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A REVIEW ON THE ICHTHYOFAUNAL DIVERSITY IN MANGROVE BASED ESTUARY OF KADALUNDI RIVER, KERALA, SOUTH INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between two authors. Author MAA designed the study, performed the water quality parameters, data collections, identification, statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author VSA managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

A review on the Ichthyofaunal diversity in Mangrove based estuary of Kadalundi River, Kerala, South India was during July, 2016, to June, 2017. It is located on the Western side of the Northern Kerala, in Kozhikode and Malappuram districts on the river mouth of Kadalundipuzha spreading in the estuary. Total 37 fish species were reported belonging to 29 families were reported from the 3 selected stations. The total population density of station-A, B and C was 2004, 1868 and 2090 respectively. The maximum number of species was reported in three stations in the month of October. The minimum species was reported in the month of January. The maximum number of species was reported in station-A (254) and minimum number of species was reported in station-A (87). The maximum number of species was reported in station-B (243) and minimum number of species was reported in station-B (70). The maximum number of species was reported in station-C (253) and minimum number of species was reported in station-C (103).

Keywords: Kadalundi River; ichthyofauna; mangrove; species richness; species evenness; Shannon-wiener index.

1. INTRODUCTION

Biodiversity includes the sum total of diversity exists entire biological organization which includes the living organism like plants, animals, microorganisms etc. The fish faunal diversity is a main branch of aquatic diversity and constitutes half of the total vertebrate species present in the world. Fish found in

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almost all aquatic habitats of the world. India is one of the mega biodiversity countries in the world and occupies the ninth position in terms of freshwater mega biological diversity [1]. India contains both freshwater and marine fish species. India there is 2,500 species of fishes of which 930 live in freshwater [2] and 1,570 live in marine [3]. The fish fauna is showing the monthly fluctuation in all habitats. The increasing levels of anthropogenic activities are severely damaging the river ecosystems. The degradation of aquatic ecosystem leads the changes in pattern of distribution of fish fauna. Therefore, in the present study an attempt made the fish fauna diversity of the Kadalundi river estuary of Kerala (Fig. 1). Kadalundi-Vallikkunnu Community Reserve has been constituted as per G.O. (MS) No. 66/2007 F & WLD dated 17.10.2007 under Section 36 (c) of Wildlife Protection Act 1972. It is located on the Western side of the Northern Kerala, in Kozhikode and Malappuram districts and the river mouth spreading in the estuary. Kadalundi River is originated from Western Ghats and flowing westward nearly 130 Kms. Kadalundi River is one of the four most important rivers flowing through Malppuram district of Kerala. It extends in Kadalundi of Kozhikode Taluk of Kozhikode District and Vallikunnu of Tirurangadi Taluk of Malappuram District. The total extent of the Community Reserve is 153.8415 ha. The main aim is to protect biodiversity, cultural, traditional values with the participation of local community, to provide facilities for research, study, etc. Many migratory fishes, birds and mangrove forests are found in estuarine area of Kadalundi River. This mangrove based ecosystem harbor number of fishes. This study area is a combination of ecosystems such as sea, estuary, river, mangrove forest, marshy areas, wetlands, sacred groves and agricultural fields. The river Kadalundi has two tributaries that is Olipuzha and Karimpuzha or Oravampuram puzha. One of the oldest railway links, Kadalundi Bridge across the river, built by British over 140 years. The objective this study on the Ichthyofaunal diversity, their distribution and abundance of Mangrove based estuary of Kadalundi River, Kerala, South India.

2. MATERIALS AND METHODS

The areas selected for the study were three different stations of Kalalundi river estuary, borderline of Malappuram and Kozhikkode district of Kerala (Fig. 1). The stations selected for the studies are Heros Nagar (Station-A), Palakkal (Station-B) and Keezhayil (Station-C) are collected for the study. Frequency of sampling for both water quality parameters and fish data collection was four times in each month and selected morning hours between 7 am-10 am. All the study area is rich with different types of mangrove forests. There are 8 varieties of mangrove forests are found in the study area, *Rhizophora mucronata* (Long fruited stilted Mangrove), *Avicinia officianalis* (White Mangrove), *Acanthus ilicifolius* (Sea Holly mangrove), *Sonneratia alba* (Mangrove Apple), *Sonneratia caseolaris*, *Bruguiera cylindrica* (Small leaved Orange mangrove), *Excoecaria agallocha* (Blind your eye Mangrove) and *Acrostichum aureum*. During study period mean value of water quality parameters such as temperature, pH, transparency, alkalinity, dissolved oxygen, dissolved CO_2, Salinity, total solids, total dissolved solids, total suspended solids and electrical conductivity also tabulated. The rain fall data were obtained from world online monthly climatic data (https://www.worldweatheronline.com). The water temperature and air temperature were measured by thermometer. The Secchi's disc was used to measure transparency. The digital pen (Elico model) was taken for the determination of pH in the different study zone. Alkalinity was measured by using sulphuric acid with digital titrator. The Mohr-Knudsen method titration procedure and Winkler's method was followed for salinity and dissolved oxygen determination was respectively [4]. Total solids measured by beaker and evaporation method till dryness over a heater. Total suspended solids measured by water filtration method through a pre weighed filter paper. Total dissolved solids were measured by filtrate evaporation till dryness. The fish data were collected from downstream zone of Kadalundi river estuary by using different types of net like gill net, cast net and also from local fish landing centers. For the analysis, four sample of each fish species were taken and thoroughly washed to remove debris of fish, blood stains, patches etc. The data collected four times in a month and mean value taken. The phenotypic characterization were identified to the lowest taxonomic level following standard references using FAO species catalogue of the world, [5]. For the purpose of documentation, the photographs were taken. The fish species brought to laboratory and preserved with 10% formalin. All the characters of the fish were measured. Each fish were identified up to their species level. The different community parameters such as total species richness, species evenness and Shannon-Wiener diversity index were calculated as a summary of distribution and abundances of fish species.

