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Fish Availability and Environmental Criteria of Kadinamkulam Backwater

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ABSTRACT

The topographical alterations of shore lines due to the construction of new ports, recreational developments and pollution hazards lead to changes in environmental conditions. These changes favour less the selection of native fishes that result in a decline of biodiversity. Kadinamkulam backwater (latitude of 8° 35′ – 8° 40′ N and a longitude of 76° 45′ – 76° 52′ E) lies almost parallel to the adjoining Arabian sea in the Kerala coast of India. The present study focuses the relationship of physico-chemical features, dissolved gases, nutrients and sediment characteristics of the estuary with the availability of fin and shellfishes. Monthly collection of fish species, water samples and sediments were made for a period of one year. The results were correlated by Karl Pearson correlation analysis. The significance with each environmental parameter and availability of fishes are presented. The results suggest that this approach can facilitate biodiversity management by enabling the optimal utilization of limited management resources and raises awareness of the importance of estuarine biodiversity.

Keywords: dissolved gases, estuary, finfish, nutrients, shellfish

INTRODUCTION

India is a vast country with a rich diversity of biotic resources. India's large biodiversity is due to a varied physical environment viz. latitude, longitude, altitude, geology and climate. The topographical alterations in shore lines due to the construction of new ports, recreational developments and pollution hazards lead to the changes in environmental conditions. These changes favour less selection of the native fishes and result in the decline of biodiversity (Wohlfarth 1986). Kerala registered a maximum number of 50 threatened fishes (Tyagi and Ponniah 2001). The remote nature and difficulty of monitoring and studying the complex marine environments due to the three dimensional interchange of mass and energy shows the difficulty in quantifying the level of biodiversity. The greatest impact on species deletions will be in those systems where there are limited numbers of representatives of a particular functional group, especially if the species is a dominant one (Charrier *et al*. 1996).

The dynamics of several environmental and oceanic factors such as monsoon, upwelling, currents and productivity influence the distribution, aggregation and abundance of fish stocks (Beaumont *et al*. 2007). Over-fishing due to increased number of fishing vessels, sonar, spotter planes and other sophisticated fishing gears causes depletion of fisheries (Perez 1996).

The biodiversity of inland is alarmingly declining primarily due to unsuitable and unethical fishing practices prevalent in the rivers and streams. A variety of destructive type of fishing activities are being practiced in the inland water bodies of Kerala such as poisoning using chemicals, insecticides and seeds of plant origin, dynamiting, electric fishing, etc. (Kurup 2000). The marine ecosystem is needs resource management due to over fishing, pollution, habitat destruction and climate changes on fisheries (Beaumont *et al*. 2007). The declining trend of fishes is of considerable significance in determining the cycle of changes related to other biological aspects of fishes such as feeding and breeding. Thus, the present study focuses the environmental conditions and the level of the existing stocks of Kadinamkulam estuary.

MATERIAL AND METHODS

A monthly survey of fin fishes and shellfishes of Kadinamkulam estuary was carried out during the early morning. Samples of fishes and shellfishes were preserved in 4% formalin for identification. Identification of fishes was carried out using standard keys (Jayaram 1981; Munro 1982; Talwar and Jhingran 1991). A stratified random sampling method was followed to assess the count of each species (Krishnaswami 1993). The survey study was carried out for a period of one year (April 2000 to March 2001). The water and sediment samples were analyzed by standard methods (Trivedy and Goel 1986). More or less 50 fishes of each group were taken and three collections were made in a month. The average was considered and the results of environmental parameters were correlated. The percentage of species and correlation between the environmental parameters were represented by Karl Pearson Correlation Coefficient (Krishnaswami 1993).

RESULTS AND DISCUSSION

It is imperative to understand the biodiversity of habitats to understand resource potential and to exploit natural living resources for the welfare of mankind. The fauna of a brackish water system is generally composed of marine and freshwater organisms which are adopted to waters of different salinities besides truly resident estuarine species Most fish species collected from these environments are transient forms inhabiting the estuarine and riverside environments, while others are marine forms. In the dry season, due to seawater mixing and consequent increase in salinity, the presence of marine species mostly for feeding purposes is evident (Baran 2000). The commercially important groups which contribute to the major catches belong to the estuarine habitat and are highly seasonal, since the catches depend upon the adjacent sea and river. According to Panikkar

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(1969), the estuarine fauna along the southwest coast of India partially or completely eliminates the estuarine or marine fishes during monsoon and repopulating the species during post monsoon.

