Indian Journal of Marine Sciences
Vol. 39(2), June 2010, pp. 238-247

Seasonal variation in fishery diversity of some wetlands of the Salcete Taluka, Goa, India

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Received 6 January 2009; revised 7 July 2009

Status of fishery potential of three coastal wetlands, Salcete Taluka viz. Betul Assolna Velim wetland, Loutolim Raia Ambora wetland and Curtorim Macazana wetland in relation to prevailing environmental parameters viz. surface water temperature, DO, salinity and pH were examined. Twenty two species of fin fishes of commercial importance were recorded during the study in the three wetlands which showed seasonal variations in abundance. Average fish catch in these wetlands ranged from 20 to 100 kg.day^{-1} comprising mainly of *Etroplus* spp (pearl spots), *Sillago sihama* (silver whiting), *Mugil cephalus* (grey mullet), *Lutianus argentimaclatus* (red snapper), *Lates calcarifer* (sea bass), *Channos channos* (milk fish) and *Gerres* spp. Average fish catch was higher in Betul Assolna Velim wetland, followed by Loutolim Raia Ambora wetland, and Curtorim Macazana wetland. During the monsoon and pre-monsoon seasons, higher species diversity of fish was recorded at Betul Assolna Velim wetland and Loutolim Raia Ambora Wetland compared to the Curtorim Macazana wetland. Betul Assolna Velim wetland fishery also showed relatively higher evenness values during all seasons. Cluster analysis showed species like *Sillago sihama*, *Mugil cephalus,* and *Etroplus* spp. were recorded in all three wetlands in large numbers throughout the year while *Johnius dussumeri* and *Megalops cyprinoides* appeared only during the post monsoon season in the Curtorim Macazana wetland. *Trichiurus savala* was absent during the post monsoon season in all the three wetlands. Salinity appears to be a major factor influencing the abundance and diversity of fin fish species in these wetlands.

[Keywords: Coastal wetlands, Environmental factors, Fish fauna, Goa, Salcete Taluka, Species diversity]

Introduction

Anthropogenic activities as well as ecological processes contribute to the fishery status of wetlands. It is also strongly affected by socio-economic factors such as land policies, property rights, population migration, urbanization, resources availability, other commercial activities, and market for the resources. Thus, studies on status of wetlands require an integrated interdisciplinary approach as any alterations or disturbances of the wetlands can have an adverse impact on the environment and fishery potential.

Recent studies by the Space Application Centre, Ahmedabad[1] with the help of remotely sensed data (1:50,000 scale), coupled with ground truth validation, reveal the presence of wetlands along the coastal stretch measuring an area of 25.75 sq.km, especially in Tiswadi Taluka of North Goa district (3.97 sq.km) and Salcete Taluka of South Goa district (6.70 sq.km)[1]. Above coastal wetlands are comprised of aquaculture ponds, waterlogged swamps, mangrove swamps and inundated low lying reclaimed lands bordering the estuaries known as khazan lands (Table 1). Over the past 150 years, these ecosystems have been experiencing tumultuous changes like unabated reclamation, silting and pollution due to mining and other industrial activities and dumping of domestic wastes, etc due to anthropogenic activities[3].

Agriculture and fisheries are the two major sources of traditional subsistence in the wetlands of Goa[2]. Inland freshwater wetlands contribute about 10% to the fishery resources, mainly during the pre-monsoon season (February – May). Presently, very little information is available on the fishery resource potential of the wetlands of Goa. Present study consists the composition and diversity of fish population in the three important wetlands of Salcete Taluka, having different environmental influence. Attempts had been made to generate baseline fishery data of these wetlands for their sustainable utilization.

Materials and Methods

Study Area

The Salcete Taluka is located in the heart of central coastal plains of South Goa District, (12º39' - 13º18' N and 77º22' - 77º52' E), with a geographical area of about 292.94 sq. km at an elevation range of 10-400 m

Table 1—Details for Coastal Wetlands along the Goa Coast

Sr. No.	Level I	Level II	Total area (in sq. km.)
1	Non-vegetated wetland	a. Mud flat/Tidal flat	49.28
		b. Sandy beach/Pit	09.51
		c. Rocky coast	02.36
		d. Rock exposures	N. A.
2	Vegetated wetlands	a. Mangroves	6.74
		b. Marsh vegetation	0.89
		c. Other vegetation	N. A.
3	Water bodies	a. Estuary	
		b. Creek	N. A.
		c. Bay	
4	Shore land	a. Coastal dunes	8.84
		(vegetated)	4.17
		b. Saline area	1.98
		c. Reclaimed mud flat	48.67
		d. Flood-prone area	
5	Other landforms	a. Salt pans	4.45
		b. Aquaculture ponds	N. A.
		c. High water line/Low water line	

above mean sea level. The river Sal passes through this relatively plain land. (Fig.1). Present study is limited to three major coastal wetlands viz. Betul Assolna Velim (BAV) wetland (15° 09' 46" N; 73° 58' 17.5" E), Loutolim Raia Ambora (LRA) wetland (15° 18' 49.8" N; 74 °59' 06.7" E) and Curtorim Macazana (CM) wetland (15° 17' 18.2" N; 74° 01' 18.12" E) (Fig.1). The BAV wetland is located at the mouth of River Sal and is being extensively fished. The LRA wetland is situated along the mid reach of the Zuari Estuary and has barge building yards in the vicinity and is also being extensively fished. The CM wetland which is located in the upper reaches of the Zuari Estuary receives more fresh water influx during the southwest monsoon, where the fishing activity is not very intensive.