Fish species diversity was determined using Shannon-Weiner's Diversity index, ***H*** as follows:

$$H = -\sum_{i=1}^{s} Pi \ ln(Pi)$$

Where ***Pi*** is the relative abundance of each species calculated as the proportion of individuals of a given

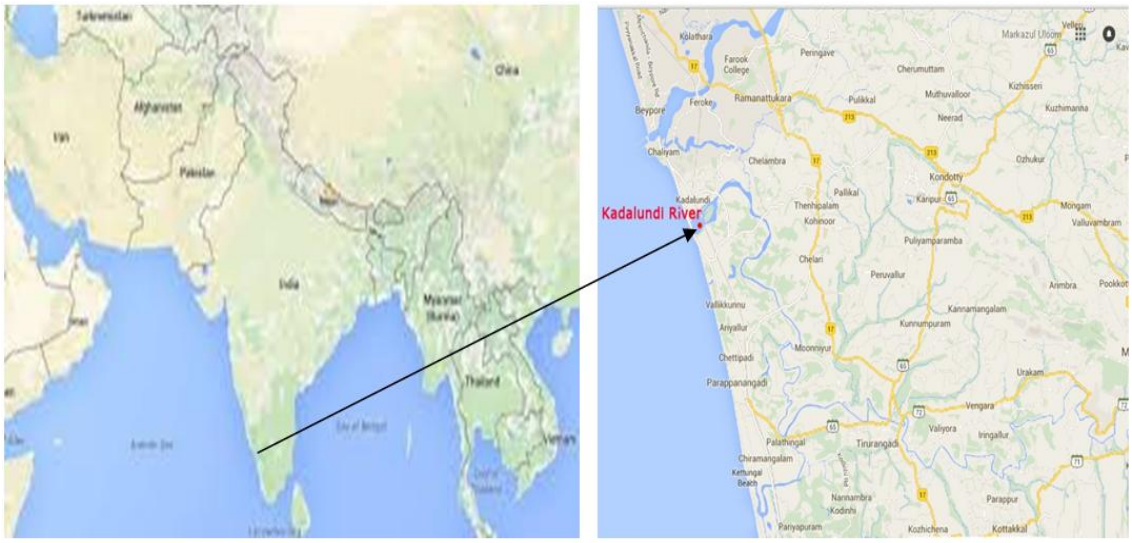

Fig. 1. Route map of Kadalundi river

species to the total number of individuals in the community. Shannon's equitability (E_H) was used to determine whether the population is evenly distributed among the species present. It was calculated using;

$$E_H = H/\ln S$$

Where H is Shannon's diversity index; S is total number of species in the habitat (Species Richness).

3. RESULTS

The Mangrove zone of Kadalundi river estuary of Kerala was taken every month for collection of water and fish species. Throughout the study period monthly variation in atmospheric temperature and water temperature was maximum during pre-monsoon months and there was a decrease during monsoon months in all the three sites. Dissolved oxygen at all the three stations showed higher values during pre-monsoon months during the duration of the study. Maximum value of dissolved carbon dioxide during monsoon months and the minimum in pre-monsoon months throughout the study period was observed in all the three sites. This monsoonal minimum was mainly attributed to the heavy runoff, which is in accordance with the results of [6] in Colerron estuary. The general trend observed in the present study was positive correlation of transparency with temperature, pH with alkalinity and total solids with electrical conductivity. The negative correlation of dissolved CO_2 with dissolved oxygen. Total 37 fish species were reported belonging to 29 families were reported from the 3 selected stations (Tables 4, 5 and 6). *The families are Ambassidae, Aridae, Bagridae, Belonidae, Carangidae, Cichlidae, Clupeidae, Cynoglossidae, Cyprinidae, Engraulidae, Gerreidae, Gobiidae, Latidae, Leiognathidae, Lobotidae, Lutjanidae, Megalopidae, Mugilidae, Platycephalidae, Scatophagidae, Sciaenidae, Serranidae, Siganidae, Sillaginidae, Soleidae, Sparidae, Sphyraenidae, Terapontidae and Triacanthidae*. Only bony fishes were found in my survey. The total population density of station-A, B and C was 2004, 1868 and 2090 respectively (Tables 4, 5 and 6). The maximum population density was reported in three stations in the month of October. The minimum population density was reported in the month of January. The maximum population density was reported in station-A (254) and minimum population density was reported in station-A (87). The maximum population density was reported in station-B (243) and minimum population density was reported in station-B (70). The maximum population density was reported in station-C (253) and minimum population density was reported in station-C (103). A perfect understanding of the fish faunal diversity of a system is an essential prerequisite for successful implementation of fisheries development, sustainable utilization of fishery resources and for adopting suitable conservation measures. Here we have encountered only estuarine zones from river Kadalundi river estuary, Kerala. *Ambassis gymnocephalus* was reported maximum in 3 stations i.e., 268, 271 and 278 (Tables 4, 5 and 6 respectively). *Ambassis gymnocephalus* was absent in April and May in station-A and March, April and May months of station-B and C. *Siganus vermiculatus* was reported only in November month of station-A, B and was the minimum number in station-A, i.e., 2 (Table 4).

Triacanthus biaculeatus was reported minimum in station-B and C, i.e., 0 (Tables 5 and 6). *Triacanthus biaculeatus* locally known as short nosed tripod fish / Muttudi fish/ Helicopter fish, was found only from staion-A. *Triacanthus biaculeatus* usually found in very close to sea zone. *Ableness sp, Caranx ignobilis, Etroplus suratensis, Liza macrolepis, Mugil cephalus, Sillago sihama* are the six species are regularly found in 3 stations of the estuary. With these six species *Paretroplus maculates* and *Cyanoglossus macrostomus* also found regularly in station-B and station-C. The maximum species richness (H_{max}) (Tables 7, 8 and 9) was reported in three station in the month of October (3.443, 3.465 and 3.465 respectively) and minimum species richness (Tables 7, 8 and 9) was reported in station-A is February (2.639), station-B is June (2.639) and station-C is January (2.639). The maximum species evenness (E) (Tables 7, 8 and 9) was reported in station-A is December (0.93), station-B is February (0.97) and station-C is May (0.93). The minimum species evenness (Tables 7, 8 and 9) was reported in station-A is August (0.81), station-B and C is July (0.73 and 0.76 respectively). The maximum Shannon-Weiner index (H^1) (Tables 7, 8 and 9) was reported in station-A, B and C is October (3.10, 3.09 and 3.13 respectively) and the minimum Shannon-Weiner index (Tables 7, 8 and 9) was reported in station-A is February (2.34), station-B and C is July (2.00 and 2.11 respectively) and station-C is January (2.639).