The occurrence of fin and shellfishes in Kadinamkulam estuary on a percentage basis in relation to different months and its correlation significance with various environmental parameters are presented in **Tables 1**, **2**, **3** and **4**. A total of twenty seven species of fin and three species of shellfishes were recorded from Kadinamkulam backwater. The present results also showed a partial elimination of the estuarine or marine fishes in monsoon and their re-establishment during post monsoon. Kennish (2002) suggested that decreased freshwater flow can significantly change the salinity, sediment regimes and nutrient loadings of an estuary, which directly affects the abundance, distribution of estuarine organisms and trophodynamics of the system.

In the present study *Oreochromis mossambica* was the most abundant species in all seasons. Charrier *et al*. (1996) reported that in Kadinamkulam estuary *Etroplus* spp. and *Chanda* spp. are available during all months; populations of the former were greatly reduced due to environmental factors such as reduced level of oxygen and more ammonia and hydrogen sulphide.

A declining catch trend of catfishes was observed in the present study. Gopi (2000) reported that certain catfishes are vulnerable to extinction. Chandrashekariah *et al*. (2000) reported that the fish *Glossogobius giuris* in Western Ghats is threatened and the present study also showed that they are few in this estuary. Among the mullet species, *Mugil cephalus* and *Liza parasia* contributed considerably to the fishery (Charrier *et al*. 1996). In the present study also these fishes were recorded more or less in high relative numbers.

Although there was no evidence to prove that the dec-

Table 1 Biodiversity of Fin and shellfishes of Kadinamkulam Estuary (%).

Name of fish	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Anabas testudineus	1.14	2.45	2.56	0.49	0.00	0.00	0.00	0.00	0.73	1.02	0.21	0.31
Anguilla bengalensis	0.00	0.00	0.00	0.00	0.00	0.53	0.40	0.61	0.79	0.00	0.00	0.00
Arius arius	0.00	0.00	0.76	0.82	0.00	0.00	0.00	0.00	0.00	1.61	0.21	0.07
Caranx ignobilus	2.29	3.68	7.68	8.29	3.61	2.89	3.95	0.00	0.00	1.57	0.42	0.15
Caranx sehfsciatis	1.72	0.00	3.79	3.24	1.82	2.82	3.95	0.00	0.00	0.00	0.42	0.10
Chanda nama	0.00	0.00	3.79	0.40	0.00	1.78	2.18	3.34	0.56	0.26	0.16	0.21
Chanda ranga	0.97	2.15	0.63	0.40	0.00	0.87	0.90	0.84	0.66	0.00	0.00	0.00
Channa marulius	0.00	0.00	2.56	0.16	0.10	0.00	0.00	1.01	0.32	1.53	0.52	0.36
Channa striatus	0.00	0.00	0.00	0.65	0.17	0.51	0.00	0.57	0.22	0.00	0.00	0.00
Elops machnata	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.32	0.00	0.00	0.28
Etroplus maculatus	0.00	0.00	5.05	0.82	0.64	1.56	1.97	2.47	1.21	1.33	0.52	0.13
Etroplus suratensis	28.62	30.66	12.29	11.13	1.04	2.62	3.88	5.00	3.04	38.32	5.22	2.77
Gerrus filamentosus	0.00	0.00	1.89	2.48	0.00	5.66	7.89	2.47	3.54	3.07	0.42	0.28
Glossogobius giuris	0.00	0.00	0.00	0.00	0.00	0.87	0.40	0.09	0.36	0.00	0.00	0.00
Hyphoramphus improvis	0.00	0.00	0.50	0.32	0.00	2.71	0.82	0.87	0.30	0.00	0.00	0.00
Liza parsia	0.00	0.00	0.38	0.00	0.00	7.84	7.89	2.55	2.67	0.00	0.21	0.13
Megalops cyprinoides	6.87	4.29	1.89	1.01	0.31	2.11	3.95	1.31	1.67	1.55	0.63	0.28
Metapenaeus brevicornis (shellfish)	0.00	0.00	0.00	0.00	0.00	2.56	3.67	0.49	0.00	0.00	0.00	0.00
Metapenaeus dobsoni	0.00	0.00	0.00	0.00	0.00	2.56	1.89	0.49	0.00	0.00	0.00	0.00
Mugil cephalus	11.45	14.71	2.56	8.19	1.81	3.61	7.89	5.19	4.88	0.00	1.04	0.41
Mystus gulio	5.72	3.07	0.50	1.62	0.00	0.00	0.00	0.61	0.56	1.59	0.15	0.07
Oreochromis mossambica	34.34	29.43	50.50	8.19	1.81	0.00	0.00	42.55	40.47	11.24	26.10	28.26
Penaeus indicus (shellfish)	0.00	2.76	0.00	49.06	88.19	48.15	38.84	25.73	34.40	36.79	63.69	65.77
Penaeus monodon (shellfish)	0.00	0.00	0.00	0.00	0.16	0.03	0.03	0.09	0.02	0.05	0.05	0.00
Periophthalmus weberi	0.00	0.00	0.50	0.16	0.18	0.33	0.40	0.20	0.00	0.00	0.00	0.00
Puntius filamentosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.67	0.00	0.00	0.00
Scylla serrata (shellfish)	0.57	0.67	0.26	0.08	0.18	0.20	0.19	0.15	0.10	0.05	0.03	0.26
Tachysurus subostratus	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.26	0.00	0.00	0.00
Terapon jarbua	0.57	0.00	0.63	0.82	0.00	0.51	0.82	0.00	0.00	0.00	0.00	0.15
Valamugil cunnaecius	5.72	6.13	1.28	1.66	0.00	8.71	7.87	2.85	2.25	0.00	0.00	0.00