Physico-chemical parameters

Water quality data were collected for two years on a monthly basis from June 2005 to April 2007. The seasons have been classified as pre – monsoon (February – May), monsoon (June – September) and post-monsoon (October – January) based on the south-west monsoon. Surface water quality parameters such as temperature, salinity, pH, and dissolved oxygen, were measured in the field using a thermometer, refractometer (INDEX digital Refractometer), pH meter (Mettler Toledo pH meter), and DO meter (YSI Model 58 Cole Parmer digital DO meter) respectively. In addition, air temperature was also measured at all locations.

Fishery Resources

The fishery resources were evaluated on a monthly basis, for two years from June 2005 to

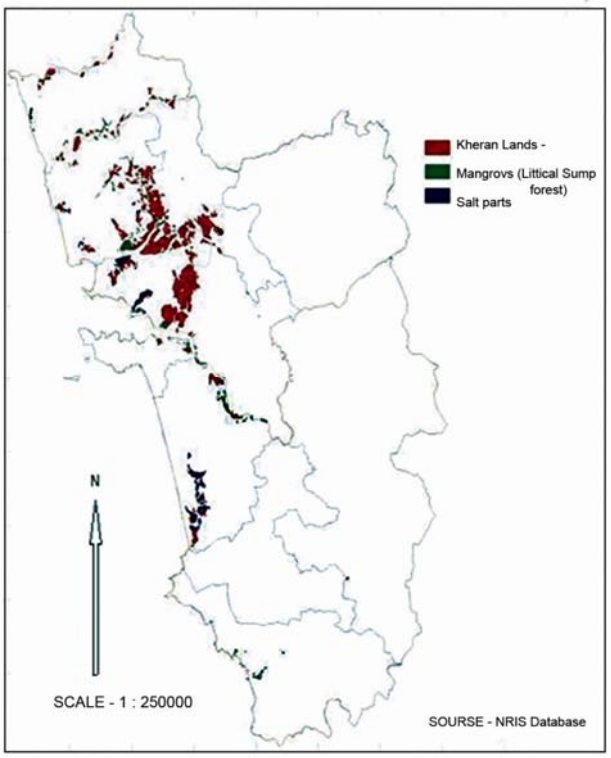

Fig. 1—Wetland map of Goa

April 2007 by random sampling of the catch during the harvesting period and fin fish species were identified[4]. Statistical analyses of the fishery data were done using PALSTAT software for Shannon H diversity index, evenness, and cluster analysis[5].

Results

Physical parameters

The air and surface water temperatures recorded in the three prioritized wetlands are shown in Figures 2 a & b. Variations in water and air temperatures observed within and between the three prioritized wetlands were marginal. Surface water and air temperatures ranged between 23 and 32 °C & 21-5 and 32°C, respectively in these wetlands. Drop in water temperature coincided with the south west monsoon season in all the three studied wetlands. DO values did not show much variation and ranged between 3.2 and 5.1 ml.l^{-1} (Fig.2c). Higher DO values in all the three wetlands were recorded during the monsoon season. pH values ranged between 6.8 and 8.2 (Fig. 2d) and the CM wetland, recorded relatively higher values. The low values in all wetlands coincided with the monsoon season. Salinity showed wide seasonal variation in all the wetlands studied and ranged between 0.1 and 34.5 ppt at the LRA Wetland. In the BAV wetland, it ranged between 0.2 and 34 ppt while at CM, it was from 0 to 32 ppt (Fig.2e). In all the three wetlands the salinity values were close to limnetic conditions during the monsoon season and the higher values were typical of the dry period (pre-monsoon season).

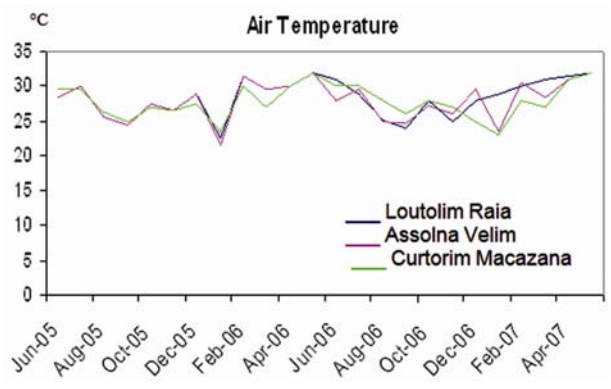

Fig. 2a—Seasonal variations of the air temperature in the three wetlands

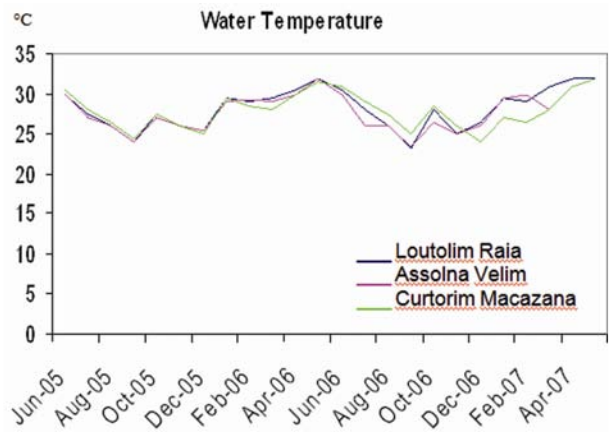

Fig. 2b—Seasonal variations of the surface water temperature in the three Wetlands

