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Some Factors Affecting Contribution of Cichlid Species *Etroplus suratensis* and *Tilapia rendalli* to the Gill-net Catches of a Man-made Lake in Sri Lanka

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Abstract

In the gill-net fishery of Parakrama Samudra, a man-made lake in Sri Lanka, some factors affecting species composition of the commercial landings were studied from February 1985 to February 1986, with particular reference to the cichlid species, *Etroplus suratensis* and *Tilapia rendalli*. The proportions in the catches of a water beating technique, a modified gill-net fishing method, were found to be significantly different from that of normal gill netting. These differences in the catches of *E. suratensis* and *T. rendalli* are suggested to be due to their restricted movements, associated with reproductive behavior. The increase of catches of two cichlid species with elevation of water level may have been brought about by their aggregation in recently inundated peripheral areas of the lake to feed on macrophytes.

The importance of stratifying data according to fishing method and mesh size of gill net in order to determine species composition is discussed. Using this method of analysis, annual fish yield in Parakrama Samudra in 1985 was estimated to be about 46 $kg \cdot ha^{-1}$.

Introduction

The fish fauna of Parakrama Samudra (2,662 ha), a man-made lake in Sri Lanka, consists of 34 species (Fernando 1984). They represent 64% of the total of 53 species of the indigenous freshwater fish fauna (De Silva 1983; Fernando 1984). Of these, four species of cichlids form an important proportion in the commercial gill-net catches. Changes in species composition after the introduction of the African cichlid *Oreochromis mossambicus* (Peters) in 1952, have been described by De Silva and Fernando (1980). The indigenous species, *Labeo dussumieri* (Valenciennes) and *Barbus sarana* (Hamilton-Buchanan) were recorded to contribute significantly to the total landings during the rainy seasons (De Silva and Fernando 1980; De Silva 1983). Other factors such as morphometry of the lake and water level fluctuations were found to influence the abundance of *O. mossambicus* (De Silva 1985; Amarasinghe and Upasena, in press). However, no attempts have been made to identify factors affecting species composition in the commercial catches in relation to management of the fishery.

In the present study, some factors affecting species composition of the commercial catches of Parakrama Samudra are described with particular reference to the cichlid species, *Etroplus suratensis* (Bloch), the Asian estuarine cichlid which has been transplanted into freshwater (Willey 1910) and the exotic *Tilapia rendalli* (Boulanger). The data used in this study were collected in the course of a detailed investigation directed toward formulating a management plan for the fishery of Parakrama Samudra.

Materials and Methods

Catch and effort statistics were collected from the commercial fishery of Parakrama Samudra from February 1985 to February 1986. The craft used in the fishery are nonmechanized fiberglass outrigger canoes and the main gear are nylon gill nets of stretched mesh sizes ranging from 76 mm to 114 mm. The contribution of sporadic cast-net fishing and hook-and-line fishing to the fishery were observed to be negligible during the study period. Gill nets are usually set overnight and some fishermen in outrigger canoes beat the water with wooden poles to drive fish towards the nets. The efficiency of this fishing method, termed the "beating technique" has been detailed by Amarasinghe and Pitcher (1986).

In each month, species composition of the total weight landed and number of net pieces per craft were recorded from randomly selected crafts. On most occasions, more than 60% of the total number of crafts operating in each landing site were sampled; 928

craft-days were observed in detail out of a total of 1,325 craft-days operated over 97 sampling days. The use of "beating technique" and the corresponding catches from these randomly chosen crafts were determined through interview and inspection. Number of net pieces of mesh sizes between 76 and 102 mm and number of large mesh gill nets (102-114 mm) used by individual crafts and their corresponding catches were also recorded. Data for nets of different mesh sizes were separated into these two groups since the fishermen exclusively use 76 mm and 89 mm mesh gill nets for catching smaller *O. mossambicus* and they prefer to use large mesh sizes of 102-114 mm during the months when large *O. mossambicus* are relatively abundant. Before analysis, the data were stratified for three geographically distinct basins of the lake, namely Topa wewa, Eramudu wewa and Dumbutulu wewa, which are connected by narrow channels. The need for this spatial stratification in a catch and effort survey in Parakrama Samudra has been shown by Amarasinghe and Pitcher (1986).

Samples of *E. suratensis* and *T. rendalli* were obtained from the commercial catches and the total length and the greatest body depth were measured to the nearest 0.1 cm. Data on water level fluctuations in the reservoir were obtained from the Irrigation Department.

