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DIURNAL VARIATIONS IN FOOD RESOURCE PARTITIONING AMONG SOME CO-OCCURRING FISHES IN THE NEGOMBO ESTUARY OF SRI LANKA

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ABSTRACT

The diurnal variation in the % overlap of the diet and coefficient of electivity for different food items in 10 species of food fishes namely *Acanthopagrus berda*, *Ambassis commersoni*, *Chanos chanos*, *Etroplus maculatus*, *Etroplus suratensis*, *Epinephelus tauvina*, *Lates calcarifer*, *Leiognathus splendens*, *Tricanthus brevirostris* and *Tachysurus caelatus*, co-occurring in the northeastern region of the Negombo estuary, a highly productive brackish water body in the western coast of Sri Lanka was studied to get an insight on their ecological segregation. High dietary overlap was evident among *A. berda*, *A. commersoni* and *T. caelatus* and between *C. chanos* and *E. suratensis*. Most of the co-occurring fishes feed on different food items resulting in ecological segregation. If they feed on the same food items, feeding is at different intensities. These intensities as well as the preference for a particular food item vary with the time of the day. Some of the food items such as insect larvae, fish and detritus were selected by fish whenever these are the components of the diet. Diurnal variation in the intensity of feeding on different food items and preference for different food items appear to be among the major factors that contribute to ecological segregation of co-occurring fish species in the northeastern region of the Negombo estuary.

INTRODUCTION

Fish communities in the tropics are highly complex and found to consist of specialized co-evolved populations (Fryer and Illes, 1972; Lowe-McConnel, 1975; Welcome, 1976; Goulding, 1980; Moyle and Senanayake, 1984). High diversity in these fish communities is maintained by localized environmental conditions and preference for different microhabitats and food items (Costa and Fernando, 1967; Lowe-McConnel, 1975; Connel, 1978). Closely related and morphologically similar species in a fish community utilize the same food and habitat resources for their co-existence. Earlier studies have shown that there is a high ecological overlap among the co-occurring fish species with respect to space and food (Costa and Fernando, 1967; Bishop, 1973).

Resource partitioning among the co-occurring fish species in some water bodies in Sri Lanka has been studied by several workers (Costa and Fernando, 1967; Moyle and Senanayake, 1984; Edirisinghe and Wijeyaratne, 1986; Wijeyaratne and Costa, 1992; Wijeyaratne and Perera, 2001). Although there appears to be a high overlap in the dietary composition of co-occurring fish species, it is hypothesized that ecological segregation exists due to differences in their feeding chronology. However, not much information is available on the diurnal variation in the food resource partitioning among the co-occurring fish species in highly productive habitats such as lagoons and estuaries in Sri Lanka. The present study was therefore carried out in one of the highly productive estuaries in Sri Lanka, namely the Negombo estuary which extends for about 3200 ha and sustains a commercial fishery yielding around 294,000 kg year^{-1} (Samarakoon and Van Zon, 1991) to have an insight on the ecological segregation of co-occurring fish species by analyzing the diurnal variation pattern in the food resource partitioning.

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MATERIALS AND METHODS

The fish samples were collected from the northern region of the Negombo estuary (Figure1) at every 3 hour interval for a period of 24 hours in November 1996. The samples were collected using a cast net of 2.0 cm stretched mesh operated from a non-mechanized log raft. At each sampling occasion, the net was hauled 10 times and the fishes caught were immediately preserved in 10% formalin for detailed analysis in the laboratory. At each sampling occasion, plankton samples were also collected using a plankton net of 50 μ mesh and were immediately preserved in 10% formalin. In the laboratory, the fishes were identified to the species level using De Bruin *et al.* (1994) and Pethiyagoda (1991). The fishes were then