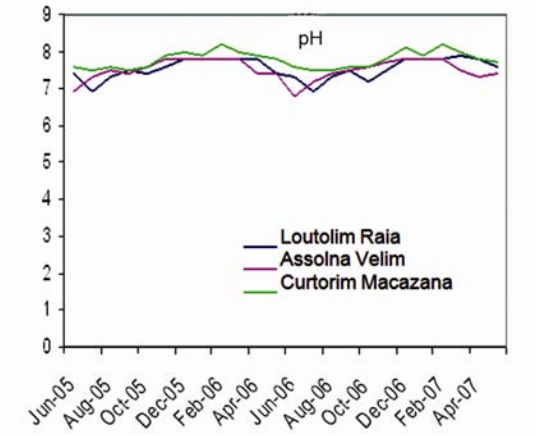

Fig. 2c—Seasonal variations of the dissolved oxygen values in the three wetlands

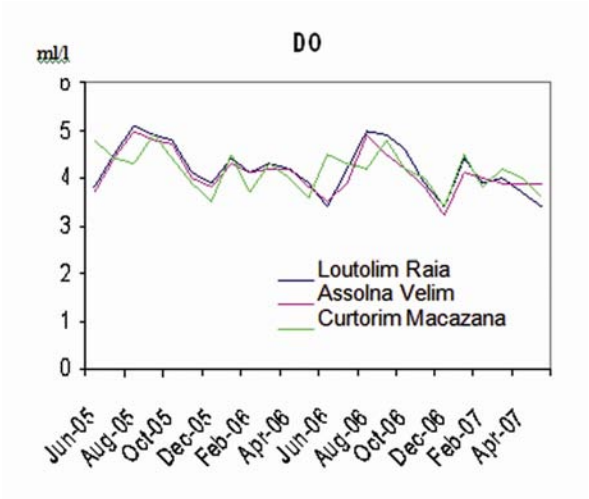

Fig. 2d—Seasonal variations of the ph values in the three wetlands

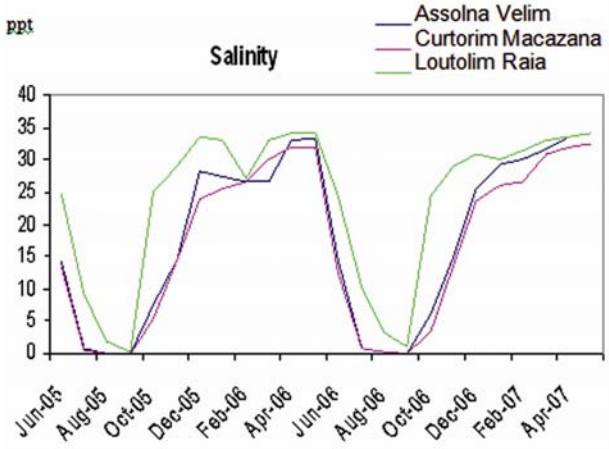

Fig. 2e—Seasonal variations of the salinity values in the three wetlands

Seasonal variation in composition of fin fishes

Details of the dominant species of fish in the three wetlands are presented in Table 2. In all, twenty two species of fish belonging to four orders and 21 families were encountered during the study from all wetlands. Species such as *Etroplus spp*., *Mugil cephalus*, *Sillago sihama* and *Gerres* spp generally dominated the catch during all seasons. Taxonomic classification is depicted in Table 3. During the monsoon season, the fish catch was dominated by species such as *M. cephalus*, *S. sihama*, and *Etroplus spp*. with an average fish catch of 70-100 kg per day. *Trichiurus savala* was the only species that was not present in all the three wetlands during the post monsoon season. Species such as *Johnius dussumeri* and *Megalops cyprinoids* were not caught in the pre-monsoon and monsoon season in the CM wetland. The fish catch was generally higher during the monsoon season and the month of June in all the three wetlands (Figs. 3 – 5).