Table 2 Karl Pearson correlation showing the significance (5%) by relating number of fishes and physico-chemical parameters.

Name of fish	Temperature	pH	Salinity	Alkalinity	Dissolved oxygen
Anguilla bengalensis	-	-	-	0.87**	-
Caranx ignobilus	-0.67*	-		-0.61*	0.65*
Caranx sehfsciatis	-0.63*	-	-0.62*	-	0.63*
Chanda nama	-	-	-	-	-
Chanda ranga	-	0.60*	-0.53*	-	-
Channa marulius	-0.51*	-	-	-	-
Channa striatus	-	-	-	-	0.65*
Etroplus maculatus	-0.74**	-	-	-	-
Gerrus filamentosus	-	-	-	-	-
Glossogobius giuris	-	-	-	-	0.51*
Hyphoramphus improvis	-	-	-0.58*	-	0.66*
Liza parsia	-	-	-0.52*	0.55*	-
Metapenaeus brevicornis	-	-	-0.59*	-	-
Metapenaeus dobsoni	-	-	-0.61*	-	-
Periophthalmus weberi	-0.63*	-	-0.63*	-	0.63*
Puntius filamentosus		-	-	0.75**	-
Scylla serrata	-	0.59*	-	-	-
Terapon jarbua	-0.58*	-	-	-	-
Valamugil cunnaecius	-	-	-0.70**		-

* Significant, ** highly significant

Table 3 Karl Pearson correlation showing the significance (5%) by relating number of fishes and nutrients of Kadinamkulam back water.

Name of fish	Hydrogen sulphide	Ammonia nitrogen	Nitrite nitrogen	Phosphate phosphorus	Silicate silicon
Caranx sehfsciatis	-0.53*	-	-	-	-
Chanda nama	-0.51*	-	-	-	-
Channa striatus	-0.58*	-	-	-0.54*	-
Eroplus maculatus	-	-	-	-	-
Glossogobius giuris	-	-0.62*	-	-	-
Hyphoramphus improvis	-	-	-	-	-
Liza parsia	-	-0.66*	-	-	-
Metapenaeus brevicornis	-	-0.68*	-	-	-
Metapenaeus dobsoni	-	-0.67*	-	-	-
Oreochromis mossambica	-	-	-	-	-0.51*
Periophthalmus weberi	-0.64*	-	-	-0.50*	-
Puntius filamentosus	-	-	-	-	-0.56*
Scylla serrata	-		-	-	0.55*
Tachysurus subostratus	-		0.57*	-	-
Valamugil cunnaecius	-0.51*	-0.71**	-	-	-

* Significant, ** highly significant

Table 4 Karl Pearson correlation showing the significance (5%) by relating number of fishes and sediment parameters of Kadinamkulam backwater.