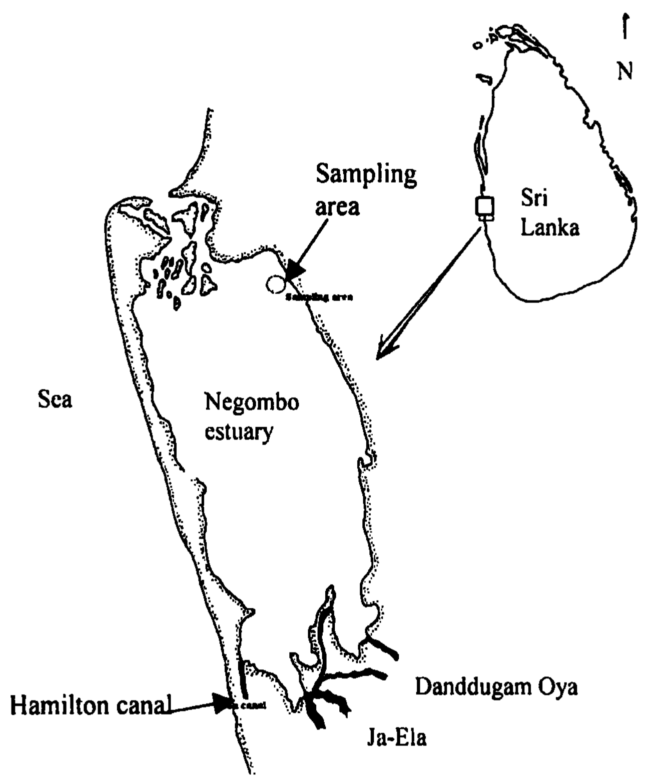


Figure 1. Map of Negombo estuary showing sampling site

eviscerated and the stomach contents were scooped out. The food items in the stomach contents were identified under the optical microscope as much as possible using John (1987) and Bellinger (1992). The stomach contents were quantitatively analyzed by determining the relative volume of food items using a cell of *Spirogyra* as an arbitrary unit. The relative importance of major taxonomic groups of food items in the diet of each species collected at different times of the day was thus determined.

The similarities among the diets of different fish species were determined by calculating the similarity index using the following equation from Schoener (1970).

$$S = 100 - \frac{1}{2} \sum |Px_i - Py_i|$$

where

S = Similarity index

Px_i = Relative importance (%) of a particular food item in species x

Py_i = Relative importance (%) of the same food item in species y

The values for S range from 0 to 100 and give the % overlap in the diet between the two species considered.

The overlap in occurrence during the 24 hour period among the different species was also determined using the same equation taking Px_i as the relative abundance of (% of) species x at time i and Py_i as the relative abundance (%) of species y at the same time.

In the present study, values of < 33.3 were considered to indicate a low overlap, values between 33.3 and 66.7 to indicate a moderate overlap and the values > 66.7 to indicate a high overlap as suggested by Moyle and Senanayake (1984).

The plankton species in the samples were identified as much as possible using John (1987) and Bellinger (1992). The plankton samples were quantitatively analyzed using a cell of *Spirogyra* as an arbitrary unit. The relative volumes of major taxa of plankton were thus estimated and the relative importance of each major taxon` in the plankton samples was determined.

The preference of each fish species for different food items at different times of the day was determined by calculating the coefficient of electivity using the following equation from Ivlev (1961).

$$\textbf{Coefficient of electivity} = (r-p) / (r+p)$$

where

r = Relative importance of a particular food item in the diet

p = Relative importance of a particular food item in the environment

Values for the coefficient of electivity range from –1 to +1. Value of +1 indicates complete selection by the fishes and –1 indicates complete avoidance.

RESULTS

A total of 10 species of fishes were encountered in the northeastern region of the Negombo estuary during the present study. They were *Acanthopagrus berda, Ambassis commersoni, Chanos chanos, Etroplus maculatus, E. suratensis, Epinephelus tauvina, Lates calcarifer, Leiognathus splendens, Tricanthus brevirostris* and *Tachysurus caelatus*. All these species are commercially important as food fish. In addition, 2 species, namely, *E. maculatus* and *E. suratensis* being popular aquarium fish, have an ornamental value too.

The relative importance of these species at each time of sampling is given in Table 1. The highest number of species was recorded at 1000 h while at 0700 h only one species namely, *E. maculatus* was recorded. The relative abundance of each species at different times of sampling expressed as a % of the total number of individuals of that species caught during the entire period of sampling is given in Table 2. *A. berda* and *E. suratensis* were recorded at 6 sampling occasions while six species, namely *E. maculatus, E. tauvina, L. calcarifer, L. splendens, T. brevirostris* and *T. caelatus* were recorded only once during the 24 hour sampling period.

The food items recorded in the stomach contents of these fish species are listed in Table 3. Of the 10 species of fish recorded, 4 species, namely *E. maculatus, E. suratensis, C. chanos* and *T. brevirostris* were found to be strictly herbivorous while the others were omnivorous.

