ISSN: 2347-5129
IJFAS 2015; 2(3): 171-175

www.fisheriesjournal.com
Received: 19-11-2014
Accepted: 27-12-2014

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Ichthyofaunal diversity and status with reference to physicochemical characteristics in Sharavathi Estuary, Uttara Kannada District.

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Abstract
Estuaries are an important component of the coastal ecosystem. The current study conducted at three stations of the Sharavathi estuary revealed the presence of total of 32 species belonging to nine orders and 25 families. The members of order Perciformes were dominant with 14 families, of which Carangidae and Gerridae consisted of three species each, whereas Lutjanidae and Stromateidae had two species each. Among non-perciform fish, Pleuronectiformes and Clupeiformes consisted of three species each, whereas other orders had one species each. The distribution of fish species was lower in station 3 compared to other sampling sites. Analysis of physicochemical characteristics indicated that the levels of calcium, nitrate, sulphate and magnesium were higher at station 3 compared to other two sampling stations. Taken together, these results suggest that the decline in fish population might be due to the unfavorable physicochemical characteristics in part of the Sharavathi estuary.

Keywords: Ichthyofaunal diversity, Sharavathi, Estuary, Water quality, Perciformes.

1. Introduction
An estuary is a partially enclosed body of water formed where freshwater from rivers and streams flows to the ocean, mixing with the salty seawater. These are recognized as important fish habitats, serving especially as spawning and nursery sites, migration routes, and areas naturally supporting large populations of certain coastal fish species [1, 2]. The fluctuation if any, in the physicochemical characters in this environment has a profound influence on the seasonal occurrence of the juveniles and fish stocks [3]. India has rich estuarine and brackish water resources along the east and west coasts. Sharavathi River begins at Ambutirtha in Tirthahalli taluk of Shivamogga district and flows for 132 km to merge with Arabian Sea near Honnavar. About 1600 ha of estuarine portion extends from the river mouth to village of Gerusoppa of Western Ghats [4]. This river has two major dams with a hydel power station at Linganamakki and Gerusoppa in Shivamogga district. These dams are implicated in the alterations of estuarine characters, primarily by reducing its salinity [5]. In recent days, some industries are also contributing to the pollution of estuarine water affecting the fish diversity. Although previous study has reported 29 species in the Sharavathi estuary zone [6], the distribution of fish diversity at different zones of the estuary with reference to physicochemical conditions are not clear. There is a need to document the status of fish diversity from time to time as studies on these lines will be helpful for proper management of fishes in this area. The objective of the present investigation was to determine the status of fish diversity and water quality in different zones of the Sharavathi estuary.

2. Materials and Methods
2.1 Study area
The study was carried out at Sharavathi estuary zone extending between 14º 16' - 14º 17'N and 74º 25' - 74º 26'E. The estuary region (6-7 km) was divided into three stations (Fig. 1A and B), namely station 1 (river mouth, the joining point of Sharavathi estuary and Arabian Sea near a place called Tonka), station 2 (near Honnavar) and station 3 (near Kasarkod).

Fig 1(A & B): Map of India showing the location of Karnataka State (A) and three study stations at Sharavati estuary (B), 1) River mouth, 2) near Honnavar and 3) near Kasarkod.

2.2 Collection of fish

The study was carried out between July 2013 and March 2014, as a part of M.Sc dissertation work. Sampling of the fish was done with the help of expert fisherman using drag net having mesh size 2 mm × 3 m × 1 m size as well as cast net of standard size. Samples were collected at all the three stations during low tide. Photographs of the fish were taken with the help of Sony cybershot camera in the study area and were later identified using taxonomic literatures [7, 8, 9, 10].

The percentage occurrence of fish species in each station was calculated using the formula

$$\frac{\text{Number of species in each station}}{\text{Total number of species}} \times 100$$

The percentage occurrence of fish species in each order was calculated using the formula

$$\frac{\text{Number of species in each order}}{\text{Total number of species}} \times 100$$

2.3 Collection of water samples

The water samples were collected from all the three stations (3 sites per station) at around 11 am. The pH values in these water samples were recorded using a digital pH meter (Transinstruments, Singapore). The concentrations of chloride, nitrate, sulphate, bicarbonate, calcium, magnesium, and iron were estimated in the water samples using the laboratory procedures [11, 12]. The data on all water quality parameters were expressed as means ± SE.