Species diversity and evenness

Seasonal and spatial variations in the species diversity of fin fishes were recorded during this study. Shanon – H diversity index was high in all the three wetlands during the three seasons and ranged from 2.8 - 2.9 at BAV wetland, 2.6 - 2.8 at LRA Wetland and 2.6 - 2.68 at CM wetland, respectively

Table 2—Details of some coastal wetlands in Salcete

Sr. No	Name of the Wetland	Name of the Village	Area in ha	Depth in meters	Main Fish Species
1	Loutolim Raia Ambora	Loutolim	16	1	*Etroplus spp, Sillago sihama, Mugil cephalus, Lutianus argentimaclatus, Lates calcarifer, Channos channos*
2	Curtorim Macazana	Curtorim	5	0.5	*Etroplus spp, Mugil cephalus, Gerres spp.*
3	Betul Assolna Velim	Assolna	13	1	*Etroplus spp, Mugil cephalus, Sillago sihama*, *Lutianus argentimaclatus*, *Johnius dussumeri*, *Ambassis* spp

Table 3—Fish Diversity encountered in the wetlands

Sr. No	Class	Order	Family	Scientific name	Popular English name	Local Name
1	Teleostomi	Clupeiformes	Elopidae	*Megalops cyprinoides*	Tarpen	Ker
2			Engraulidae	*Anchoviella commersonii*	Indian Anchovy	Motiyali
3			Charidae	*Chanos chanos*	Milk fish	Gholasi
4		Cyprinoformes	Cyprinidae	*Danio acquipinnatus*	Giant Danio	Daddeo
5				*Puntius* spp	Barbs	Pitol
6			Claridae	*Clarius batrachus*	Spotted cat fish	Tigur
7			Bagridae	*Arius serratus*	Saw edged cat fish	Sangat
8				*Oreochromis niloticass*	Tilapia	Tilapia
9		Cyprinodontiformes	Cyprinpdontidae	*Panchax lineatus*	Stripped top minnow	Kanare
10		Perciformes	Latidae	*Lates calcarifer*	Giant Perch	Chanak
11			Ambassidae	*Ambassis* spp	Glass perches	Burato
12			Theraponidae	*Therapon jarbua*	Crescent perch	Karkaro
13			Sillaginidae	*Sillago sihama*	Silver whiting	Muddoshi
14			Lutianidae	*Lutianus argentimaclatus*	Red snapper	Tamus
15			Gerridae	*Gerres oblongus*	Oblong silver biddy	Shetuk
16			Leiognathidae	*Leiognathus* spp	Pony fish	Khapi
17			Sciaenidae	*Johnus dussumeri*	Jew fish	Dodiaro
18			Chaetodontidae	*Chaetodontops collaris*	White collar red coral fish	Mutri
19			Cichlidae	*Etroplus* spp	Pearl spots	Kalunder
20			Trichiuridae	*Trichiurus savala*	Small headed ribbon fish	Bale
21			Mugiladae	*Mugil cephalus*	Grey mullet	Shevto
22			Scatophagidae	*Scatophaus argus*	Spotted butter fish	Banshire