Table 1

The relative abundance of different species of fish at each time of sampling in the northeastern region of the Negombo estuary during the 24 hour period of the day.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Relative abundance (%)							
Species	0100h	0400h	0700h	1000h	1300h	1600h	1900h	2200h
Ab	2.9	5.3	-	38.5	80.0	88.9	-	88.8
Ac	88.3	94.7	-	-	-	-	94.6	-
Cc	-	-	-	23.0	13.3	-	-	-
Em	-	-	100.0	-	-	-	-	-
Es	2.9	-	-	15.4	6.7	11.1	2.7	5.6
Et	-	-	-	-	-	-	2.7	-
Lc	-	-	-	-	-	-	-	5.6
Ls	-	-	-	7.7	-	-	-	-
Tb	-	-	-	15.4	-	-	-	-
Tc	5.9	-	-	-	-	-	-	-

Table 2

The relative abundance of each species of fish at different times of sampling expressed as a % of the total number of individuals of that species caught during the entire period of sampling.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Relative abundance (%)							
Species	0100h	0400h	0700h	1000h	1300h	1600h	1900h	2200h
Ab	2.2	6.6	-	11.1	26.7	17.8	-	35.6
Ac	25.2	45.4	-	-	-	-	29.4	-
Cc	-	-	-	60.0	40.0	-	-	-
Em	-	-	100.0	-	-	-	-	-
Es	14.3	-	-	28.5	14.3	14.3	14.3	14.3
Et	-	-	-	-	-	-	100.0	-
Lc	-	-	-	-	-	-	-	100.0
Ls	-	-	-	100.0	-	-	-	-
Tb		-	-	100.0	-	-	-	-
Tc	100.0	-	-	-	-	-	-	-

The relative abundance of major taxa of food items in the diet of each species estimated using all samples collected throughout the day is shown in Figure 2. Shrimps were the major food item of *A. berda*, *A. commersoni*, *E. tauvina*, *L. calcarifer*, *L. splendens* and *T. caelatus*. Filamentous green algae were the major food item of *E. maculatus*, *E. suratensis* and *C. chanos*. In *T. brevirostris*, the major food item was diatoms. The relative importance of major taxa of food items recorded in the stomach contents of the fishes that co-occur at each sampling occasion is given in Figure 3.

Table 3

Food items of the fish species that inhabit the northeastern region of the Negombo estuary.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Ab	Ac	Cc	Em	Es	Et	Tb	Tc	Lc	Ls
Blue green algae										
Lyngbya	+	+	+		+		+	+		+
Anabaena	+				+				+	
Microcystis	+	+	+		+		+	+	+	+
Green algae										
Cladophora		+			+					
Spirogyra	+	+	+	+	+		+	+	+	
Diatoms										
Navicula			+		+		+			+
Cymbella					+					
Coscinodiscus			+		+		+			
Crustacea										
Shrimps	+	+				+		+	+	+
Nauplii larvae								+		
Mosquito larvae		+						+		
Fish		+				+		+		
Detritus	+		+	+	+	+	+		+	
Sand	+		+				+			

The % overlap among the diets of different species that co-occur at each sampling occasion is given in Table 4. High overlap in the diets was recorded among *A. berda, A. commersoni* and *T. caelatus* whenever they occur together. Similarly, the diet of *C. chanos* had a high overlap with that of *T. brevirostris* and *E. suratensis.* The diets of *A. berda* and *L. splendens* also had a high overlap. At 0100 h, 50% of the possible combinations of co-occurring fishes had high overlap while at 1000 h, 30% of possible combinations had high overlap.

