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Study of fish fauna in the streams of Oliyagankele forest reserve and in Lenabatuwa tank

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Abstract

Sri Lanka's biological diversity is concentrated in a small land mass, among the global biodiversity rich countries. It has a remarkable variety of life both in terms of fauna and flora. Sri Lanka is the home for thirty-two endemic fresh water fish species. Aquarium trade, private collectors, laboratory experiments and gene banks of developed countries create a high demand for Sri Lankan fresh water fishes. Oliyagankele forest reserve and Lenabatuwa tank are situated in the Matara district. Investigations were carried out over a period of 04 months (May 2004 to August 2004) at 04 sites located in two streams and 02 sites of the tank, to find out the currently occurring fish species, their distribution pattern, and the influence of physico-chemical parameters on the fish distribution. FBI (Family Biotic Index) value was calculated for the two streams and the tank separately. The overall check list consisted of twenty nine fish species and among them were six endemic species. The FBI value calculated for the Lenabatuwa tank (6.9) indicated poor water quality, while the stream 2 revealed a fair water quality with a FBI value of 5.20 and stream 01exhibited the best water quality with a FBI value of 3.36. According to the result of statistical analysis of Pearson's correlation, most families and genera (except family Heteropneustidae and Channidae, genus *Channa, Pseudosphromenus* and *Puntius*) were found to be significantly correlated with different physico-chemical parameters. The Student- Newman- Keuls test revealed that the mean values of physico-chemical parameters such as temperature, DO, BOD, COD, phosphate concentration and the conductivity were significantly different ($p< 0.05$) among sites while such a significant difference was not observed with pH and the nitrate concentration.

Introduction

In terms of species, genera and ecosystem, Sri Lanka has a very high biodiversity and it is one of the 25 hotspots in the world. Sri Lanka has the highest biodiversity per unit area of land among Asian countries in terms of flowering plant and all vertebrate groups except birds (Myers, 1988).

The freshwater fishes consist of ornamental and edible animals with economic value. Sri Lanka has no perennial natural lakes, but man-made small, medium and large irrigation reservoirs. Today most of these water resources are dominated by exotic species. The island has 103 river basins that cover the entire island, having a length of 4500 km (Arumugam, 1969), which are also rich in fish fauna. A major effort in surveying the island's freshwater fish fauna was made by Pethiyagoda (1991), whose results were published in a book titled "Fresh water fishes of Sri Lanka", which provides guides to the identification of fresh water fishes and their distribution pattern in river basins. A total of 108 fish species, out of which 62 species of fresh water fishes, including 26 salt water dispersants and 20 exotic fishes have been recorded from Sri Lanka (Pethiyagoda, 1994). In 1992-1994, morphological and osteological characteristics of fish were also studied by Kotalawala and Jinadasa (1992) and Kotalawala (1994). The IUCN is also involved in studying the freshwater fauna in the country.

A large segment of the biodiversity of Sri Lanka is contained within a variety of forest types, comprising of tropical wet evergreen lowland forest, wet sub-montane forest and etc. Of all the forest types, the tropical wet lowland rainforests are the richest in biodiversity and endemism. The biodiversity rich forests of the wet zone are largely fragmented into small blocks by human colonization in the surrounding area of the forest. These forests are severely affected from intrusion and clearing land for cultivation, mainly for tea. The habitats of wild fresh water fauna especially those of the fishes have been directly affected by environmental factors such as water quality parameters. Most of the endemic freshwater fish are seriously affected by changes in water quality caused by siltation and pollution. Since the Oliyagankele forest reserve also falls into the category of wet zone forest in Sri Lanka, the study of its freshwater fauna is of uttermost importance in view of its conservation.

A. Location and geography of Oliyagankele forest reserve

The Oliyagankele forest reserve is a medium size lowland tropical rain forest, which is situated at Wilpita in the Matara district, approximately 15Km north of Matara closer to the small town of Kamburupitiya; about 6Km away from Akuressa to the west and 1.5Km from Kamburupitiya to the east. The forest boundaries are, a) the villages of Bubule-wela in the south, b) the villages of Athuraliya and Wilpita in the west and c) Ranchagoda, Lenabatuwa and Sapugoda villages, and the Lenabatuwa tank in the northeast. This forest is found on 6° 05'N, 80° 31'E and covers about 500ha (IUCN, 1995). Oliyagankele is separated from the Welihena forest by the Wilpita Group of Rubber and Tea plantations located in the northeast. A well-

developed road system surrounds the forest and the Kamburupitiya – Akuressa main road running from east to west dissects the forest. Moreover, minor roads have also caused forest fragmentation. This forest has only about 15ha of closed canopy forest and 28.7 ha of planted area (figure 01).