4. DISCUSSION

Environmental factors are considered as essential to determine the composition, distribution and assemblage of fish species in an aquatic environment [7]. The atmospheric temperature and water temperature was maximum during pre-monsoon months and there was a decrease during monsoon and this may be due to the high fresh water inflow during monsoon season or the increased temperature during pre-monsoon months can be due to high solar radiation, which agrees with the data made by [8]. The atmospheric temperature and water temperature was very low during winter month's shows negative correlation with fish diversity. The water is more transparent fish population density shows negative correlation. Some fish species shows positive correlation with increasing pH while some others shows positive correlation with declining pH. Dissolved oxygen at all the three stations higher values during pre-monsoon, it may be due to not renewal of fresh water inflow and showed the negative correlation with the data of [9]. The chief reason for this may be comparatively with other years the rain availability was less during the study year. Maximum value of dissolved carbon dioxide during monsoon months and the minimum in pre-monsoon This monsoonal minimum was mainly attributed to the heavy runoff, which is in accordance with the results of [6] in Colerron estuary. The chief reason for this may be comparatively with other years the vast climatic changes occurred during the study year. The general trend observed in the present study was positive correlation of transparency with temperature, pH with alkalinity and total solids with electrical conductivity. The negative correlation of dissolved CO_2 with dissolved oxygen. In Kadalundi estuarine system depth was associated with the occurrence of the families are *Ambassidae, Aridae, Bagridae, Belonidae, Carangidae, Cichlidae, Clupeidae, Cynoglossidae, Cyprinidae, Engraulidae, Gerreidae, Gobiidae, Latidae, Leiognathidae, Lobotidae, Lutjanidae, Megalopidae, Mugilidae, Platycephalidae, Scatophagidae, Sciaenidae, Serranidae, Siganidae, Sillaginidae, Soleidae, Sparidae, Sphyraenidae, Terapontidae and Triacanthidae*. Fish species like *Ableness sp., Caranx ignobilis, Etroplus suratensis, Cynoglossus macrostomus, Mugil cephalus Liza macrolepis* and *Sillago sihama* reported in almost all months and shows positive correlation with all physicochemical parameters studied. During monsoon more positively correlated population density (maximum species richness) was reported in three stations in the months of September and October. This data agreed with the study of Fish diversity, habitat ecology and their conservation and management issues Tropical River in Ganga basin, India [10]. In India, monsoon starts in June and ends in October, so each fish species will get much time for spawning and maturity. There was no rain reported in January, so each fish will not get time for spawning and maturity. This is the main reason for less fish population density (negatively correlated) was reported in three stations in the month of January. Seasonal variations in rainfall create or eliminate micro-habitats which are important for fishery abundance [11]. This indicates that rainfall has a direct relationship with the species present in the water body. Seasonal variations in rainfall act as a main factor, which affects the strategies of the life cycle of fish, such as their movement, feeding, growth and spawning [12]. During rainy season, more water availability, fishes will get enough space for depth, shelter and the beneficial futures of mangrove forests well grown and support the fish species diversity. Depth in tropical waters formed an important factor in structuring the species assemblages [13]. During summer more positively correlated (maximum species richness) was reported in three stations in the months of April and May. This data agreed with the study of seasonal variations in species diversity, abundance, and composition of fish communities in the northern

Indian river lagoon, floridat [14]. The species evenness was more positively correlated with post-monsoon (November, December and January) and in pr-monsoon months (March, April and May).