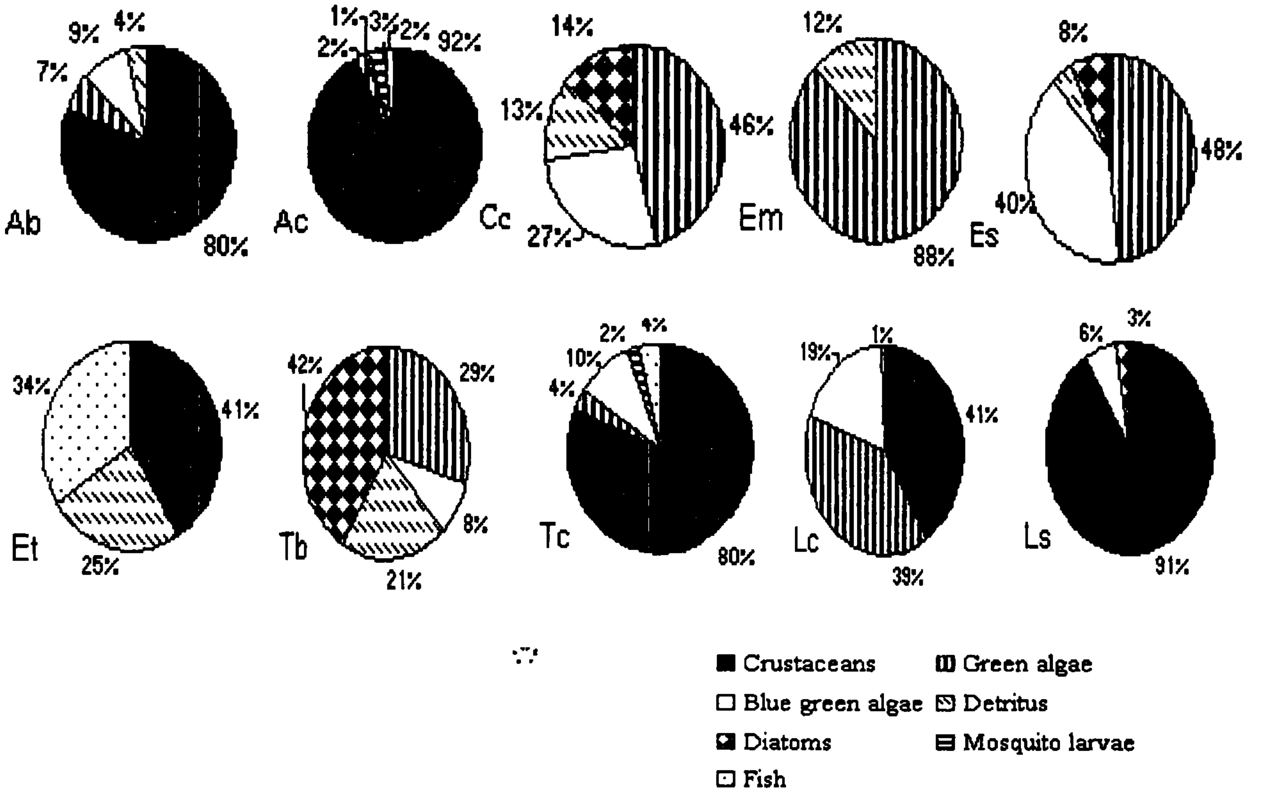
At 1300 h, 33% of the possible combinations were in the high overlap range. The diet of the 2 species recorded at 0400 h also had a high overlap. No high overlap in the diets was recorded at 1600 h, 1900 h and 2200 h. When the entire 24 hour period is considered, of the total of 27 combinations, 28.6% showed high overlap 14.3% showed moderate overlap and 57.1 % showed low overlap.

The overall overlap in the dietary composition of fish estimated by pooling the data obtained throughout the entire 24 hour period of sampling is given in Table 5. Of the 45 possible combinations, 10.9% indicated high dietary overlap, 37.8% showed moderate overlap and 51.3% indicated low overlap.

The % overlap in the occurrence of different fish species during the 24 hour period is given in Table 6. Of the possible 45 combinations, only one combination showed high overlap while 13% of the possible combinations showed moderate overlap and 84.4% showed low overlap.

The variation of the relative volume of major taxa of planktonic food items in the northeastern region of the Negombo estuary during the 24 hour sampling period is shown in Figure4. Planktonic crustaceans which mainly consisted of copepods, shrimps and nauplii dominated the plankton community throughout the day.

The coefficients of electivity of major taxonomic groups of food items in different species of fish at different times of the day are given in Table 7. Fish species appear to select a certain food item at one time of the day and avoid it at another time of the day. For example *A. berda* appears to select blue green algae at 0100 h but reject it at 1000 h, 1300 h and 1600 h. However, insect larvae, fish and detritus appear to have complete selection by the fish whenever they are found in the diet.



Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos*;
Em = *Etroplus maculatus*; Es = *Eroplus suratensis*; Et = *Epinephelus tuavina;*
Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*;
Tc = *Tachysurus caelatus.*

Figure 2. The mean composition of the diet of different species of fish in the northeastern region of the Negombo estuary.