Topographically the forest reserve is moderately hilly (rising to a maximum elevation of about 100m from a base of about 20m) and it lies in the undulating terrace of the southern lowland of Sri Lanka. The mean annual rainfall is between 2160 to 3500mm per annum (IUCN, 1994). The monthly air temperature variation does not exceed 2 ^{0}C (27- 29 ^{0}C). Oliyagankele forest reserve is considered as the most interesting and diverse of the forest in the Matara district. It was declared as a Strict Nature Reserve in 1939 (Gazette Notification, No 8497) and presently administered by the Department of Forest Conservation. This forest reserve has a high floral and faunal diversity, with a high proportion of endemic species.

In addition to above ecological value and status, Oliyagankele Forest Reserve also has a high socio-economic significance. The periphery of Oliyagankele forest supports twelve villages of varying sizes, with a total population of 17,950 and 3714 households (IUCN, 1995). The number of households is expected to increase by about 20% during the next fifteen years, which will lead to an increase in the utilization of forest resources and agricultural land.

Oliyagankele Forest Reserve is also associated with several development programs. Man and the Biosphere (MAB) program, Matara Integrated Rural Development Programs (MIRDP) (which were in operation since 1979) and Participatory Forest Program (PFP) of IUCN are among them. With the ongoing development activities and increased use of forest resources, the forest environment is likely to change and the water sources would be the first ecosystem to get affected. Thus, it is important to have a sound knowledge of these resources if they are to be conserved as a strict nature reserve.

The main Objectives of the present study are, the preparation of a checklist of fish species inhabiting the area under study, to study the physico-chemical parameters and the biological properties to assess the water quality of the selected water bodies, and, to investigate the factors affecting the distribution of fish fauna in Oliyagankele.