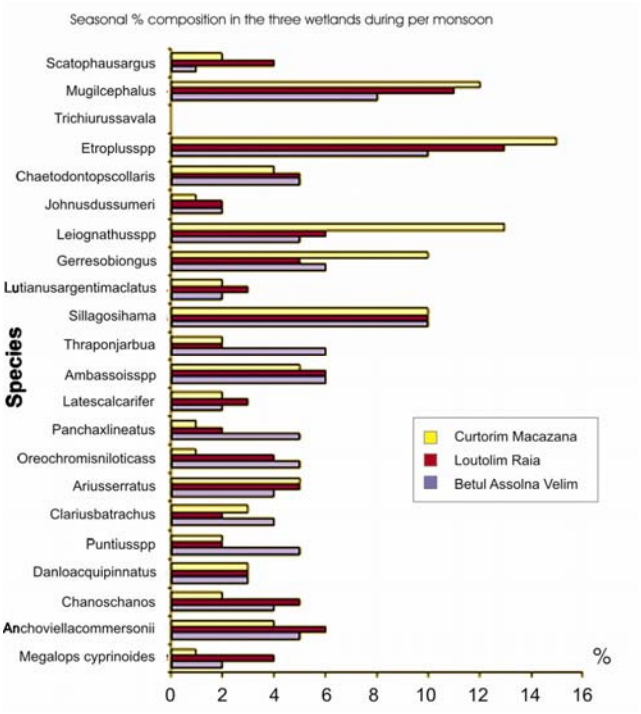

Fig. 3—Species composition (%) in the wetlands during the pre–monsoon season

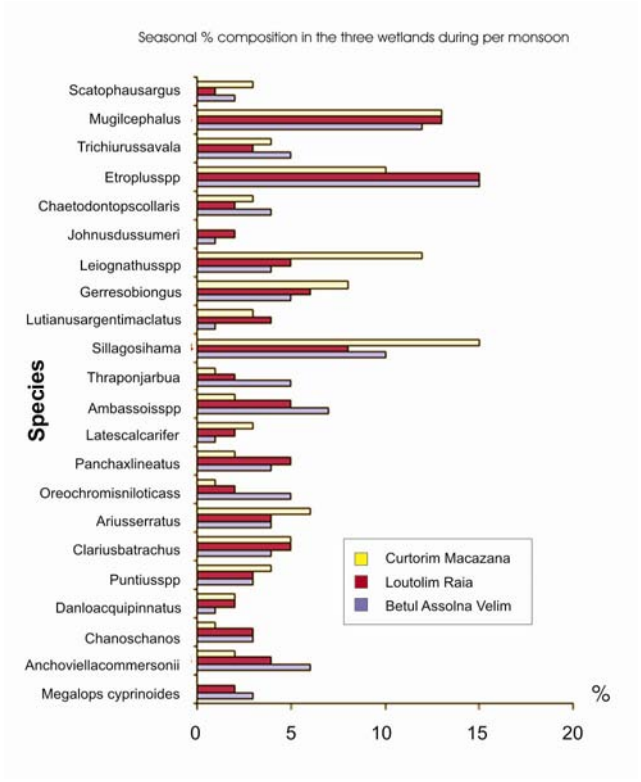

Fig. 4—Species composition (%) in the wetlands during the monsoon season

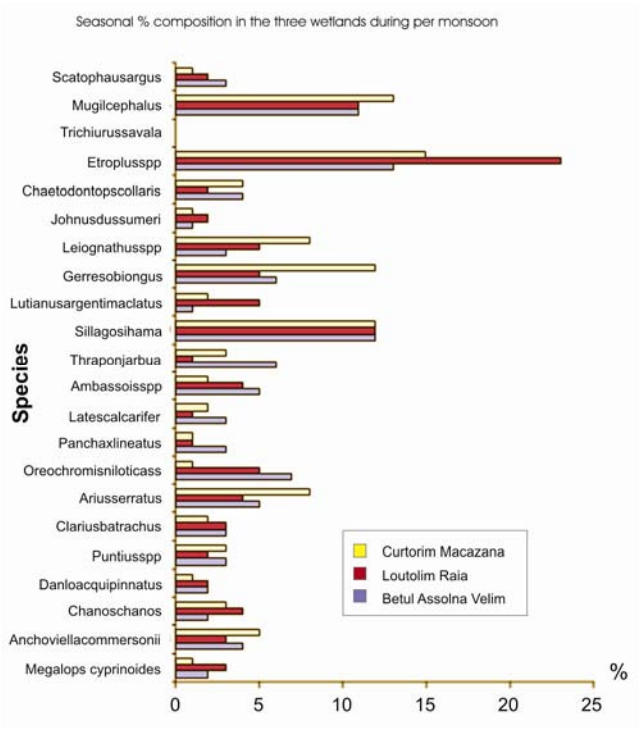

Fig. 5—Species composition (%) in the wetlands during the post–monsoon season

(Table 4). Evenness index exhibited a similar picture to that of species diversity throughout the study period. It ranged from 0.78 - 0.88 at BAV wetland, 0.68 – 0.84 at LRA Wetland and 0.67 - 0.73 at CM wetland. Higher values indicate that many species had even distribution in the population.

Cluster analysis of fin fishes

A cluster analysis was carried out on the fin fish composition observed in the three wetlands so as to understand the affinity between different species with respect to salinity. Twenty two species of fish were recorded during the monsoon season. These species depicted three well defined clusters A, and B (Fig. 6). Cluster A included species like *S. sihama*, *M. cephalus,* and *Etroplus* spp . These species were recorded in all three wetlands in large numbers and were found throughout the year. Some of the species like *Gerres oblongus* and *Leiognathus* spp also appeared in abundance during the monsoon season. These formed sub cluster B1 of the main Cluster B compared to sub cluster B2 which included species that occurred throughout.

During pre-monsoon 21 species of fish were recorded, which depicted two main clusters A and B (Fig.7). Cluster A included species like *S. sihama*, *M.*

Table 4—Species Diversity indices and evenness during the three seasons in the wetlands

	Pre Monsoon			Monsoon			Post Monsoon		
	A	B	C	A	B	C	A	B	C
Taxa	21	21	21	22	22	20	21	21	21
Shannon H	2.918	2.881	2.686	2.854	2.853	2.685	2.82	2.666	2.646
Evenness	0.8813	0.8491	0.6986	0.7887	0.7879	0.7326	0.7985	0.6846	0.6714

A: Betul Assolna Velim wetland B: Loutolim Raia Ambora wetland C: Curtorim Macazana wetland