Table 4

The % overlap among the diets of different species of fish in the northeastern region of the Negombo estuary at different times of the day.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leignathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

0100h

	Ac	Es	Tc
Ab	74.1	29.8	72.3
Ac	-	18.8	83.0
Es	-	-	13.5

0400h

	Ac
Ab	73.1

1000h

	Cc	Es	Ls	Tb
Ab	14.8	5.2	96.1	5.3
Cc	-	70.3	12.6	76.0
Es	-	-	9.1	46.8
Ls	-	-	-	9.2

1300h

	Cc	Es
Ab	15.7	16.5
Cc	-	75.9

1600h

	Es
Ab	26.5

1900h

	Es	Et
Ac	22.2	17.7
Es	-	41.7

2200h

	Es	Lc
Ac	6.3	47.5
Es	-	56.2

Table 5

Percentage overlap among the diets of the fish species collected during the 24 hour period.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Ac	Cc	Em	Es	Et	Tb	Tc	Lc	Ls
Ab	83.90	19.3	6.5	15.6	45.0	19.0	92.9	57.7	86.9
Ac	-	9.0	2.2	3.1	43.0	3.3	88.2	44.5	91.9
Cc	-	-	58.0	78.5	13.3	65.2	12.9	58.8	9.0
Em	-	-	-	63.1	0.1	41.8	3.3	39.4	3.0
Es	-	-	-	-	0.3	43.7	12.9	57.9	9.1
Et	-	-	-	-	-	21.2	45.2	42.2	41.2
Tc	-	-	-	-	-	-	11.8	38.8	9.2
Tb	-	-	-	-	-	-	-	54.3	87.8
Lc	-	-	-	-	-	-	-	-	47.6

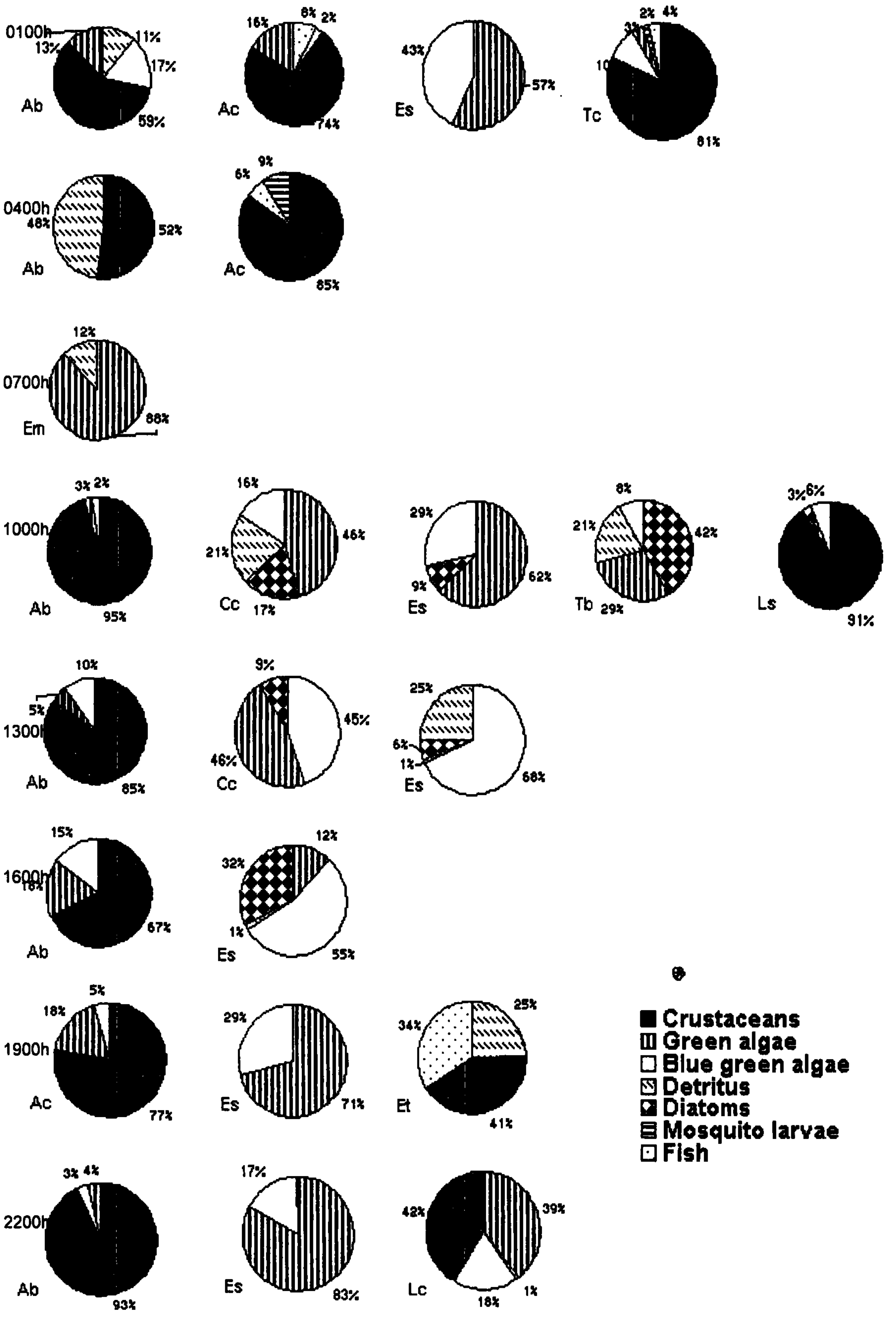


Figure 3. The relative importance of major taxa of food items in the fish species that co-occur at each sampling occasion.