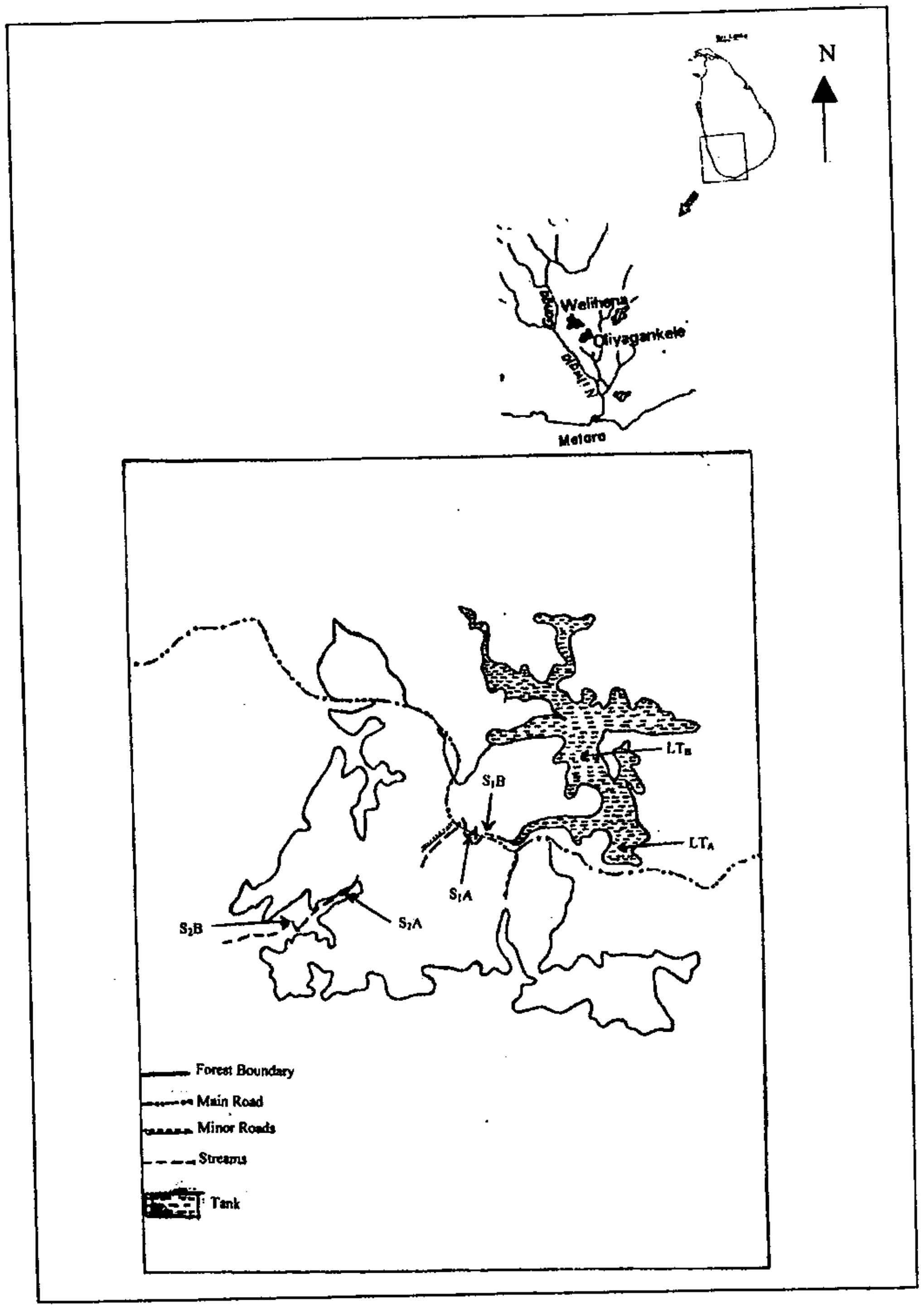

Figure 1 - Location of sites of streams in Oliyagankele forest reserve and Lenabatuwa tank (Modified after IUCN, 1994)

Materials and Methods

A. Location of sites

The principal river of the Matara district, the Nilwala, flows through the suburbs of the forest at a distance of about 1.5Km towards the south west. The internal discharge system of the forest is operated by some seasonal streams and one perennial stream that run through it. Some seasonal streams drain in to the Lenabatuwa tank or to the Nilwala River. In the dry season (February to July), the seasonal streams do not flow. One major seasonal stream originating ahead of the range forest office crosses the Kamburupitiya- Akuressa main road subsequently at two points (Figure 01), and joint the northeastern side of the Lenabatuwa tank. Some seasonal streams join the perennial stream at its origin, located at Bubula (a natural fountain of water) and runs through the paddy fields located on the southern side of the Oliyagankele and continues to flow toward the south and west to be emptied into the Kithanawala tank. Bubula is more or less open and its water is directly connected to the ditches of the paddy fields. In addition, small seasonal streams can be seen in the lowland places of Oliyagankele. During dry the season, the water gets collected in the lowland areas and most of aquatic fauna, especially the fishes, depend on these stagnant waters.

The Lenabatuwa tank lies on the north-eastern boundary of the forest and is fed by some seasonal streams that drains through Oliyagankele and the catchments of the Welihena forest.

B. Site selection

Two sites were randomly selected in each stream (01 and 02) and Lenabatuwa tank (figure 01 and table 1).

Table 01: - Sites selected in different water bodies.

Water body	Stream 01 (Seasonal)		Stream 02 (Perennial)		Lenabatuwa tank	
Site	S_1A	S_1B	S_2A	S_2B	LT_A (Littoral, closer to the shore)	LT_B (pelagic)

C. Sampling frequency

The study commenced in early May 2004 and continued until late August 2004. The study period included both the rainy and dry season. The sampling was done twice a month.

D. Fish sampling method

In Streams fishes were sampled using a drag net (Gape size of 4.25m X 2m with stretched mesh size 1.0cm) and Scoop nets, in order to obtain better results. In the Lenabatuwa tank, fishes were sampled using multimesh gill nets. The total length of the fish was measured to the nearest mm while the total weight was measured to the nearest gram. Most of the fishes were released after identification and some live specimens were brought to the laboratory for confirmation of their identity. The published information by Monro(1958) and Pethiyagoda (1991) were used for species identification.

E. Measurement of physico- chemical parameters

Following measurements were taken during field visits.

a). Stream width and depth were measured.
b). Water temperature - measured using a field thermometer.
c). Conductivity - measured using portable Field Kit- Multi-range conductivity meter (Model HI 9033).
d). Flow rate- measured using a digital flow meter (Model 438110).
e). Turbidity (Light penetration) - measured using a Secchi disk in sites of Lenabatuwa tank (LT_A and LT_B).
f). pH - measured using HORIDA pH meter M-8.
g). Dissolve Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) - measured according to Winkler procedure (Golterman, Clymo and Ohnstad 1978).
h). Salinity – calculated by Mohr titration (Golterman, Clymo and Ohnstad 1978).
i). Total alkalinity - determined by titrating with standard 0.1M HCl (Golterman, Clymo and Ohnstad 1978).
j). Nitrate - determined by simple spectrophotometric method (Yang, 1998) using spectrophotometer (UV-160A) at 410nm.
k). Soluble reactive Phosphorus - determined according to Strickland and Parson (1965) using spectrophotometer (UV-160A) at 720nm (Golterman, Clymo and Ohnstad 1978).

In addition to above parameters, substrate type of each site and the vegetation types around the site were also identified.

F. Measurement of Family Biotic Index

Benthic faunal communities were collected from each site by a Surber sampler. They were fixed in 10% Formaline, and brought to the laboratory. Benthic fauna were identified to the family or order level and Family Biotic Indices (FBI) were calculated. Considering the FBI values the water quality was determined according to the reference (biotic scores) values given by Hauer, and Lamberti, 1996.

$$\mathbf{FBI = 1/N \sum n_j t_i}$$

Where,

N = The total number of individuals in the sample.
n_j = The number of individuals in a family.
t_i = The tolerance score for that family(according to reference values).