3. Results and discussion

Estuaries are critical for the continued survival of many species of fish and other aquatic life. The present study recorded ichthyofaunal diversity with reference to physicochemical conditions in three selected sites of Sharavathi estuary. In the present study, a total of 32 species belonging to nine orders and 25 families were recorded in Sharavathi estuary (Table 1). The members of order Perciformes were dominant with 20 species (62.5%) belonging

to 14 families, of which Carangidae and Gerridae consisted of three species each, whereas Lutjanidae and Stromateidae had two species each. All other families consisted of one species each (Table 1, Fig. 2). Among non-perciform fish, Pleuronectiformes and Clupeiformes consisted three species (9.37%) each, whereas Siluriformes, Cypriniformes, Beloniformes, Myliobatiformes, Russulales, and Rajiformes had one species (3.12%) each.

Table 1: List of fishes observed in selected stations of Sharavathi estuary.

Sl. no.	Scientific name	Common name	Sl. no.	Scientific name	Common name
1.	**Perciformes** **Ambassidae** *Ambassis ambassis*	Burante	2.	**Siluriformes** **Ariidae** *Arius arius*	Sady
	Carangidae *Caranx praeustus* *Carangoids chrysophrys* *Caranx ignobilis*	Guruku Kokkara Ulua	3.	**Batrachoidiformes** **Batrachoididae** *Austrobatrachus dussumeri*	Gonke/ Gorke
	Cichlididae *Etroplus suretansis*	Kagalsi	4.	**Beloniformes** **Belonidae** *Tylosurus strongylurus*	Kaandi
	Gerridae *Gerres limbatus* *Glossogobius giuris* *Gerries filamentosus*	Silver-biddy Shady Bainge	5.	**Pleuronectiformes** **Acanthuridae** *Crossorhombus azureus* **Cynoglossidae** *Paraplagusia biliniata* **Paralichthyidae** *Pseudorhombus javanicus*	Leppi Neppi Flounder
	Leiognathidae *Secutor ruconius*	Deep pugnose			
	Lutjanidae *Lutjanus ruselli* *Lutjanus argentimaculatus*	Kemsa River snapper	6.	**Clupeiformes** **Clupeidae** *Sardinella fimbriata* *Opisthopterus tardoore* **Engraulidae** *Stoliphorus indicus*	Pedi Pachge Motyal
	Drepaneidae *Drepane punctata*	Spotted sickle fish			
	Platacidae *Platax orbicularis*	Akoli			
	Scatophagidae *Scatophagus argus*	Vulka	7.	**Cypriniformes** **Cyprinidae** *Dawkinsia filamentosa*	Blackspot barb
	Sciaenidae *Chrysochir aureus*	Doodi	8.	**Myliobatiformes** **Dasyatidae** *Dasyatis bleekeri*	Thorke
	Siganidae *Siganus vermiculatus*	Bergi	9.	**Rajiformes** **Rhinobatidae** *Glaucostegus halavi*	Guitar fish
	Sphyraenidae *Sphyraena barracuda*	Baracuda			
	Stromatidae *Pampus argenteus* *Parastromateus niger*	Maangi Kap maangi			
	Lactariidae *Lactarius lactarius*	Karchi			

Most of the non-perciform families had one species each, except for Clupeidae that consisted of two species (Table 1). Slight differences in fish species diversity were noticed in the present study compared to the previous study at Sharavathi estuary wherein 29 finfish species belonging to 24 families were observed between June 2011 and May 2012 [6]. These differences could be due to timing and site of sampling of fish species in Sharavathi estuary.

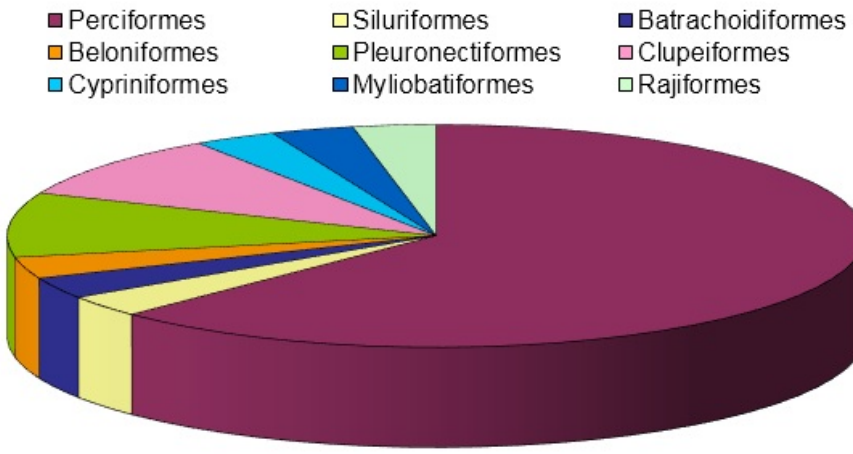

Fig 2: Percent occurrence of fishes belonging to different orders.