Table 6

The % overlap in the occurrence of different fish species in the northeastern region of the Negombo estuary.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Ac	Cc	Em	Es	Et	Lc	Ls	Tb	Tc
Ab	8.6	37.8	0.0	56.2	0.0	35.6	11.1	11.1	2.2
Ac	-	0.0	0.0	28.6	29.4	0.0	0.0	0.0	25.2
Cc	-	-	0.0	42.8	0.0	0.0	60.0	60.0	0.0
Em	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0
Es	-	-	-	-	14.3	14.3	28.5	28.5	14.3
Et	-	-	-	-	-	0.0	0.0	0.0	0.0
Lc	-	-	-	-	-	-	0.0	0.0	0.0
Ls	-	-	-	-	-	-	-	100.0	0.0
Tb	-	-	-	-	-	-	-	-	0.0

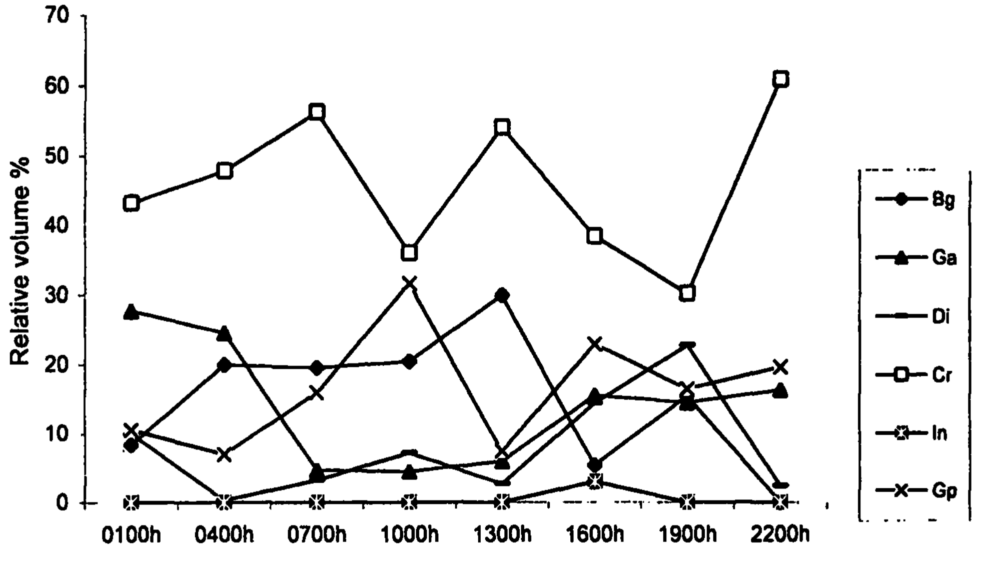


Figure 4. Variation of the relative volume of major taxonomic groups of plankton in the northeastern region of the Negombo estuary during the 24 hour sampling period.

(Bg = Blue green algae; Ga = Green algae; Di = Diatoms; Cr = Crustaceans; In = Insect; Gp = Gastropod larvae).

Table 7

The coefficient of electivity of major taxonomic groups of planktonic food items in different species of fishes in the northeastern region of the Negombo estuary during the 24 hour period of the day.

(Ab = *Acanthopagrus berda*; Ac = *Ambassis commersoni*; Cc = *Chanos chanos;* Em = *Etroplus maculatus*; Es = *Etroplus suratensis*; Et = *Epinephelus tauvina*; Lc = *Lates calcarifer*; Ls = *Leiognathus splendens*; Tb = *Tricanthus brevirostris*; Tc = *Tachysurus caelatus*).