G. Statistical analysis

JMPIN (VERSION 3.2.6) software was used for statistical analysis. The average number of fish in ten families was calculated per site and compared with selected environmental parameters.

The average number of fish in 21 genera was compared with selected physico-chemical parameters. Pearson's Correlation Coefficient was used for above comparisons and probability values below 0.05 ($p < 0.05$) were considered significant.

Results

A. Fish assemblage

Twenty-nine fish species were recorded in the study area, of which six were endemic and twenty-three indigenous (table 2). These fish species belong to ten families and twenty-one genera. The best-represented family was the Cyprinidae, which included fourteen fish species, of which the geneus *Puntius* was the most dominant species (figure 2). Three species were recorded from family Channidae, while two species were recorded for each family Aplocheilidae, Gobiidae, Belontidae and Cichlidae (figure 2). Families Cobitidae Bagridae Heteropneustidae and Siluridae were represented by one species in each family. Of the endemic species, only five species (except *Esomus danrica thermoicos*) were identified as threatened in the IUCN Red Data list. Endemic fish abundance was highest in stream 02 and lowest in Lenabatuwa tank (figure 3).

Table 02 - Freshwater fish species (introduced, indigenous and endemic) occurring in Streams of Oliyagankele forest reserve and Lenabatuwa tank.

Family	Scientific name	Sites						Status
		S1A	S1B	S2A	S2B	LTA	LTB	
Cyprinidae	*Rasbora daniconius* (Hamilton, 1822)	+	+	+	+	+	+	I
	Chela laubuca (Hamilton, 1822)	+	+					I
	Puntius vittatus (Day, 1865)	+	+	+	+	+	+	I
	Puntuus sarana (Hamilton, 1822)			+	+	+	+	I
	Puntius titteya (Deraniyagala, 1929)			+				T, En
	Puntius dorsalis (Jerdon, 1849)			+	+	+	+	I
	Rasbora caverii (Jerdon, 1849)					+	+	I
	Esomus danrica thermoicos (Valenciennes, 1842)				+	+	+	En
	Puntius filamentotus (Valenciennes, 1844)					+	+	I
	Ambylypharyngodon melettinus (Gunther and Day, 1868 – 1878)				+	+	+	I
	Labeo dussmieri (Valenciennes, 1842)					+	+	I
	Cyprinus carpio (Linnaeus, 1758)					+	+	I
	Labeo rohita (Hamilton, 1822)					+	+	IN
	Catla catla (Hamilton, 1822)					+	+	IN
Aplocheilidae	*Aplocheilus werneri* (Meinken, 1966)	+	+	+	+	+	+	En
	Aplocheilus dayi (Steindachner, 1892)				+			En
Cichlidae	*Sarotherodon mossambicus* (Trewavas, 1966)				+	+	+	I
	Etroplus suratensis (Bloch, 1785)					+	+	I
Belontidae	*Belontia signata* (Gunther, 1861)	+		+	+			En
	Pseudosphromenus cupanus (Cuvier, 1831)			+	+			I
Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1797)	+				+	+	I
Channidae	*Channa oriantalis* (Bloch & Schneider, 1801)			+				En
	Channa punctata (Bloch, 1794)			+	+	+	+	I
	Channa striata (Bloch, 1793)			+	+	+	+	I
Cobitidae	*Lepidocephalichthys thermalis* (Valenciennes, 1846)				+			I
Bagridae	*Mystus gulio* (Hamilton, 1822)				+			I
Gobiidae	*Glossogabius giuris* (Hamilton, 1822)					+	+	I
	Awaous grammepomus					+	+	I
Siluridae	*Ompok bimaculatus* (Bloch, 1794) .					+	+	I