Results

Species caught in the gill-net fishery of Parakrama Samudra during the study period are given in Table 1. The monthly average species composition of the commercial landings of sampled outrigger canoes in the three basins of the lake from February 1985 to February 1986 is shown in Fig. 1. The relative contributions of *E. suratensis* and *T. rendalli* to the fishery in each month, expressed as percentages of the total cichlid catches for normal gill netting and for the beating technique, are shown in Fig. 2 for the three basins of the lake separately. Here, the percentage contribution of *E. suratensis* and *T. rendalli* to the total cichlid catch was used due to the fact that the occasional catches of Indian carps *(Labeo rohita* and *Cirrhinus mrigala)* contributed considerably to the total landings during the period of July-October 1985. The fingerlings of these Indian carps were released from an abandoned cage culture experiment in November 1984 (Mr. J. Dassanayake, pers. comm.). The ratio of small

Table 1. List of fish species caught in the gill-net fishery of Parakrama Samudra (1985-86). Maximum recorded length and percentage contribution of six common species to the total catch are also given. (Estimated total catch for 1985-86 = 122.7 tonnes). Contribution of rest of the species to the total catch is 10.1% (+ - data from Fernando 1984; ++ - Amarasinghe, personal observations).

Species	Maximum length (cm)	Percentage of catch
Indigenous species		
Labeo dussumieri (Valenciennes)	35.0+	2.2
Barbus sarana (Hamilton-Buchanan)	30.0+	0.9
Ompok bimaculatus (Bloch)	35.0++	
Wallago attu (Bloch and Schneider)	150.0+	
Ophicephalus striatus Bloch	68.0+	
Anguilla nebulosa nebulosa McClelland	100.0+	
Glossogobius giuris (Hamilton-Buchanan)	35.0+	
Introduced species		
Oreochromis mossambicus (Peters)	42.0++	70.8
Oreochromis niloticus (Linnaeus)	46.0++	5.6
Tilapia rendalli (Boulanger)	34.0++	1.1
Osphronemus goramy (Lacépède)	30.0+	
Cyprinus carpio Linnaeus	60.0++	
Ctenopharyngodon idella (Valenciennes)	90.0++	
Labeo rohita (Hamilton)	75.0++	
Cirrhinus mrigala (Hamilton)	75.0++	
Transplanted species from the lagoons		
Etroplus suratensis (Bloch)	28.0++	9.2

mesh (76-102 mm) to large mesh (102-114 mm) nets in each month for the two fishing methods separately and the monthly fluctuations in the water level in the reservoir are also incorporated in Fig. 2.

Contingency tests (G-test; Sokal and Rohlf 1981) were carried out to determine whether the frequency distributions of *E. suratensis* and *T. rendalli* varied with mesh size and with the fishing method. The data indicate that the frequency of *E. suratensis* caught significantly varied with mesh size as well as with the fishing method ($p < 0.001$) while the frequency of *T. rendalli* varied significantly with the fishing method ($p < 0.001$) but not with mesh size (Table 2).

The relationships between the greatest body depth (GD) and the total length (TL) of *E. suratensis* and *T. rendalli* are described by the following equations.

E. suratensis : $GD = 0.4112 + 0.4173\ TL\ (r = 0.95)$

T. rendalli : $GD = 1.1290 + 0.3180\ TL\ (r = 0.93)$

These equations were used to deduce, somewhat indirectly, the effective ranges of mesh sizes for *E. suratensis* and *T. rendalli*. For