	Food item	0100h	0400h	1900h	Mean
Ac	Blue green algae	-0.57	-	-0.55	-0.56
	Green algae	-0.26	-	0.10	-0.08
	Insect larvae	-	1.00	-	1.00
	Crustaceans	0.26	0.28	0.44	0.33
	Fish	1.00	1.00	-	1.00

	Food item	0100h	0400h	1000h	1300h	1600h	Mean
Ab	Blue green algae	0.34	-	-0.80	-0.49	-0.20	-0.29
	Green algae	-0.38	-	-0.27	0.28	0.65	0.07
	Crustaceans	0.16	0.04	0.45	-0.02	0.09	0.13
	Detritus	1.00	1.00	-	-	-	1.00

	Food item	1000h	1300h	Mean
Cc	Blue green algae	-0.13	0.20	0.04
	Green algae	0.82	0.78	0.80
	Diatoms	0.41	0.53	0.47
	Detritus	1.00	-	1.00

	Food item	0100h	1000h	1300h	1600h	1900h	2200h	Mean
Es	Blue green algae	0.68	0.16	0.39	0.43	0.37	0.51	0.42
	Green algae	0.34	0.87	-	0.51	0.66	0.68	0.61
	Diatoms	-	0.11	0.38	0.38	-	-	0.29
	Detritus	-	-	1.00	1.00	-		1.00

	Food item	0700h	Mean
Em	Green algae	0.90	0.90
	Detritus	1.00	1.00

	Food item	1900h	Mean
Et	Crustaceans	0.19	0.19
	Fish	1.00	1.00
	Detritus	1.00	1.00

	Food item	2200h	Mean
Lc	Blue green algae	0.55	0.55
	Green algae	0.43	0.43
	Crustaceans	0.03	0.03
	Detritus	1.00	1.00

	Food item	1000h	Mean
Ls	Blue green algae	0.15	0.15
	Diatoms	-0.22	-0.22
	Crustaceans	0.43	0.43

Table 7 contd.

	Food item	0700h	Mean
Tb	Blue green algae	-0.42	-0.42
	Green algae	0.74	0.74
	Diatoms	0.70	0.70
	Detritus	1.00	1.00

	Food item	0100h	Mean
Tc	Blue green algae	0.07	0.07
	Green algae	-0.80	-0.80
	Crustaceans	0.31	0.31
	Insect larvae	1.00	1.00
	Fish	1.00	1.00

DISCUSSION

The Negombo estuary is considered to be a highly productive brackish water body in Sri Lanka that yields an annual fish catch of around 150 kg/ha (Samarakoon and Van Zon, 1991). It provides livelihood for about 3000 fishing families that live around the estuary. Due to its importance in the fisheries in Sri Lanka, under the provision of the Fisheries and Aquatic Resources Act No. 2 of 1996, it has been recently declared as a Fisheries Management Area (Anon., 1999).

Earlier studies have shown that around 84 fish species inhabit the Negombo estuary (Wijeyaratne and Perera, 1996). However, during the present survey, the number of species recorded in the northeastern region of the estuary was very much lower, being only 10. The main reason for this low number recorded is probably the short period of sampling. Further, in this region of the estuary, the density of brush piles, one of the most widely used fishing gear in the estuary was very low. In addition, the area sampled was close to a highly developing urban area and slightly away from the channels where the rapid exchange of water takes place due to tides. These factors may have contributed to low diversity of ichthyofauna in this region of the lagoon.

It is evident from Table 3 that only few species of diatoms, green algae and blue green algae are present in the stomach contents of the fish that inhabit this area of the estuary. Only 2 species of green algae, 3 species of blue green algae and 3 species of diatoms were recorded in the stomach contents of these fish. However, earlier studies carried out in this estuary had shown that high diversity among the food organisms of fishes occurs in this estuary. Edirisinghe and Wijeyaratne (1986) recorded five species of diatoms, three species of blue green algae and two species of green algae in the stomach contents of the fishes that were collected from brush piles. Further, in the stomach contents of grey mullets of this estuary, a total of 21 species of diatoms, four species of blue green algae and five species of green algae had been recorded (Wijeyaratne, 1984; Wijeyaratne and Costa, 1987a, 1987b, 1988a, 1988b, 1990). However, during the present study, no grey mullet species were recorded in this region of the estuary. This may also be due to the absence of their preferred food items in this area. The area sampled was dominated by filamentous algae such as *Spirogyra* and *Cladophora*. In some places, these algae have grown as mats. The dominance of these two species of filamentous algae may have resulted in the low diversity of food organisms especially that of phytoplankton in this area. This low diversity in food organisms may also have contributed significantly to the low diversity in the ichthyofauna in this region of the estuary. The high growth of filamentous algae may have resulted due to heavy nutrient inflow to this region from the surrounding urban area.