Name of fish	Organic carbon	Copper	Lead	Manganese	Nickel	Zinc
Anguilla bengalensis	0.65*	0.75**	-	-	-	-
Arius arius	-	-0.56*	0.47	0.40	0.34	-0.44
Caranx ignobilus	-0.83**	-	-	-	-	-
Caranx sehfsciatis	-0.69*	-	-	-	-	-
Chanda ranga	-	0.50*	-0.78**	-0.79**	-	0.52*
Glossogobius giuris	-	0.52*	-	-	-0.58*	-
Hyphoramphus improvis	-	-	-	-	-0.58*	-
Liza parsia	-	0.63*	-0.21	0.04	-0.64*	-
Megalops cyprinoides	-	-	-0.77**	-0.79**	0.03	0.83**
Metapenaeus brevicornis	-	0.52*	-	-	-0.61*	-
Metapenaeus dobsoni	-	0.49	-	-	-0.64*	-
Mugil cephalus	-	-	-0.64*	-0.72**	-	0.53*
Mystus gulio	-	-0.35	-0.51*	-0.68*	0.46	0.68*
Penaeus indicus	-	-	0.69*	0.78**	-	-0.50*
Periophthalmus weberi	-	-	-	-	-0.54*	-
Puntius filamentosus	0.67*	0.54*	-0.20	-0.13	-0.03	0.11
Scylla serrata	-	-	-0.73**	-0.84**	-	0.66*
Tachysurus subostratus	-	0.52*	-0.11	0.03	-0.19	0.07
Terapon jarbua	-0.56*	-	-	-	-	-
Valamugil cunnaecius	-	0.50*	-0.60*	-0.47	-0.53*	0.52*

* Significant, ** highly significant

line of penaeid prawns and crabs was due to intense seed collection and wide spread aquaculture, the reasons for the decline of such species can very well be related to intensive coir retting process and the disposal of city sewage through canals in the environment (Azis and Nair 1987). The extent of onshore migration of fish and shellfish are dependent on their extreme tolerance level of environmental parameters (Beaumont *et al*. 2008). The significance level tested by Karl Pearson correlation coefficient (5% level) also proves the above statement.

According to Sinha (2000) the Narmada Water Dispute Tribunal and Farakka Barrage changed the natural salinity regime and thus the fishery of that area was drastically changed. Heavy erosion and high sedimentation with heavy siltation altered fisheries both in the newly created lacustrine environment and downstream areas. The immeasurable quantities of organic wastes added to these water bodies increase the Biological oxygen demand and caused depletion of dissolved oxygen levels. The high level of phosphate and nitrates present in domestic sewage and agricultural run off accelerated the process of eutrophication (Sinha 1998). The distribution of fish and shellfish showed a restricted distribution in the ecosystems studied due to the concentration of pollutants particularly H_2S, NH_3, NO_2 and organic carbon was remarkably very high.

Salt water exclusion is responsible for the remarkable difference in the yield pattern in the upstream and downstream regions of a lake. The depletion of the resources upstream is not adequately compensated by natural propagation of freshwater fishes (Kurup *et al*. 1993). Heavy siltation, drastic reduction in water volume and loss of breeding grounds are the major factors responsible for the decline in fisheries (Pathak 2000). Sinha (1998) reported the presence of various heavy metals, pesticide residues in water, sediments and biotic communities. Their concentration differed in different stretches of the river, but the effluent zone registered relatively higher values. In the present study the distribution of fish showed an inverse relationship with increased concentration of heavy metals, hydrogen sulphide and ammonia, which not only cause stress to aquatic organisms (Beaumont *et al*. 2008) and also disturb the migratory pattern of fish (Kennish 2002). It is concluded that the controlled utilization of these resources and a conservation approach based on the need will play a fundamental role in the ecosystem environmental management by taking into account the pressures and demands of society in an integrated economy.

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