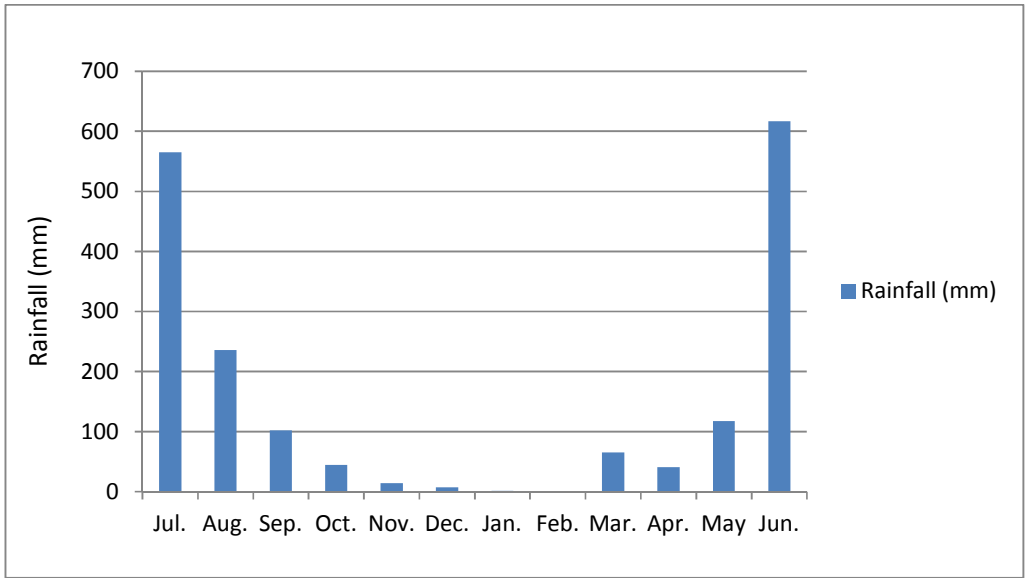

Fig. 2. Average rainfall recorded during 2016-17 in the study area

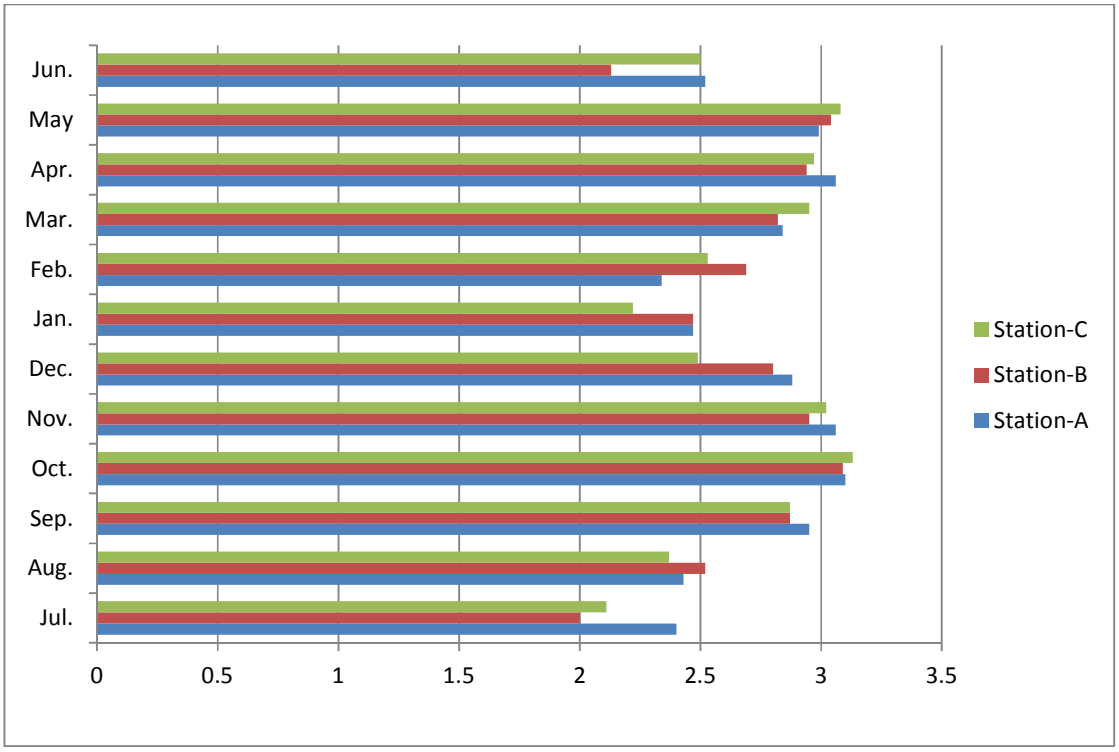

Fig. 3. Average H_{max} recorded during 2016-17 in the study area

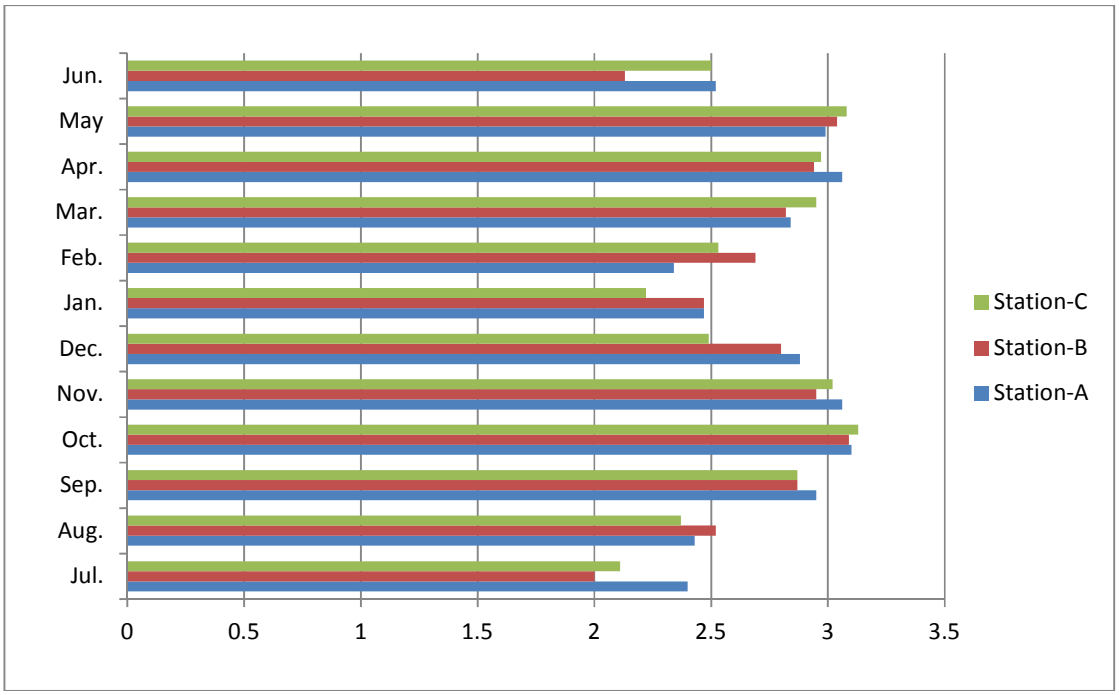

Fig. 4. Average E recorded during 2016-17 in the study area

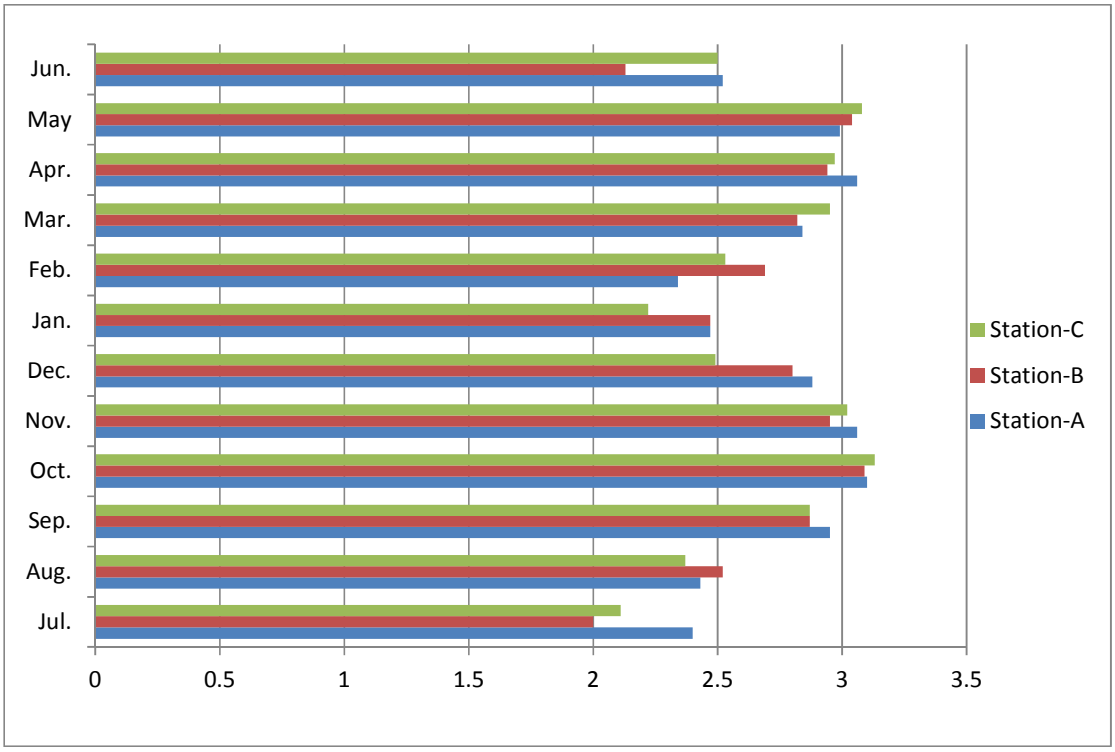

Fig. 5. Average H^1 recorded during 2016-17 in the study area

Ambassis gymnocephalus

Arius maculates

Mystus gulio

Ableness sp.

Carangoides malabaricus

Caranx ignobilis

Trachinotus blochii

Etroplus suratensis

Oreochromis niloticus

Paretroplus maculates

Anodontostoma chacunda

Cynoglossus macrostomus

Rasbora daniconius

Stolephorus indicus

Gerres setifer

Glossogobius giuris

Lates calcarifer

Leiognathus brevirostris

Lobotes surinamensis

Lutjanus argentimaculatus

Lutjanus johnii

Megalops cyprinoides

Chelon parsia

Liza macrolepis

Mugil cephalus

Onigocia pedimacula

Scatophagus argus

Daysciaena albida

Epinephelus malabaricus

Siganus javus

Siganus vermiculatus

Sillago sihama

Brachirus orientalis

Acanthopagrus berda

Sphyraena obtusata

Terapon jarbua

Triacanthus biaculeatus

Fig. 6. Ichthyofauna of Kadalundi-Vallikkunnu community reserve