Where,
En = Endemic I = Indigenous IN = Introduced T = Threatened

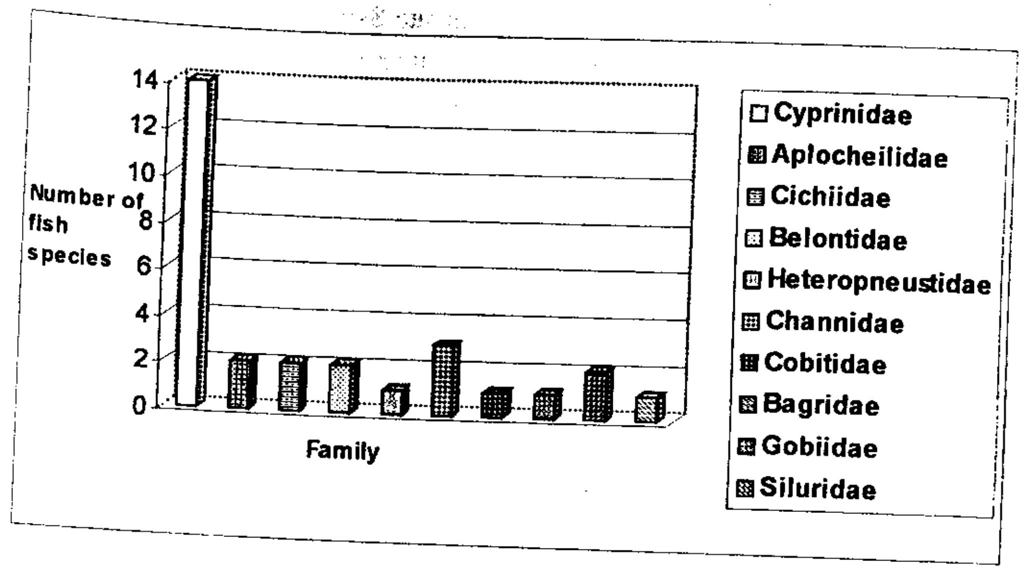

Figure 02 - Number of species in each family

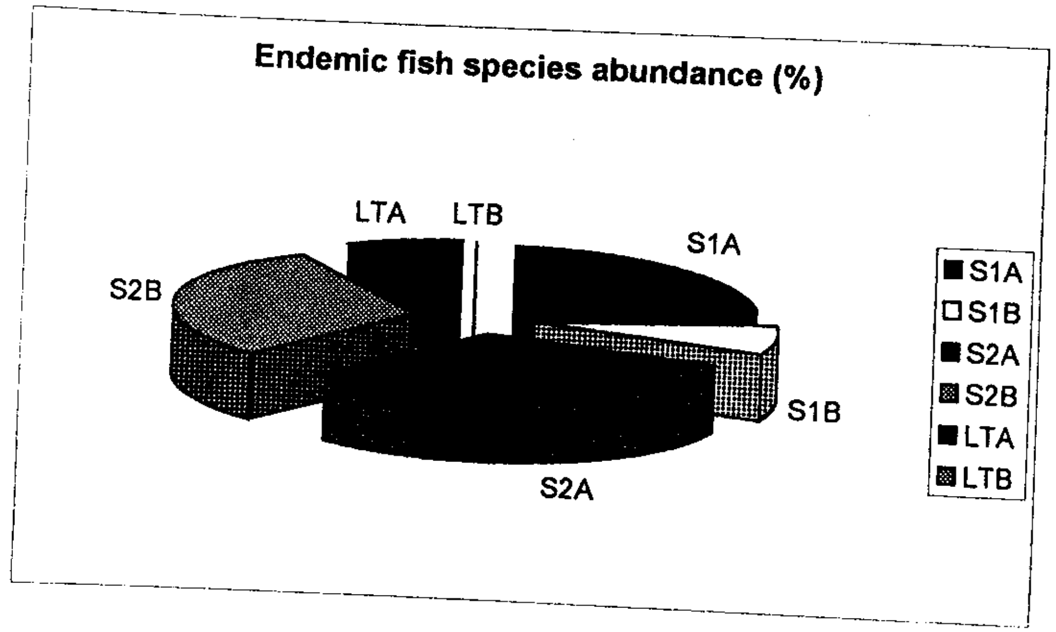

Figure 03 - Abundance of endemic fish species in sampling sites

B. Water quality and other parameters

Mean values of the water quality parameters among the studied sites are shown in Table 03.

pH value was low in site S_1A and highest in site S_2B. Temperature values recorded from sites of Lenabatuwa wewa were higher than that of the sites of two streams. Site S_1B recorded the highest conductivity value (table 3). Dissolved oxygen values were higher in sites of Lenabatuwa wewa than sites of the two streams.

Nitrate value was higher in site S_1B and it was lower in site S_2B. Highest phosphate value was recorded from LT_A and the lowest value was recorded from site LT_B. Flow rate was recorded only in Stream 02 (0.32-0.35 ms^{-1}).

Table 03 - Mean values (± standard deviation) of physico-chemical parameters in studied sites