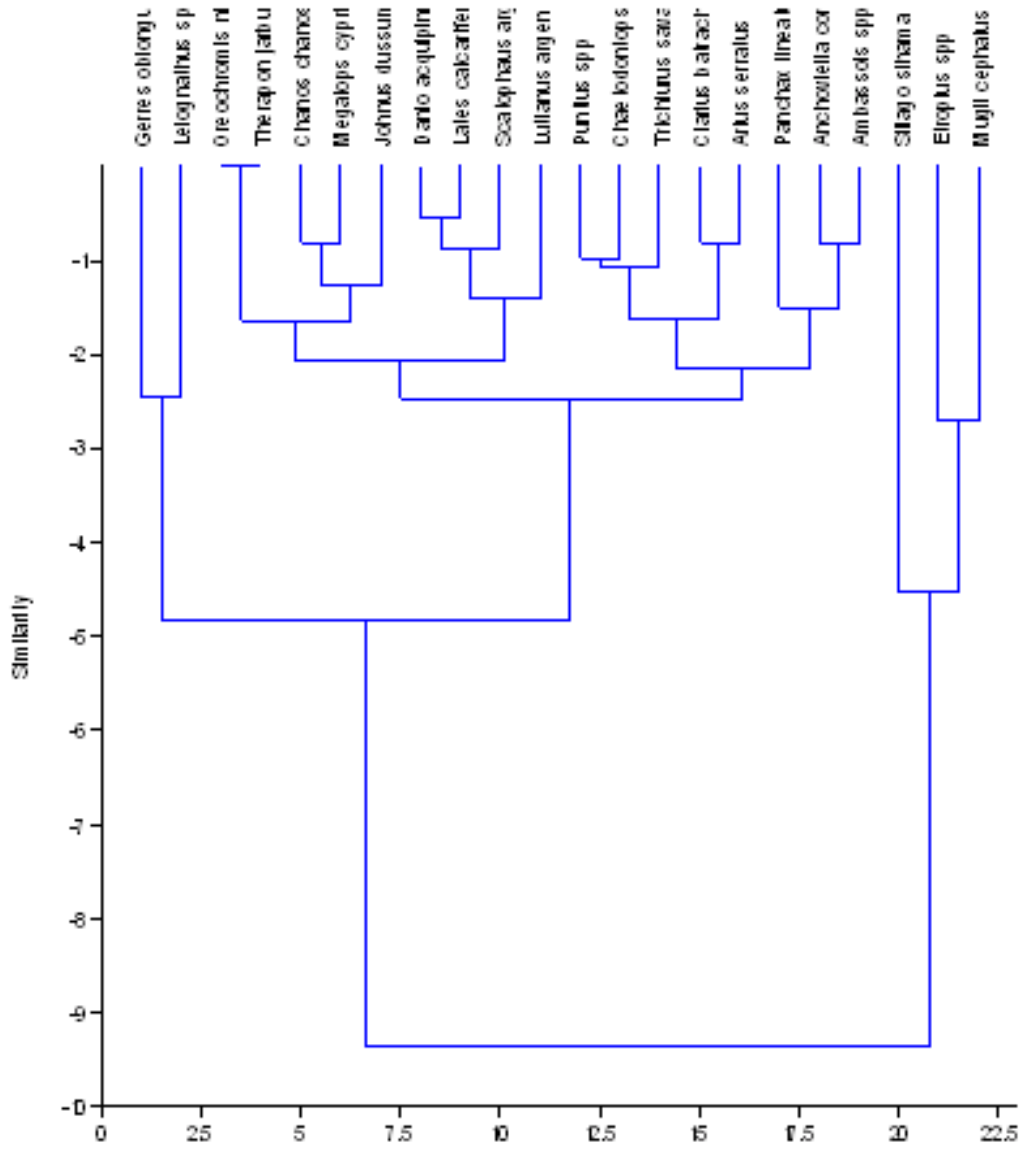

Fig. 6—Cluster analysis of the fin fish species in the wetlands during pre-monsoon season

cephalus, *Etroplus* spp, *G. oblongus,* and *Leiognathus* spp. these species that were found in abundance in all three wetlands. Cluster B had 4 sub clusters. Sub cluster B1 included *Trichiurus savala,* which was present only during the pre monsoon and monsoon season and is a species that is tolerant to less salinity, while clusters B2, B3, and B4 included the species which were relatively tolerant to wide fluctuations of salinity. During the post monsoon season 21 species of fish were recorded, forming two main clusters A