Monthly variations of physico-chemical parameters in different stations of Kadalundi River from July, 2016, to June, 2017

Table 1. Station-A

Parameters / Months	Atm. Temp. (°C)	Water Temp. (°C)	Transparency (inches)	pH	Alkalinity (mg/l)	Dissolved oxygen (mg/l)	Dissolved CO_2 (mg/l)	Salinity (ppt)	Total solids (mg/l)	Total dissolved solids (mg/l)	Total suspended solids (mg/l)	Electrical conductivity (mS/cm)
Jul.	27	26	4.6	7.52	23.56	3.98	4.54	30.84	29747	29615	132	47.40
Aug.	28	26	5.6	7.62	23.34	3.65	4.38	31.62	30481	30337	144	48.47
Sep.	28	27	5.8	7.64	23.54	3.80	4.12	31.75	30607	30459	148	48.65
Oct.	28	26	6.4	7.68	23.85	3.92	4.24	31.58	30439	30297	142	48.41
Nov.	27	25	6.8	7.72	24.22	3.44	4.10	31.45	30321	30182	139	48.24
Dec.	25	23	6.1	7.74	52.42	3.54	3.78	31.96	30800	30648	152	48.93
Jan.	27	25	6.5	8.02	102.53	4.62	3.74	32.64	31437	31277	160	49.86
Feb.	27	25	7.4	8.06	102.62	4.78	3.98	33.22	31978	31812	166	50.65
Mar.	28	26	8.5	8.12	105.20	4.88	4.08	33.72	32452	32274	178	51.33
Apr.	29	27	9.6	8.24	106.44	4.22	3.66	33.95	32668	32484	184	51.64
May	29	28	9.8	8.08	104.22	4.62	3.96	33.82	32549	32369	180	51.47
Jun.	27	25	4.8	7.42	23.82	3.54	4.31	30.59	29514	29386	128	47.06