Results indicate that there is a periodicity in the occurrence of different species of fish in this region of the lagoon. In the early morning and at dawn, the catch was dominated by *A. commersoni* which is highly popular as a food fish. However, this species does not fetch a high market price compared to other species. During the daytime, i.e., from 1000 h to 1600 h and also during the evening, i.e. around 2200 h, another popular food fish *A. berda* dominated the fish fauna. Therefore, the best times to catch *A. commersoni* in this region of the estuary during November appear to be early morning before dawn and at dusk. The best times to catch *A. berda* in this region of the Negombo estuary in November appear to be early afternoon and late evening. At dawn, the catch was dominated by *E. maculatus* that is a popular aquarium fish. Therefore, fishing at dawn in November in this region of the Negombo estuary may harvest this species in large numbers. Another popular food fish, i.e. milk fish (*C. chanos*) was caught during the late morning and mid day while the grouper (*E. tauvina*), which is another highly popular and expensive food fish was caught at dusk. The sea bass (*L.calcarifer*), which also fetches a high market price due to its popularity was caught in the late evening, i.e. at 2200 h. Therefore, carrying out fishing operations in the northeastern region of the Negombo estuary during November at midday may catch large number of popular food fish such as milk fish, and at dusk may catch large numbers of groupers and at late evening may catch a large number of sea basses. However, in order to make more precise and definite conclusions on the best time of fishing for a particular species, more studies of similar nature, extending over a period of one year should be carried out.

When the % overlap in occurrence is considered only one pair, i.e. *L. splendens* and *T. brevirostris* had a high overlap (Table 6). However, the % overlap in the diet of these two species was very low, i.e. 9.2 % (Table 3). When the dietary overlap among co-occurring species at different times of the day is considered, at 0100 h, diets of *A.berda*, *A. commersoni* and *T. caelatus* showed high overlap. However, although they co-occur at the same time and had high dietary overlap, the analysis of electivity values indicated that the preferences of these three species for different food items are different. *A. berda* showed high preference for detritus, some preference for blue green algae, little preference for crustaceans and avoided green algae. *A. commersoni* had high preference for fish, some preference for crustaceans and avoided green algae and blue green algae while *T. caelatus* had high preference for insect larvae and fish, some preference for crustaceans and avoided green algae (Table 7). Therefore, although there is high overlap in the diet, their preferences for different food items appear to vary with the species.

The co-occurring fish at 0400 h, i.e. *A. berda* and *A. commersoni* also showed high dietary overlap as at 0100 h. However, as discussed earlier, their preferences for the same food items vary. For example *A. berda* showed some selection for blue green algae while *A. commersoni* appeared to avoid it. Similarly, preference of *A. commersoni* for crustaceans is higher than that of *A. berda* and while *A. berda* showed complete selection for detritus and *A. commersoni* showed complete selection for fish (Table 7).

At 1000 h *C. chanos* showed high dietary overlap with *E. suratensis* and *T. brevirostris* while *A. berda* showed high dietary overlap with *L. splendens* (Table 4). The results of the analysis of coefficient of electivity indicate that the preference for a particular food item varies considerably, although it is present in the diet. For example *C. chanos* had high preference for green algae and some preference for detritus and avoided blue green algae while *E. suratensis* had high preference for green algae and some preference for blue green algae and diatoms. Although both species showed preference for green algae and diatoms, the preference of *E. suratensis* was higher for green algae and that of *C. chanos* was higher for diatoms (Table 7).

At 1300 h high overlap in the diet was recorded between *C. chanos* and *E. suratensis*. At this time *E. suratensis* showed high selection for detritus and some selection for blue green algae and diatoms while *C. chanos* showed high selection for green algae and some selection for diatoms and blue green algae. The selection of diatoms by *E. suratensis* was lower than by *C. chanos* while the selection of blue green algae by *E. suràtensis* was higher than by *C. chanos* (Table 7).

Most of the co-occurring fishes appear to feed on different food items at different intensities. Therefore, in most of the co-occurring fishes, there is ecological segregation due to differences in the dietary composition. However, among some co-occurring fishes in tropical waters there appears to be high dietary overlap. Such high dietary overlaps among co-occurring fish species in tropical waters had been reported by many other workers (Costa and Fernando, 1967; Moyle and Senanayake, 1984; Edirisinghe and Wijeyaratne, 1986, Wijeyaratne and Costa, 1992; Wijeyaratne and Perera, 2001). Although there is high dietary overlap, ecological segregation among the co-occurring fish species occurs due to variations in the preference for different food items. Further, the degree of preference for a particular food item also appears to vary with time of the day enhancing the ecological segregation among the co-occurring fish species.

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