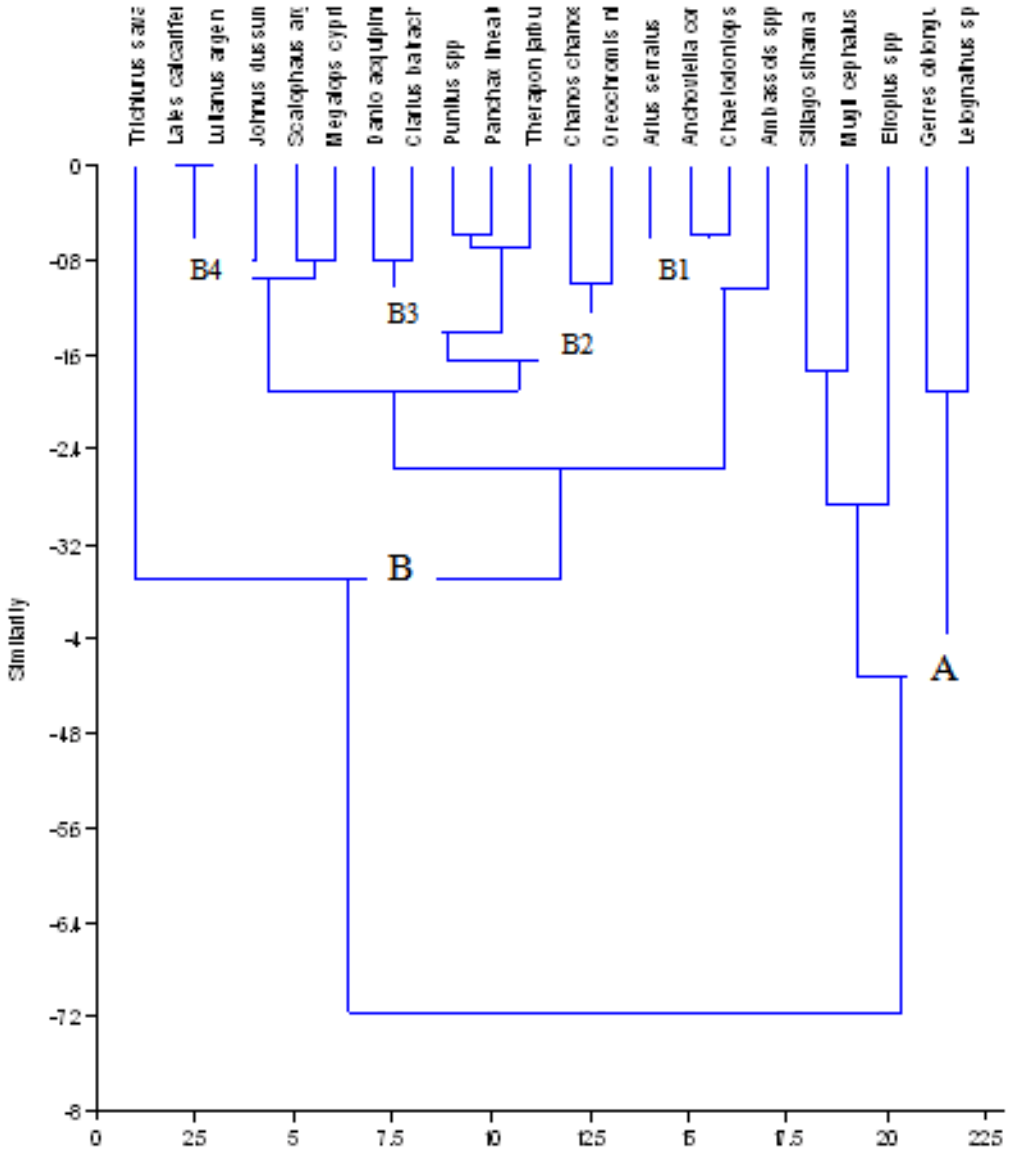

Fig. 7—Cluster analysis of the fin fish species in the wetlands during monsoon season

and B (Fig.8). Cluster A includes like *S. sihama*, *M. cephalus,* and *Etroplus* spp.,which were abundant during this season and Cluster B forming the relatively tolerant group of fish species that were tolerant to wide fluctuations in salinity.

Discussion

Wetlands in Goa are subjected to the south west monsoon that has considerable influence on the hydrographic features. Rainfall during the monsoon season contributes to the wide fluctuations in salinity and attains almost limnetic conditions in the coastal wetlands. Salinity increases with the onset of post – monsoon and stabilizes during the pre-monsoon season. Salinity fluctuations observed during the study ranged from 0 to 34.5 ppt which is in agreement with those reported earlier for the estuaries of Goa. Salinity variations in tropical estuaries are considerable and this generally controls the species composition and succession of planktonic organisms[6].

Generally, a higher abundance of finfish was associated with higher salinity waters in the coastal wetlands. Relationship between fish abundance and salinity was more closely related than that of temperature. Achuthankutty and Nair[8] have reported that among all physico-chemical variable, salinity