Table 2. Station-B

Parameters / Months	Atm. Temp. (°C)	Water Temp. (°C)	Transparency (inches)	pH	Alkalinity (mg/l)	Dissolved oxygen (mg/l)	Dissolved CO_2 (mg/l)	Salinity (ppt)	Total solids (mg/l)	Total dissolved solids (mg/l)	Total suspended solids (mg/l)	Electrical conductivity (mS/cm)
Jul.	27	26	5.8	7.32	23.76	4.32	4.20	28.40	27474	27354	120	44.03
Aug.	28	26	6.2	7.38	23.28	3.84	4.12	29.22	28245	28117	128	45.17
Sep.	28	26	6.4	7.52	24.98	3.43	4.02	29.58	28582	28446	136	45.66
Oct.	28	27	6.9	7.48	24.94	3.86	4.36	29.40	28408	28278	130	45.41
Nov.	28	26	7.2	7.52	27.62	3.42	3.90	29.24	28254	28130	124	45.19
Dec.	26	24	6.4	7.63	53.22	3.92	3.82	29.82	28813	28667	146	45.99
Jan.	26	25	6.5	7.96	98.80	4.70	3.86	30.56	29505	29353	152	47.01
Feb.	27	26	7.4	7.66	103.24	4.68	3.88	31.05	29969	29811	158	47.69
Mar.	28	27	8.8	8.12	104.20	4.60	3.62	31.64	30517	30357	160	48.50
Apr.	29	27	9.7	8.14	105.44	4.62	3.54	31.94	30532	30634	168	48.91
May	29	28	9.8	7.90	102.56	4.68	3.82	31.70	30574	30411	163	48.58
Jun.	27	25	6.1	7.30	23.44	3.94	4.04	27.50	26628	26513	115	42.77

Table 3. Station-C

Parameters / Months	Atm. Temp. (°C)	Water Temp. (°C)	Transparency (inches)	pH	Alkalinity (mg/l)	Dissolved oxygen (mg/l)	Dissolved CO_2 (mg/l)	Salinity (ppt)	Total solids (mg/l)	Total dissolved solids (mg/l)	Total suspended solids (mg/l)	Electrical conductivity (mS/cm)
Jul.	27	26	6.4	7.28	24.66	4.98	3.96	27.58	26700	26586	114	42.88
Aug.	28	26	6.5	7.36	23.22	3.68	4.14	28.35	27427	27307	120	43.96
Sep.	28	26	6.7	7.42	23.64	3.26	4.16	28.40	27480	27354	126	44.03
Oct.	28	26	6.9	7.36	24.69	3.64	4.14	28.28	27362	27240	122	43.86
Nov.	27	26	7.1	7.44	24.94	3.22	3.84	28.12	27209	27093	116	43.64
Dec.	26	25	6.3	7.36	43.34	3.28	3.96	28.60	27667	27534	133	44.30
Jan.	26	25	6.4	7.68	95.88	4.32	3.70	29.52	28530	28392	138	45.58
Feb.	28	26	7.3	7.70	102.23	4.10	3.82	29.86	28849	28707	142	46.05
Mar.	29	27	9.3	7.44	101.36	3.76	3.46	30.52	29465	29319	146	46.96
Apr.	30	28	9.7	7.86	105.12	4.12	3.36	30.90	29833	29669	164	47.48
May	30	28	9.9	7.72	101.46	4.32	3.84	30.66	29603	29447	156	47.15
Jun.	27	25	6.2	7.18	23.42	3.94	4.22	27.20	26343	26233	110	42.35

Monthly variations of Ichthyofauna in different stations of Kadalundi River from July, 2016 to June, 2017

Table 4. Station-A

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Ambassis gymnocephalus	42	53	46	33	22	14	8	6	4	0	0	40	268	13.373
Arius maculatus	0	32	38	27	19	11	6	0	8	12	16	0	169	8.433
Mystus gulio	0	0	22	28	32	12	0	16	21	28	32	0	191	9.530
Ableness sp.	10	8	6	5	5	4	4	5	6	8	6	10	77	3.842
Carangoides malabaricus	2	2	3	3	3	4	3	0	0	0	0	0	20	0.998
Caranx ignobilis	3	4	3	2	3	2	2	2	6	8	10	4	49	2.445
Trachinotus blochii	0	0	0	3	2	0	0	0	0	4	3	2	14	0.698
Etroplus suratensis	2	4	8	10	8	7	4	5	9	12	16	6	91	4.540
Oreochromis niloticus	2	2	2	2	3	2	1	2	2	3	2	0	23	1.147
Paretroplus maculatus	0	0	2	2	0	2	2	0	2	3	2	0	15	0.748
Anodontostoma chacunda	4	7	8	11	8	0	0	0	6	8	12	9	73	3.642

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Cynoglossus macrostomus	3	4	9	13	8	4	6	10	14	24	18	4	117	5.838
Rasbora daniconius	4	6	7	8	2	0	0	0	0	3	2	2	34	1.696
Stolephorus indicus	0	0	3	4	5	2	0	0	8	18	12	8	60	2.994
Gerres setifer	3	4	5	6	3	2	1	0	0	0	0	4	28	1.397
Glossogobius giuris	2	2	3	4	2	1	0	0	2	4	2	1	23	1.147
Lates calcarifer	0	0	0	0	1	3	2	3	2	0	0	0	11	0.548
Leiognathus brevirostris	0	0	3	5	6	8	9	6	2	0	0	0	39	1.946
Lobotes surinamensis	0	0	2	4	3	0	0	0	0	0	0	0	9	0.449
Lutjanus argentimaculatus	0	0	0	0	0	0	0	0	2	5	3	0	10	0.499
Lutjanus johnii	2	2	2	3	0	0	0	0	0	2	3	2	16	0.798
Megalops cyprinoides	3	4	6	3	2	1	0	0	0	0	0	2	21	1.047
Chelon parsia	2	2	3	0	0	0	0	2	2	4	3	0	18	0.898
Liza macrolepis	6	8	10	12	7	10	13	16	18	21	22	28	171	8.532
Mugil cephalus	8	10	16	20	16	11	8	11	13	15	19	13	160	7.984
Onigocia pedimacula	2	4	6	3	2	1	0	0	2	3	2	1	26	1.297
Scatophagus argus	0	0	2	3	0	0	0	0	0	3	3	2	13	0.648
Daysciaena albida	0	0	0	3	2	0	0	0	2	5	4	2	18	0.898
Epinephelus malabaricus	0	0	0	3	2	0	0	0	2	4	3	2	16	0.798
Siganus javus	0	0	0	3	2	0	0	0	0	2	4	2	13	0.648
Siganus vermiculatus	0	0	0	0	2	0	0	0	0	0	0	0	2	0.099
Sillago sihama	8	10	12	15	8	14	16	12	10	8	6	5	124	6.187
Brachirus orientalis	0	8	9	10	8	5	0	0	4	8	5	0	57	2.844
Acanthopagrus berda	0	0	0	0	0	0	0	0	2	5	4	1	12	0.598
Sphyraena obtusata	0	0	2	3	0	0	0	0	2	3	2	0	12	0.598
Terapon jarbua	0	0	2	3	2	2	2	1	0	0	0	0	12	0.598
Triacanthus biaculeatus	0	0	0	0	0	0	0	0	0	2	2	0	4	0.199
Total Population Density	**108**	**176**	**240**	**254**	**188**	**122**	**87**	**97**	**151**	**225**	**218**	**150**	**2004**	