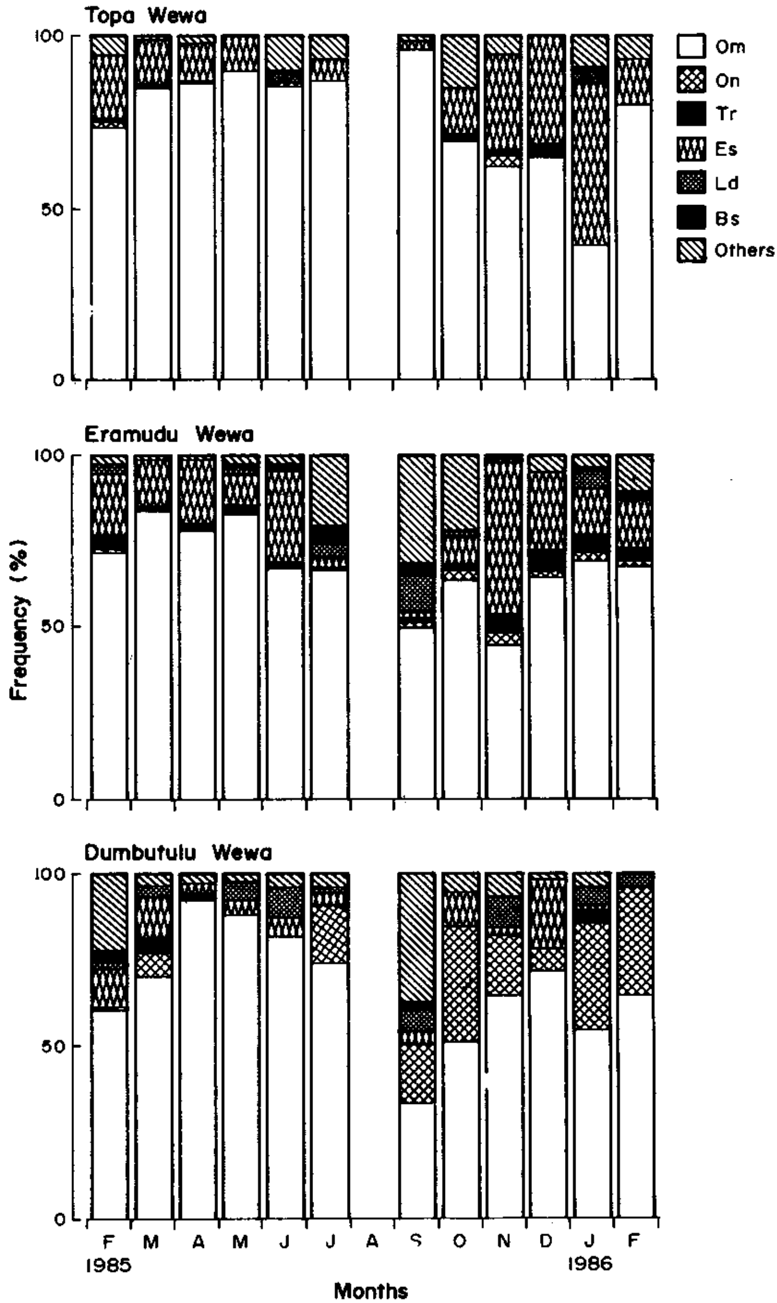

Fig 1. Species composition (percentage) of the sampled crafts in Parakrama Samudra (February 1985 - February 1986). Sampling was not carried out in August 1985. (Om - *O. mossambicus;* On - *O. niloticus;* Tr - *T. rendalli;* Es - *E. suratensis;* Ld - *L. dussumieri;* Bs - *Barbus sarana*).

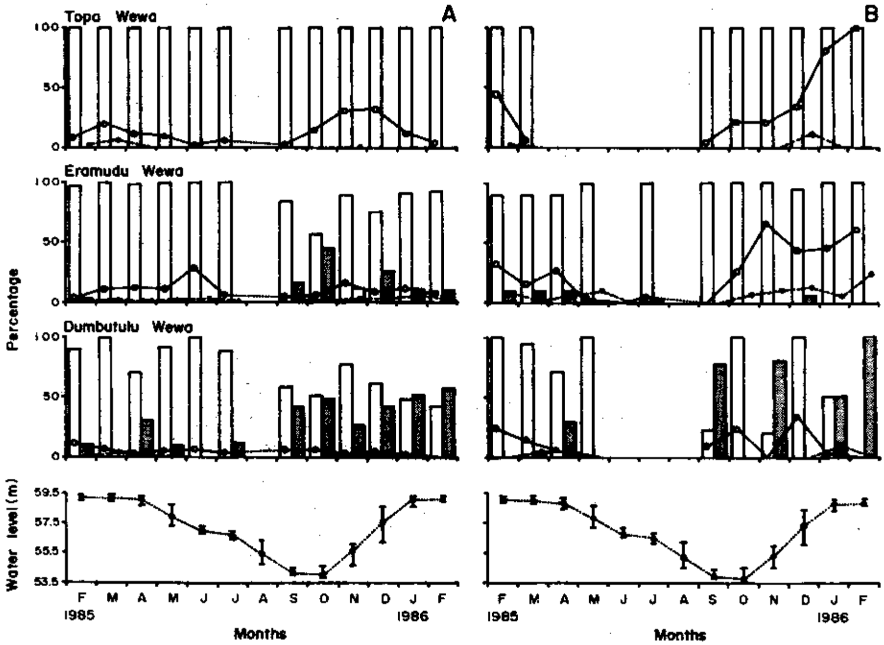

Fig. 2. Relative contribution (percentage) of *E. suratensis* (solid lines) and *T. rendalli* (broken lines) to the total cichlid catch for two fishing methods. A. Normal gill netting. B. Beating technique. Percentages of small mesh gill nets (open bars) and large mesh gill nets (shaded bars) used in each fishing method are shown here. Monthly water level fluctuation in the reservoir in meters above mean sea level (vertical lines - range) in the reservoir is also given.