Richness in fish faunal diversity has been recorded in number of estuarine systems. About 52 fish species were found in Ponnani estuary [13], whereas 61 species of fishes from Kali estuary, 55 species from Gangavali estuary and 80 species from Aghanashini estuary have been documented [5]. However, in the current study, the presence of 32 species in the Sharavathi estuary reflects a general decline in the fish population. Earlier studies have suggested that the continuous release of freshwater from hydroelectric power plants cause reduction in the salinity, thereby affecting the fish life at Sharavathi estuary [5, 6]. While the decrease in the salinity can potentially harm the fish species at estuary, other physicochemical conditions also seem to play a detrimental role in waning fish population at specific sites. In the present study, the fish diversity status documented in three stations of the Sharavathi estuary reveals that the distribution of fish is not identical. Although fish were found in all the three stations in the study area, there was a general decline in the fish population at station 3 (19%) compared to that of stations 1 and 2 (47% and 34% respectively, Fig. 3). This decrease in fish species diversity at station 3 was correlated with the alterations in physicochemical characteristics (Table 2). Whereas the concentrations of bicarbonate and iron did not show much variation among the three stations, the pH was slightly acidic in stations 2 and 3. Nevertheless, alkaline pH was recorded in the station 1 indicating higher salinity at the river mouth region where the Sharavathi estuary joins the Arabian Sea. Furthermore, marine invasion to freshwater is characterized by higher concentrations of chloride [14]. In the present study, the chloride levels were higher in station 1 followed by stations 2 and 3, reflecting the salt water intrusion at the river mouth region. In addition, concentrations of calcium, nitrate, sulphate and magnesium were high in station 3 compared to those of station 1 or 2. While high levels of calcium and magnesium suggest an increase in hardness of water [15], augmented levels of sulphate and nitrate are indicative of some form of pollution in water [16, 17, 18, 19]. Most of these ions are harmful to fish health when present in excess concentration [20]. Therefore, the depletion in the percent of fish species in station 3 might to be due to the contamination in this part of the estuary.

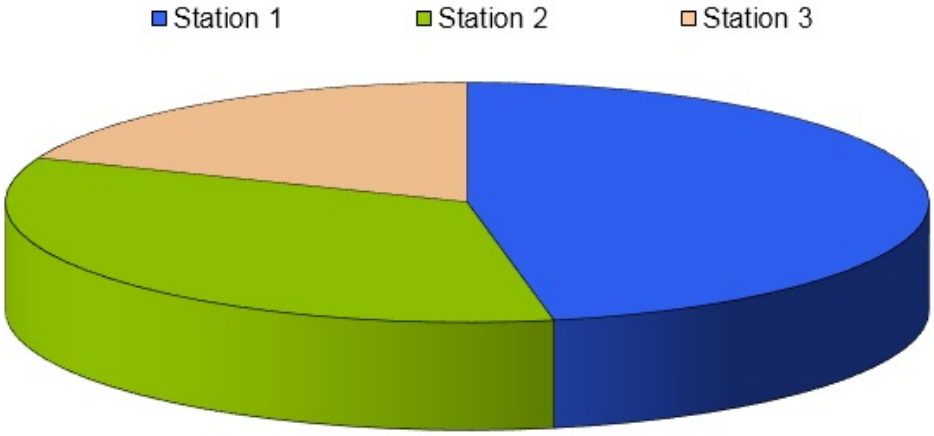

Fig 3: Percent distribution of fish species in different zones of the study area.

Table 2: Physicochemical characteristics at different stations of the study area.

Sl no.	Parameters	Station 1	Station 2	Station 3
1	pH	8.26±0.18	6.53±0.03	6.33±0.16
2	Chloride (mg/l)	1639.46±15.98	1469±5.90	784.47±7.64
3	Nitrate (mg/l)	4.60±0.27	4.33±0.06	12.51±0.29
4	Sulphate (mg/l)	4.70±0.14	12.4±0.83	37.80±0.702
5	Bicarbonate (mg/l)	23.06±0.56	28.80±0.34	26.56±0.08
6	Calcium (mg/l)	130.8±0.69	131.30±0.24	145.06±1.50
7	Magnesium (mg/l)	8.52±0.14	6.40±0.30	28.10±0.17
8	Iron (mg/l)	<0.1	<0.1	<0.1

4. Conclusion

The study shows the dominance of fish species belonging to Perciformes, probably owing to their physiological adaptations to the physicochemical conditions of the estuarine water. The observation that the percent of fish in station 3 is lower than other two sampling sites suggests that the depletion in fish diversity might be due to unfavorable physicochemical conditions in the estuarine water. Since the contamination in the estuarine environment seriously affects the fish species, the initiation of necessary measures for the conservation is needed to prevent further damage to the ichthyofaunal diversity in the Sharavathi estuary.

5. Acknowledgement

The authors are thankful to the Chairman, Department of Studies in Zoology, Karnatak University, Dharwad for providing facilities to carry out this work.

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