Table 5. Station-B

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Ambassis gymnocephalus	44	52	56	32	26	14	10	4	0	0	0	33	271	14.507
Arius maculatus	0	36	39	31	24	12	0	0	14	26	22	0	204	10.179
Mystus gulio	0	0	16	22	25	0	0	14	22	28	18	0	145	7.235
Ableness sp.	10	9	8	5	4	4	3	4	6	8	9	11	81	4.336
Carangoides malabaricus	2	2	2	3	5	3	2	2	2	0	0	0	23	1.231
Caranx ignobilis	2	3	3	4	2	2	2	3	6	10	8	4	49	2.623
Trachinotus blochii	0	0	2	3	2	0	0	0	0	4	3	2	16	0.856
Etroplus suratensis	2	4	6	10	11	14	5	7	9	18	14	5	105	5.620
Oreochromis niloticus	0	2	3	4	3	2	2	2	2	3	2	0	25	1.338
Paretroplus maculatus	2	2	3	5	2	2	2	2	3	5	3	2	33	1.766
Anodontostoma chacunda	4	5	11	12	6	0	0	0	9	18	12	0	77	4.122
Cynoglossus macrostomus	2	5	6	10	5	3	5	7	10	17	12	5	87	4.657
Rasbora daniconius	2	4	5	6	3	2	0	0	0	2	3	0	27	1.445
Stolephorus indicus	0	0	2	5	4	2	0	0	3	8	6	2	32	1.713
Gerres setifer	2	4	5	6	3	2	1	0	0	0	0	2	25	1.338
Glossogobius giuris	0	2	2	3	2	0	0	0	3	2	2	0	16	0.856
Lates calcarifer	0	0	0	0	3	3	2	2	2	0	0	0	12	0.642
Leiognathus brevirostris	0	0	2	4	5	6	4	3	2	0	0	0	26	1.391
Lobotes surinamensis	0	0	0	3	2	0	0	0	0	0	0	0	5	0.267
Lutjanus argentimaculatus	0	0	0	0	0	0	0	0	2	3	2	0	7	0.374
Lutjanus johnii	0	2	2	3	2	0	0	0	2	3	2	0	16	0.856
Megalops cyprinoides	1	2	2	3	2	1	0	0	0	0	0	2	13	0.695
Chelon parsia	2	2	3	2	0	0	0	0	2	3	2	0	16	0.856
Liza macrolepis	3	5	6	9	11	6	8	10	12	18	12	6	106	5.674
Mugil cephalus	8	12	18	20	22	12	8	6	8	12	16	10	152	8.137
Onigocia pedimacula	2	3	5	2	2	2	0	0	2	3	2	0	23	1.231
Scatophagus argus	0	0	2	3	3	0	0	0	2	4	3	0	17	0.910
Daysciaena albida	0	0	0	3	2	0	0	0	0	2	2	0	9	0.481
Epinephelus malabaricus	0	0	2	3	0	0	0	0	2	4	3	0	14	0.749
Siganus javus	0	0	0	2	2	0	0	0	0	2	0	0	6	0.321
Siganus vermiculatus	0	0	0	0	2	0	0	0	0	0	0	0	2	0.107
Sillago sihama	6	9	11	14	17	20	14	10	8	12	8	4	133	7.119

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Brachirus orientalis	0	10	8	6	4	3	0	0	3	8	10	0	52	2.783
Acanthopagrus berda	0	0	0	0	0	0	0	2	3	4	3	2	14	0.749
Sphyraena obtusata	0	2	3	2	0	0	0	0	2	3	2	0	14	0.749
Terapon jarbua	0	2	2	3	2	2	2	2	0	0	0	0	15	0.802
Triacanthus biaculeatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Population Density	**94**	**179**	**235**	**243**	**208**	**117**	**70**	**80**	**141**	**230**	**181**	**90**	**1868**	