Sites → / Parameters ↓	S_1A	S_1B	S_2A	S_2B	LT_A	LT_B
pH	6.62 (±0.50)	6.79 (±0.49)	7.11 (±0.73)	7.60 (±0.66)	7.15 (±1.21)	7.41 (±0.87)
Temperature / Ċ	26.20 (±0.88)	26.06 (±0.86)	26.20 (±1.06)	26.40 (±1.40)	30.75 (±1.09)	30.87 (±1.35)
Conductivity / µs cm^{-1}	48.88 (±3.64)	49.92 (±3.61)	44.45 (±3.63)	35.91 (±2.59)	38.37 (±3.12)	38.37 (±3.12)
DO / mg L^{-1}	5.4 (±0.79)	6.20 (±0.78)	3.40 (±1.71)	7.20 (±0.39)	7.88 (±0.65)	7.83 (±0.90)
BOD / mg L^{-1}	0.69 (±0.52)	1.00 (±0.76)	0.77 (±0.44)	1.00 (±0.39)	3.75 (±1.24)	2.39 (±0.81)
COD / mg L^{-1}	0.6 (±0.002)	0.53 (±0.004)	0.55 (±0.004)	0.6 (±0.002)	0.56 (±0.001)	0.48 (±0.004)
Nitrate / mg L^{-1}	9.382 (±2.29)	10.957 (±7.61)	7.545 (±4.43)	4.686 (±3.61)	9.488 (±4.26)	9.134 (±4.27)
Phosphate / mg L^{-1}	18.185 (±7.27)	25.637 (±7.65)	11.967 (±2.61)	12.127 (±1.39)	33.890 (±7.03)	10.096 (±3.39)
Total alkalinity / mg L^{-1}	0.00002 (±0.0001)	0.00002 (±0.0001	0.0004 (±0.0002)	0.0004 (±0.0002)	0.00002 (±0.0001)	0.00002 (±0.0001)
Salinity / ppt	0.04 (±0.002)	0.04 (±0.002	0.04 (±0.012)	0.03 (±0.002)	0.04 (±0.002)	0.04 (±0.001)
Flow rate / ms^{-1}	0	0	0.32	0.35	-	-
Turbidity	-	-	-	-	218.87 (±25.57)	209.41 (±27.09)
Water level / m	0.15	0.15	0.15	0.15	7.65	7.70

Different substrate components were identified as Boulders, Gravel, Sand, Silt and Detritus. Major components of substrate in each site are given in table 04.

Table 04 - Substrate type in each site.

SITE	SUBSTRATE TYPE
S_1A	Boulders + Gravel + Detritus
S_1B	Boulders + Gravel + Detritus
S_2A	Gravel + Sand + Detritus
S_2B	Gravel + Silt
LT_A	Silt + Detritus
LT_B	Silt + Detritus

The substrate of the sites of Lenabatuwa wewa (LT_A and LT_B) was composed of silt and detritus while that of stream sites S_1A and S_1B was composed of boulders, gravel and detritus matter.

C. FBI values

The highest abundance was recorded from macro invertebrates belonging to the family Lymnaeidae. Oligocheata and chironomidae, other than red-blood chironomidae, recoded the lowest abundance (table 5).

Table 05 - Abundance of macro invertebrate in Lenabatuwa tank.

Family/Order	Abundance	Biotic score	Total
Lymnaeidae	174	06	1044
Physidae	06	08	48
Sphaeridae	173	08	1384
Decapoda	06	06	36
Red-blood Chironomidae	06	08	48
Other Chironomidae	02	06	12
Rhyacopilidae	06	00	00
Oligocheata	02	08	16
Libellulidae	10	09	90
Total	385		2678
FBI	6.90		

FBI = Family Biotic Index   Biotic score = (Hauer, and Lamberti, 1996).

Abundance of macro invertebrates recorded from streams 1 and 2 and the biotic score of the respective families are shown in table 6. Macro invertebrates diversity in stream 2 was higher than that in stream 1. Abundance of order decapoda and family Rhyacopilidae was higher in stream 1, compared to other order/families. The lowest abundance was recorded for families Simuliidae, Leptophlebiidae, Ceratopogonidae and Psephenidae. Macro invertebrates of the family Lymnaeidae recorded the highest abundance in sites in stream 2 while families Ceratopogonidae, Potomanthidae, Elmidae and Chloroperlidae recorded the lowest abundance (table 6).

Table 06 - Abundance of macro invertebrate recorded from stream 01 (ST1) and 02 (ST2)

Family/Order	Number of organisms		Biotic score		Total	
	ST 01	ST 02	ST 01	ST 02	ST 01	ST 02
Decapoda	43	29	06	06	258	174
Hydropsychidae	12	-	04	-	48	-
Baetidae	02	-	04	-	08	-
Anthericidae	13	02	06	02	78	04
Rhyacopilidae	105	85	00	00	00	00
Oligochaeta	21	29	08	08	168	232
Simuliidae	01	05	06	06	06	30
Libellulidae	10	62	09	09	90	558
Leptophlebiidae	01	145	02	02	02	290
Lestidae	03	04	09	09	27	36
Ceratopogonidae	01	01	06	06	06	06
Potomanthidae	03	01	04	04	12	04
Psephenidae	01	250	04	04	04	1000
Lymnaeidae	06	340	06	06	36	2040
Physidae	02	13	08	08	16	104
Blood-red Chironomidae	-	01	-	08	-	08
Other chironomidae	-	20	-	06	-	120
Pyralidae	-	03	-	05	-	15
Elmidae	-	01	-	04	-	04
Tipiulidae	-	02	-	03	-	06
Chloroperlidae	-	01	-	01	-	01
Sphaeridae	-	182	-	08	-	1456
Total	229	1176			769	6088
FBI	**3.36**	**5.20**				

FBI = Family Biotic Index Biotic score = (Hauer, and Lamberti, 1996).