Table 2. Results of the G-tests (G values) to determine if the frequency distributions of *E. suratensis* and *T. rendalli* varied with mesh size and with the fishing method. (*** - significant at 0.1% level; ns - not significant; na - data not available or not adequate.)

	Topa wewa	Eramudu wewa	Dumbutulu wewa
E. suratensis			
Fishing method	65.625***	120.332***	23.113***
Mesh size	na	15.413***	71.943***
T. rendalli			
Fishing method	na	62.249***	na
Mesh size	na	0.112 (ns)	na

this purpose, it was assumed that *E. suratensis* and *T. rendalli* are caught in gill nets at the region of the greatest body depth. The results show that gill nets of mesh sizes above 102 mm are not efficient for catching *E. suratensis* whereas the effective range of mesh sizes for *T. rendalli* is 64-120 mm (Table 3).

Table 3. Maximum recorded length, mean landing size, corresponding range of the greatest body depth and effective range of mesh sizes for *E. suratensis* in each lake area and for *T. rendalli* in whole lake. Note that computations for *T. rendalli* were performed using the pooled data for all three lake areas as the sample size was small.

Lake area	Maximum length (cm)	Mean length ± 2 S.D. (cm)	Corresponding range of the greatest depth (cm)	Effective range of mesh sizes (mm)
E. suratensis				
Topa wewa	24.4	17.1 – 3.4	6.1 - 9.0	64 - 89
Eramudu wewa	28.0	17.7 – 3.9	6.1 - 9.5	64 - 95
Dumbutulu wewa	26.5	18.1 – 4.0	6.3 - 9.8	64 - 95
T. rendalli				
Whole lake	34.0	23.6 – 9.7	5.6 - 11.8	64 - 120

Since the catches of *E. suratensis* and *T. rendalli* differed significantly with fishing method and the former also with mesh size, in addition to seasonal and spatial stratifications (Amarasinghe and Pitcher 1986), data were stratified according to fishing method and mesh size of gill net in analyzing catch and effort data. Species composition (see Table 1) and the fish catch by fishing method as well as by mesh size in three basins of the reservoir (Table 4) were estimated using this method of analysis. The total fishing effort in individual fishing methods in each fishing area of the reservoir is also incorporated in Table 4.

Table 4. Total catch (tonnes) and fishing effort (net piece days per year) in the fishery of Parakrama Samudra in 1985 (stratified according to fishing method, mesh size of gill net and lake area).

	Topa wewa		Eramudu wewa		Dumbutulu wewa	
	Catch	Effort (x 10^3)	Catch	Effort (x 10^3)	Catch	Effort (x 10^3)
Normal gill netting						
Small mesh	24.0	24.96	40.0	38.44	11.5	11.58
Large mesh	-	-	14.0	10.78	6.6	0.60
Beating technique						
Small mesh	3.4	1.68	14.5	5.37	5.2	2.02
Large mesh	-	-	1.6	0.77	1.9	0.51

Discussion

Both *E. suratensis* and *T. rendalli* exhibit biparental care (Ward and Samarakoon 1981; Lowe-McConnell 1982; Philippart and Ruwet 1982) and are substrate brooders which nest at the peripheral areas where vegetation is available and gill nets are not suspended. Chandrasoma and De Silva (1981) suggested that the 1:1 sex ratio in *T. rendalli* in Parakrama Samudra is due to its biparental care and monogamous union. Ward and Samarakoon (1981) showed that both male and female of a nesting pair of *E. suratensis* in an estuarine population spent more time holding station and guarding young than wandering and foraging. From our observations, the nesting behavior of *E. suratensis* in Parakrama Samudra is essentially similar to that of the estuarine populations. As such, these territorial fishes, to a certain extent, may restrict their movements to nesting areas in contrast to *O. mossambicus* in which males guard the territories. The sex ratios presently recorded and those observed by De Silva and Chandrasoma (1980) and De Silva (1986) suggest the likely restricted movements of male *O. mossambicus*. This evidence suggests that the normal gill netting is less effective for catching territorial fishes. Conversely, in the beating technique, the fishes are driven towards the nets so that this fishing method is likely to be effective for territorial fishes as well as for roaming fishes. De Silva et al. (1984) indirectly inferred from the daily pattern of activity in a lagoon of the southern part of Sri Lanka that *E. suratensis* was a visual feeder. This may explain the poor catches of *E. suratensis* in gill nets which are laid overnight.