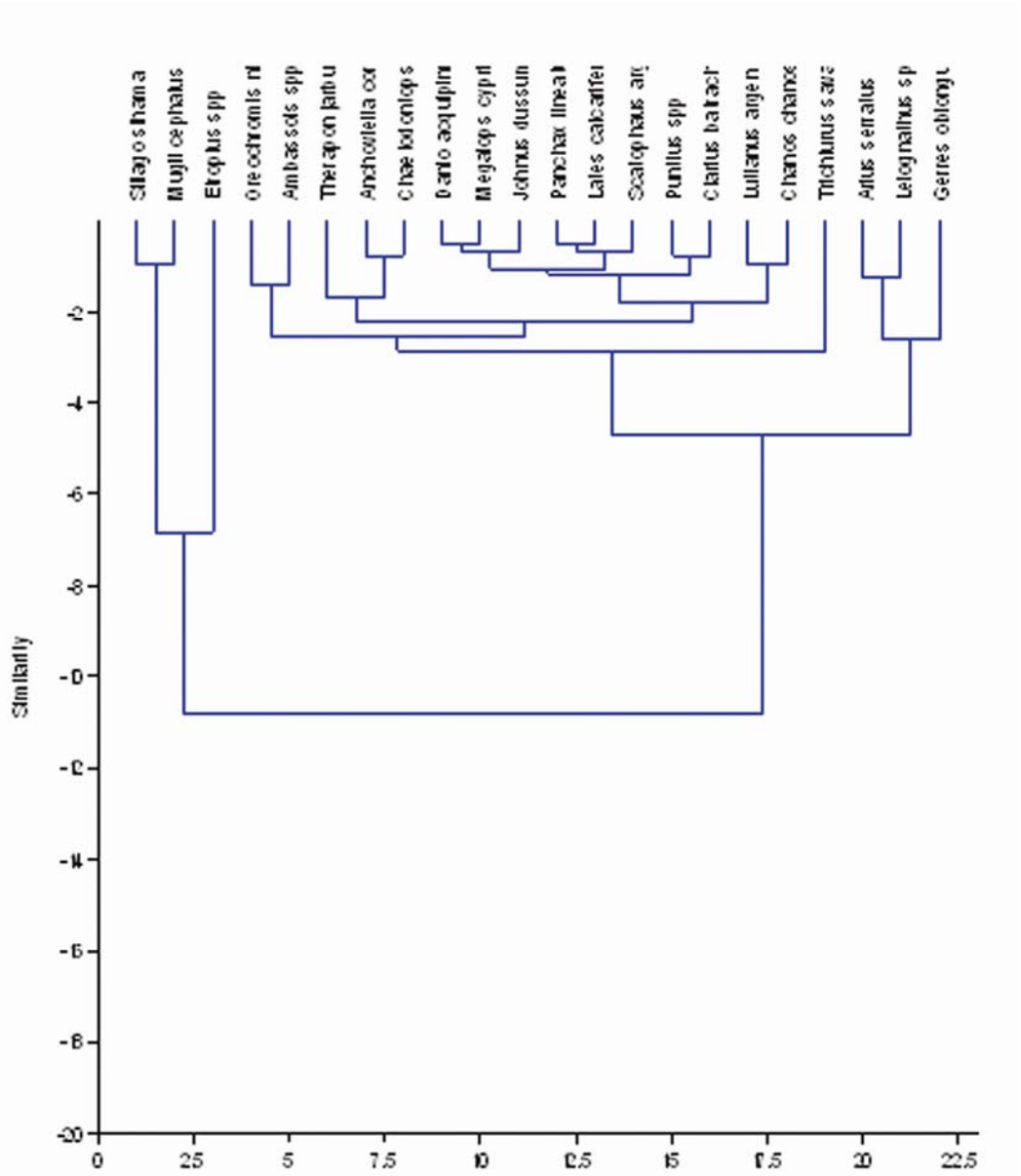

Fig. 8—Cluster analysis of the fin fish species in the wetlands during post-monsoon season

plays a vital role in controlling the distribution and abundance of prawns in the estuaries of Goa. Abundance of fin fish also followed the same trend in the coastal wetlands studied, suggesting that salinity is a critical factor for the fish resources in the wetlands. During the study, although water temperature showed minor fluctuations over the season (23 to 32ºC), the higher water temperature values in general were recorded during pre - monsoon and lower water temperature values during the monsoon season as reported for the Mandovi Estuary of Goa[7]. Oxygen distribution provides a good index of productivity and quality of the environment. Higher oxygen concentration is indicative of higher photosynthetic efficiency and phytoplankton production. In the present study DO concentration was found to vary from 3.2 to 5.1 $ml.l^{-1}$, indicating a well oxygenated water bodies. Variations in pH in the wetlands under study were marginal. However, seasonally higher values were recorded during the pre

– monsoon season. This is comparable to the observations of De Souza[7], as evaporation due to high solar radiation increases the pH of estuarine and connected water bodies.

It has been well established that estuarine environment acts as a nursery for a number of species of prawn and fin fishes. This is evident from the fact that several reports on their occurrence are available from the estuaries along the Indian coasts[6,8,9]. Salinity and temperature are considered to be important factors responsible to make the estuary as a nursery ground for fin fish as well as prawns. But, presently many authors have come to the conclusion that it is the combination of several factors such as low salinity, relatively high temperature, sufficient nutritionally rich food, and protection from the predators that provide stable environments for the growth of the young fish[8,10,11]. A similar trend is also observed in the coastal wetlands as they are found linked to the estuaries[2, 3,12-16].

Very little information is available on the fishery resources and catch data from the wetlands of India. This is mainly due to the wetland fin fishery being carried out in the traditional manner where daily catches are small compared to commercial fisheries. In Goa, fishing is practiced in all coastal wetlands throughout the year. Coastal wetland fish fetch a fairly high price compared to the inland wetland fishery. Intense fishing activity is restricted for a week both during the full and new moon phases. This is because the abundance of fish and prawns is generally high during these periods. Fishing activity will be temporarily suspended during monsoon season when there is heavy rain showers and when the nearby paddy fields are in the flowering stage.

In the present collections, very small juvenile stages of fishes were generally absent because the mesh size of the nets used was large for smaller specimens to escape. In Goa, eighty nine species of fish belonging to thirty four different families have been reported to land during the pre-monsoon season[4, 17, 18]. However, during the present study in the three wetlands of Salcete twenty two species of fin fishes were recorded. Species such as *M. cephalus*, *S. sihama*, *Etroplus* spp. and *Gerres* spp. formed the mainstay of the fishery. Although there were monthly variations in the catch composition of different species, the overall picture showed that the first three species contributed more or less equally to the catch in the wetland studied and their total contribution was > 80%.

If development and management of wetland fisheries are to be sustainable, the available scientific and technical information can be mobilized and applied more effectively to ensure sustainable rather than short-term benefits. Environmentally sound management practices of wetland fisheries can only minimize destruction of resource base on which sustainable development depends.

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