Family Biotic Index (FBI), revealed that water quality in the sites of Stream 01 was good, while the water quality in the sites of stream 02 was fair and, poor water quality was recorded in the Lenabatuwa tank.

D. Statistical analysis

Family Gobidae, showed a positive correlation with BOD, total alkalinity and, family Cobitidae showed a positive correlation with mean average number of respective fish families, while Cyprinidae, Cichlidae and Bagridae showed negative correlation with salinity (Table 07).

Table 07 - Probability values between fish families and physico-chemical parameters.

Family	Probability level of Parameters (p<0.05)									
	pH	Salinity/ ppt	Temperature/ c	Conductivity / μs cm^{-1}	DO / mg L^{-1}	BOD / mg L^{-1}	COD / mg L^{-1}	Nitrate / mg L^{-1}	Phosphate / mg L^{-1}	Total alkalinity / mg L^{-1}
Cyprinidae		-0.0268								
Aplocheilidae					-0. 0012					
Cichlidae		-0.0213								
Belontidae					-0.0390					
Cobitidae								-0.0113		+0.0002
Bagridae		-0.0006						-0.0072		
Gobiidae						+0.0277			+0.0483	

Belontia species showed a negative correlation with salinity, nitrate, and total alkalinity with their average number. Genera such as *Rasbora* species, *Esomus* sp. *Sarotherodon* sp, and *Aplocheilus* sp, recorded correlation with only one physico-chemical parameters (Table 08).

Table 08 - Probability values between fish genera and physico-chemical parameters.

Genus	Probability level of Parameters (p<0.05)									
	pH	Salinity/ ppt	Temperature/ c	Conductivity / µs cm^{-1}	DO / mg L^{-1}	BOD / mg L^{-1}	COD / mg L^{-1}	Nitrate / mg L^{-1}	Phosphate / mg L^{-1}	Total alkalinity / mg L^{-1}
Rasbora sp		-0.0108								
Chela sp	-0.0229			+0.0298				-0.0256		
Esomus sp								-0.0031		-0.0080
Ambylypharyngodon sp		-0.0213								
Aplocheilus sp					-0.0012	+0.0277			+0.0483	
Etroplus sp								-0.0256		
Sarotherodon sp								-0.0062		-0.0441
Belontia sp		-0.0158						-0.0113		-0.0002
Lepidocephalichthys sp								-0.0076		
Mystus sp		-0.0006				+0.0277			+0.0483	
Glossogabius sp										

Variation of physico-chemical parameters among six different sites is shown in table 09.

Table 09 - Variation of physico-chemical parameters among six different sites based on Student- Newman- Keuls test (Letters next to each value indicate significantly different groups recorded from Student- Newman- Keuls test. Similar letters indicate non-significant physico-chemical parameters among different sites).

Site / Parameter	Mean value					
	S_1A	S_1B	S_2A	S_2B	LT_A	LT_B
pH	6.62^a	6.79^a	7.08^a	7.64^a	7.15^a	7.41^a
Temperature/ Ċ	26.18^a	20.06^a	26.18^a	26.38^a	30.75^b	30.58^b
DO / mg L^{-1}	5.49^b	6.26^b	3.49^a	7.26^c	7.88^c	7.83^c
BOD / mg L^{-1}	0.69^a	1.01^a	0.39^a	0.84^a	3.13^b	2.49^b
COD / mg L^{-1}	0.6^e	0.53^b	0.55^c	0.60^e	0.56^d	0.48^a
Nitrate/ mg L^{-1}	10.62^a	12.54^a	7.54^a	4.68^a	9.48^a	10.04^a
Phosphate/ mg L^{-1}	18.18^{ab}	25.63^{ab}	11.96^{ab}	12.12^{ab}	33.87^{ab}	10.09^a
Conductivity/ µscm^{-1}	48.88^{ab}	49.92^b	44.45^{ab}	35.91^a	38.37^{ab}	38.37^{ab}

Mean values of physico-chemical parameters such as temperature, DO, BOD, COD, phosphate and conductivity were significantly different among sites. Values of temperature and BOD in Lenabatuwa wewa were significantly different ($P < 0.05$) from the stream sites. DO in the site S_2A was significantly different ($P < 0.05$) from the rest of the sites. COD values of the six different sites with significantly different ($P < 0.05$) from each other. pH and the nitrate concentration were not significantly different among sites.