The proportion of *E. suratensis* and *T. rendalli* in the catches increased with the elevation of the water level in the lake. *T. rendalli* is a macrophyte feeder (De Silva and Fernando 1980; Lowe-McConnell 1982; Philippart and Ruwet 1982). *E. suratensis* in lakes mainly feeds on detritus and terrestrial plants (Schiemer and Hofer 1983; De Silva et al. 1984). Therefore, both species would prefer recently inundated areas where there is rich supply of food. These feeding habits likely result in their relatively high catches with increasing water level. The relatively high percentages of *E. suratensis* and *T. rendalli* in normal gill netting during the months of high water level has undoubtedly occurred as a result of poor catches of *O. mossambicus* during this period.

The total fish production was estimated by adding up the weight of individual species computed for each fishing method and each group of mesh sizes separately (see Table 4). Using this method of analysis, the annual fish yield in Parakrama Samudra for 1985 is estimated to be about 46 $kg \cdot ha^{-1}$. This is a lower value than the annual yield of 120 $kg \cdot ha^{-1}$ in 1982-1983 (Amarasinghe and Pitcher 1986). As shown in this study, gill netting is not the most effective gear for *E. suratensis* and *T. rendalli* so that the probability of these species being overfished is minimal.

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References

Amarasinghe, U.S. and T.J. Pitcher. 1986. Assessment of fishing effort in Parakrama Samudra, an ancient man-made lake in Sri Lanka. Fish. Res. 4(3-4):271-282.

Amarasinghe, U.S. and T. Upasena. Morphometry of a man-made lake in Sri Lanka: a factor influencing recruitment to cichlid fishery. J. NARA 32. (In press)

Chandrasoma, J. and S.S. de Silva. 1981. Reproductive biology of *Puntius sarana*, an indigenous species and *Tilapia rendalli (melanopleura)*, an exotic, in an ancient man-made lake in Sri Lanka. Fish. Manage. 12:17-28.

De Silva, S.S. 1983. Reproductive strategies of some major fish species in Parakrama Samudra reservoir and their possible impact on the ecosystem - a theoretical consideration, p. 185-192. *In* F. Schiemer (ed.) Limnology of Parakrama Samudra, Sri Lanka. Junk Publishers, The Hague.

De Silva, S.S. 1985. Observations on the abundance of the exotic cichlid *Sarotherodon mossambicus* (Peters) in relation to fluctuations in the water-level in a man-made lake in Sri Lanka. Aquacult. Fish. Manage. 16:265-272.

De Silva, S.S. 1986. Reproductive biology of *Oreochromis mossambicus* populations of man-made lakes in Sri Lanka: a comparative study. Aquacult. Fish. Manage. 17:31-47.

De Silva, S.S. and C.H. Fernando. 1980. Recent trends in the fishery of Parakrama Samudra, an ancient man-made lake in Sri Lanka, p. 927-937. *In* J.I. Furtado (ed.) Tropical ecology and development. University of Malaya Press, Kuala Lumpur.

De Silva, S.S., P. Maitipe and P.R.T. Cumaranatunga. 1984. Aspects of the biology of the euryhaline Asian cichlid, *Etroplus suratensis*. Environ. Biol. Fish. 10:77-87.

Fernando, C.H. 1984. Reservoirs and lakes of South East Asia (Oriental Region), p. 411-446. *In* F.B. Taub (ed.) Lakes and reservoirs. Elsevier Science Publishers, Amsterdam.

Lowe-McConnell, R.H. 1982. Tilapias in fish communities, p. 83-113. *In* R.S.V. Pullin and R.H. Lowe-McConnell (eds.) The biology and culture of tilapias. ICLARM Conference Proceedings 7. 360 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Philippart, J-Cl. and J-Cl. Ruwet. 1982. Ecology and distribution of tilapias, p. 15-59. *In* R.S.V. Pullin and R.H. Lowe-McConnell (eds.) The biology and culture of tilapias. ICLARM Conference Proceedings 7. 360 p. International Center for Living Aquatic Resources Management, Manila, Philippines.

Schiemer, F. and R. Hofer. 1983. A contribution to the ecology of the fish fauna of the Parakrama Samudra Reservoir, p. 135-154. *In* F. Sciemer (ed.) Limnology of Parakrama Samudra, Sri Lanka. Junk Publishers, The Hague.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. 2nd ed. W.H. Freeman, San Francisco.

Ward, J.A. and J.I. Samarakoon. 1981. Reproductive tactics of the Asian cichlids of the genus *Etroplus* in Sri Lanka. Environ. Biol. Fish. 6:95-103.

Willey, A. 1910. Notes on the freshwater fisheries of Ceylon. Spolia Zeylan. Bull. Natl. Mus. Sri Lanka 7:88-105.

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