Table 6. Station-C

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Ambassis gymnocephalus	56	64	58	24	20	12	6	4	0	0	0	34	278	13.301
Arius maculatus	0	42	36	32	26	18	0	0	15	22	15	0	206	9.856
Mystus gulio	0	0	16	21	24	0	0	18	22	24	14	0	139	6.650
Ableness sp.	12	10	8	5	4	2	3	5	8	12	10	8	87	4.162
Carangoides malabaricus	2	2	2	4	3	3	2	2	3	0	0	0	23	1.100
Caranx ignobilis	2	2	3	4	3	2	4	6	10	8	5	2	51	2.440
Trachinotus blochii	0	0	2	3	2	0	0	0	0	3	4	3	17	0.813
Etroplus suratensis	2	4	6	9	7	4	6	8	11	16	14	8	95	4.545
Oreochromis niloticus	2	2	3	3	2	2	2	3	2	4	3	0	28	1.339
Paretroplus maculatus	2	4	5	8	4	3	2	2	3	5	3	2	43	2.057
Anodontostoma chacunda	4	8	9	11	14	0	0	0	8	15	10	2	81	3.875
Cynoglossus macrostomus	2	3	5	8	6	3	2	3	6	12	10	4	64	3.062
Rasbora daniconius	2	3	4	5	3	0	0	0	2	3	3	2	27	1.291
Stolephorus indicus	0	0	2	3	4	2	0	0	2	5	3	2	23	1.100
Gerres setifer	2	3	3	5	2	2	0	0	0	0	2	2	21	1.004
Glossogobius giuris	0	2	2	3	2	1	0	0	0	2	3	0	15	0.717
Lates calcarifer	0	0	0	3	3	4	3	2	2	0	0	0	17	0.813
Leiognathus brevirostris	0	0	2	5	6	8	9	12	5	0	0	0	47	2.248
Lobotes surinamensis	0	0	2	3	0	0	0	0	0	0	0	0	5	0.239
Lutjanus argentimaculatus	0	0	0	0	0	0	0	0	2	3	2	0	7	0.334
Lutjanus johnii	0	2	2	3	2	0	0	0	0	2	2	0	13	0.622
Megalops cyprinoides	2	2	3	2	2	1	0	0	0	0	0	2	14	0.669
Chelon parsia	2	2	4	3	0	0	0	0	2	4	2	0	19	0.9090
Liza macrolepis	5	7	8	11	8	10	11	13	15	18	20	16	142	6.794
Mugil cephalus	14	18	21	23	24	17	13	10	12	16	18	10	196	9.377
Onigocia pedimacula	0	2	4	3	2	0	0	0	3	3	2	0	19	0.9090
Scatophagus argus	0	0	2	2	2	0	0	0	4	3	3	2	18	0.861
Daysciaena albida	0	0	0	2	2	2	0	0	0	3	3	2	14	0.669
Epinephelus malabaricus	0	0	2	4	2	0	0	0	2	4	2	0	16	0.765
Siganus javus	0	0	0	3	2	0	0	0	0	2	0	0	7	0.334
Siganus vermiculatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sillago sihama	14	18	21	24	28	34	37	22	15	14	12	10	249	11.913

Ichthyofauna	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Total	Percentage
Brachirus orientalis	0	10	12	11	8	5	0	0	6	12	8	0	72	3.444
Acanthopagrus berda	0	0	0	0	0	0	0	2	4	5	3	2	16	0.765
Sphyraena obtusata	0	0	2	3	0	0	0	0	2	3	2	0	12	0.574
Terapon jarbua	0	0	0	0	2	2	3	2	0	0	0	0	9	0.430
Triacanthus biaculeatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Population Density	**125**	**210**	**249**	**253**	**219**	**137**	**103**	**114**	**166**	**223**	**178**	**113**	**2090**	

Monthly variations of Shannon and Wiener diversity index of Ichthyofauna in different stations of Kadalundi River from July, 2016 to June 2017

Table 7. Station-A

Months	Species Richness (H_{max})	Species Evenness (E)	Shannon-Wiener Index (H^I)
Jul.	2.890	0.83	2.40
Aug.	2.995	0.81	2.43
Sep.	3.332	0.89	2.95
Oct.	3.443	0.90	3.10
Nov.	3.367	0.91	3.06
Dec.	3.091	0.93	2.88
Jan.	2.772	0.89	2.47
Feb.	2.639	0.89	2.34
Mar.	3.218	0.88	2.84
Apr.	3.332	0.92	3.06
May	3.332	0.90	2.99
Jun.	3.091	0.82	2.52

Table 8. Station-B

Months	Species Richness (H_{max})	Species Evenness (E)	Shannon-Wiener Index (H^I)
Jul.	2.772	0.72	2.00
Aug.	3.135	0.80	2.52
Sep.	3.367	0.85	2.87
Oct.	3.465	0.89	3.09
Nov.	3.433	0.86	2.95
Dec.	3.044	0.92	2.80
Jan.	2.708	0.91	2.47
Feb.	2.772	0.97	2.69
Mar.	3.258	0.87	2.82
Apr.	3.295	0.89	2.94
May	3.258	0.93	3.04
Jun.	2.639	0.81	2.13

Table 9. Station-C

Months	Species Richness (H_{max})	Species Evenness (E)	Shannon-Wiener Index (H^I)
Jul.	2.772	0.76	2.11
Aug.	3.044	0.78	2.37
Sep.	3.367	0.85	2.87
Oct.	3.465	0.90	3.13
Nov.	3.401	0.89	3.02
Dec.	3.044	0.82	2.49
Jan.	2.639	0.84	2.22
Feb.	2.772	0.91	2.53
Mar.	3.218	0.92	2.95
Apr.	3.295	0.90	2.97
May	3.295	0.93	3.08
Jun.	2.890	0.86	2.50

5. CONCLUSION

The mangrove's all beneficial features support the species diversity of the Kadaludi estuarine area. The fishery in Kadaludi estuarine system is facing tremendous pressure due to the faulty construction along Pipe Bridge across the river. This has affected the tidal rhythm and fishery patterns of the estuary that maintained the hydro-biological balance in the river ecosystem. From the study it could be concluded

that depth, temperature, pH and salinity invariably had significant bearing on the species diversity, distribution and fishery production in the tropical Kadaludi river estuary. The natural and anthropogenic stresses, nowadays this entire species community faces tremendous problem in Kadalundi river estuary. The Industrial wastes, sewage, pollutants discharged to river estuary at many places, changes the natural water quality and affects the diversity of ichthyofauna, thus there is an urgent need for proper investigation and documentation of fish diversity. Muddy blocks in the river and presence of plastic are contributing affecting to the fish habitat. The dumping of thick layers of mud from the sea into the waterways of the river during summer is a severe threat to the aquatic ecosystem. It affects the habitat of fish species. The special species living hidden between the stones in the river, mangroves are also losing their habitat as these are sealed with mud blocks, plastics etc. The guest species of the rainy season; *Rasbora daniconius*, *Scatophagus argus*, *Megalopa cyprinoids* are seriously affecting these changes in the habitat. The umpteen plastic bottles dump at the bottom of the mangrove habitat also spoil the fish habitat.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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