Discussion

The presence of twenty-nine total species, which belonged to 10 families, revealed that the reserve area contained a high diversity of fish. The best-represented family was the family- Cyprinidae (Figure 02). Genus *Puntius* was the most abundant fish spices in the family Cyprinidae. *Puntius titteya, Esomus danrica thermoicos, Aplocheilus werneri, Aplocheilus dayi, Belontia signata* and *Channa oriantalis* were the endemic fish species. Of these *Puntius titteya* was also included in the threatned endemic fish species list (IUCN, 2000 and 2002). Endemic fish species abundance was highest in the stream 02. *Puntius titteya, Aplocheilus werneri, Belontia signata* and *Channa oriantalis* were recorded from the S_2A site of the stream 02. Only *Aplocheilus werneri* was captured in the site S_2B. Site S_2A was fully covered by vegetation and could be considered as a fountain of water, which was not affected even during the dry season. The upper areas of site S_2A contained a silt and detritus substrate. *Puntias titteya* was recorded only in this area where substrate type was compatible with its mode of life. *Chela laubuca* was recorded only in the stream 01. Most of the other species were widely distributed through out the streams and tank with high densities.

The diversity of the Ichtiofauna varies with abiotic factors revealing that fish prefer to live in dynamic environments. For instance genus *Chela* sp showed a significant negative correlation with increasing pH indicating that it prefers slightly acidic pH and inhabited only in stream 01.It also showed a significant positive correlation with conductivity. Most of the stream sites were very shallow and for this reason it was difficult to measure turbidity using a Secchi disk. Genus *Aplocheilus* of the family Aplocheilidae showed a significant negative correlation with DO where average numbers of Aplocheilidae fish increased significantly with declining DO. The presence of the family Belontidae was correlated with DO negatively. Family Gobiidae and genus *Glossogabius* sp. showed a positive correlation with the BOD. According to table 03 the highest BOD values were recorded in the tank, together with high average number of fish of this genus. Genus *Etroplus* sp. was also positively correlated with BOD.

According to the result of the statistical analysis family Cyprinidae, Cichlidae and Bagridae showed a negative correlation with salinity. Genus *Rasbora, Ambylypharyngodon, Belontia, and Mystus* also showed a negative correlation with salinity. But the highest average number of *Belontia sp.* fish was recorded in site S_2A due to other factors. Family Cobitidae and the genera *Ambylypharyngodon, Belontia* and *Lepidocephalichthys* showed a positive correlation with total alkalinity. Statistical analysis indicated that none of the recorded families and genera did not seem to have a significant correlation with temperature and COD, because the COD alone could not affect fish distribution effectively and on one hand since the temperature did not change among the sites significantly on the other. Family Cobitidae and Bagridae were negatively correlated with nitrate and family Gobiidae showed a positive correlation with phosphate concentration and BOD Genus *Lepidocephalichthys, Mystus, Sarotherodon, Belontia,* Ambylypharyngodon and *Esomus* exhibited negative correlation with the nitrate concentration and BOD. Genus *Etroplus* and *Glossogabius* were positively correlated with the phosphate concentration.

In general the substrate composition of a site is the major factor, which affects the distribution of fishes. The present study did not show a highly significant difference in the substrate composition among sites. Therefore the correlation of substrate type with fish distribution was not statistically analyzed. Family biotic indices obtained indicated a comparatively poor water quality in the tank, best water quality in stream 01 and fair water quality in stream 02. Poor water quality of the tank can be attributed to its poor circulation, while the high water quality in stream 01 can be attributed to the undistributed forest area where it is located. As for stream 02, it flows through paddy fields and therefore it could become polluted from fertilizer runoff as well as from domestic wastewater effluent.

Conclusion

Considering all the above information it can be concluded that the Oliyagankele forest reserve has a high species diversity in terms of its fish fauna. Most endemic species were recorded in the above mentioned habitats with the submerged vegetation and restricted to the upper parts of the streams (site S_1A). Endemic species have been exported more in comparison to the non-endemics. *P. titteya, A. dayi, A. werneri* and *L. thermalis* were on top of the exported quantity list. These species were present in the Oliyagankele forest reserve. Thus ecologically, it is very

important to protect the ichtifauna in Oliyagankele forest reserve. According to the observations made in this study, microhabitats have been threatened due to deforestation, human settlement, and paddy and tea plantation. The rapid decline of fish population and diversity is mainly caused by plantations. Therefore effective conservation measures should be taken to protect the fresh water fish fauna of Oliyagankele forest reserve and Lenabatuwa tank. The Forest Department is mandated administratively and legally to protect the forest and the tank and hence has taken several steps to conserve the Oliyagankele forest reserve and the Lenabatuwa tank. Minimizing the main causative factors such as deforestation, habitats alteration, agrochemicals, overexploitation of fish species for exports etc., extension of the government support for conservation activities, creating awareness among the people, continuation of field monitoring are the aspects that need immediate attention for the conservation and protection of the Oliyagankele forest reserve.

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