for the gut contents of *P. multiradiatus* and other fish species.

(Abbreviations are given in the Tables 1 and 2)

The PC-2 which had an eigen value 1.66 accounted for 46.8 % of the variance. The species such as *P. filamentosus, P. multiradiatus, O. mossambicus* and *T. pectoralis* had higher positive scores and this positive loading was influenced by blue green algae, insects, diatom and green algae. The greater negative scores were associated with macrophytes and detritus. High negative scores for PC-2 were also reported for *E. maculates, O. niloticu* and, *P. dorsali.*

The sixteen fish species observed in this study including *P. multiradiatus* were clustered according to their consumed volumetric proportions of food items (Figure 2). This sixteen fish species were clustered in to two groups at 34.48% similarity level according to the Bray-Curtis similarity index (Bray – Curtis, 1957) based on the volumetric proportions of the food. Diets of *P. multiradiatus, O. mossambicus* and *T. pectoralis* were grouped together in the cluster dendogram, indicates that these three fish species share almost similar feeding ranges with blue green algae, green algae and detritus.

Table 5. Eigen values, percentage variance explained and coefficient of the principal component analysis of seven food items of fish species.

	PC1	PC2	PC3	PC4	PC5
Eigen value	2.0841	1.6622	1.5176	1.0491	0.8346
Proportion	0.261	0.208	0.190	0.131	0.104
Cumulative	0.261	0.468	0.658	0.789	0.893
		variance			
		Food items			
BGA	-0.455	0.406	0.163	0.010	-0.331
GA	-0.314	0.401	0.100	0.528	0.343
DIA	-0.354	0.291	-0.460	-0.342	-0.030
MAC	-0.125	-0.509	-0.125	0.483	-0.535
INS	0.629	0.260	-0.100	-0.124	0.006
DET	-0.380	-0.419	-0.169	-0.468	0.196
EGG	-0.013	0.134	0.579	0.364	-0.505
COP	-0.112	-0.264	0.602	0.053	0.438

(Abbreviations are given in the Table 1)

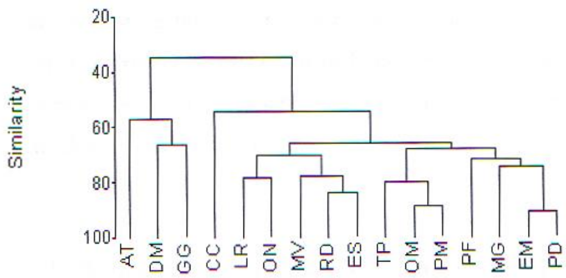

Figure 2. Dendogram of Cluster analysis of the dietary volumetric distribution of the sixteen fish species including *P. multiradiatus* according to the Bray-Curtis similarity index (Bray – Curtis, 1957).

(Abbreviations are given in the Tables 1 and 2)

Shoener's index showed high dietary overlap between *P. multiradiatus* with *O. mossambicus* (86.8%), *P. dorsalis* (67.6%) and with *T. pectoralis* (65.8%) (Figure 3, Table 6) while *R. daniconius*, *E. maculatus*, *P. filamentosus*, *M. gulio*, *M. vittatus*, *C. catla*, *L. rohita*, *E. suratensis* and *O. niloticus* had moderate dietary overlap with *P. multiradiatus*. Low dietary overlap was observed between *P. multiradiatus* with *A. tstudineus* (26.2%) and with *D. malabaricus* (8.4%).

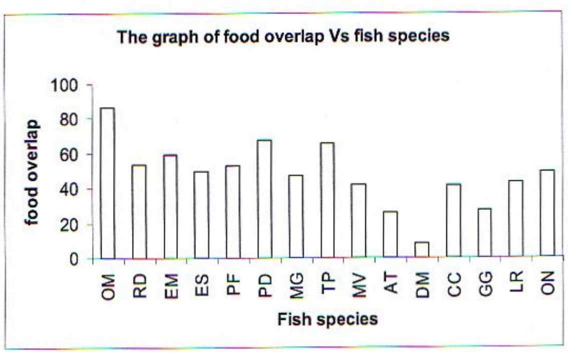

Figure 3. Percentage distribution of dietary overlap between *P. multiradiatus* with

Fish species such as O. *mossambicus* and other *Oreochromis* spp. have a high commercial value in inland fisheries industry mainly in Asia and Africa. The fresh water commercial fishery in Sri Lanka is almost entirely based on these tilapias that account about 90% of the landings (Amarasinghe, 1998). According to the results *O. mossambicus* and *T. pectoralis* had high dietary overlap with *P. multiradiatus*. Therefore, a possible range expansion of *P. multiradiatus* in to other inland water bodies and streams may impose a threat to the inland fisheries industry of the country. Most of the natural streams and irrigation canals in the country are interconnected during rainy season and further range expansion of *P. multiradiatus* is expected.

Diets of the *P. multiradiatus* reflect characteristic omnivorous feeding habit by having wide spectrum of food items ranging from various types of plankton to invertebrates and plants. It is also proven from the present study, that *P. multiradiatus* is a euryphagous feeder (i.e.- feeding on a wide range of organisms). This explains the high feeding plasticity of the *P. multiradiatus*. It should be emphasized that the feeding behavior of endemic stone sucker, *Garra ceylonensis* is very much similar to the invasive *P. multiradiatus*. This suggests that the range expansion of *P. multiradiatus* may also be a threat to the existence of endemic fish species in Sri Lanka.

It is a common ecological phenomenon that when the habitats are altered new species emerge replacing at least some of the existing species resulting in species succession (Wijeyaratne *et al.*, 2001). Therefore, with the present rate of aquatic habitat alteration, the native ichthyofauna of Sri Lanka will be adversely affected and new species such as *P. multiradiatus* will take their place in such habitats. As this is the first study on feeding habits of this species, no comparative reference can be made. However, it is too early to know the final impacts of the invasion of fresh water aquatic ecosystems by *P. multiradiatus*. Therefore further study on other ecological aspects and its effects on the community structure are highly recommended.

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