Traditional Environmental Knowledge and Biodiversity

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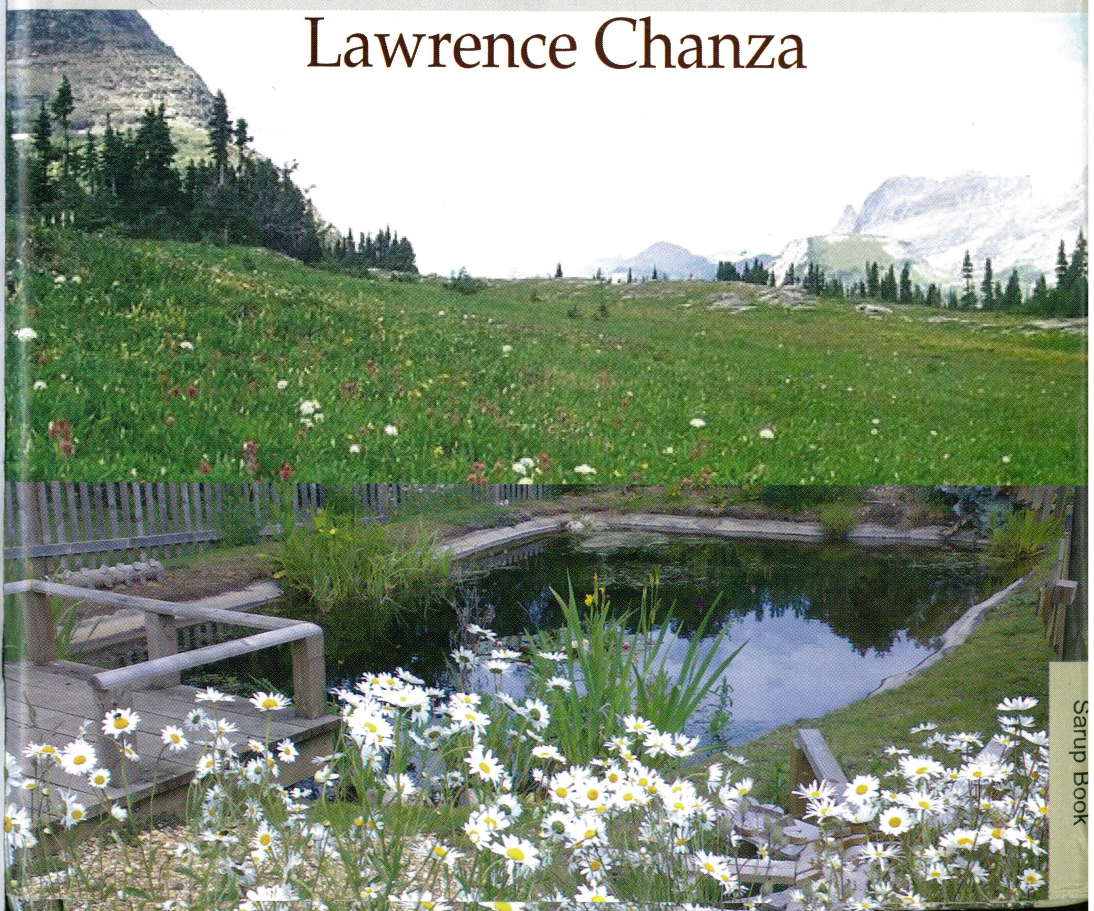

Sarup Book

SECTION–V

TRADITIONAL KNOWLEDGE AND LIVELIHOOD

SECTION–VI

DIFFERENT APPROACHES TO BIODIVERSITY CONSERVATION

15

Sustainability of Livelihood Resources in Central West Coast, Uttara Kannada District, Karnataka, India

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ABSTRACT

Bivalves (Clams and oysters) contribute to the livelihoods of many people in India. Shell and sand mining in the molluscan beds, over-exploitation of bivalves, and sustained freshwater flows from the hydroelectric projects are expected to have adverse consequences on estuarine bivalve resources. The present study was conducted in the four major estuaries of Uttara Kannada District (Kali, Gangavali, Aghanashini, and Sharavathi), to see the diversity of edible bivalves and their distribution. The study was conducted in 2011-2012 period in these estuaries. The status of edible bivalves of the estuaries was assessed through primary observations and interviews with local fisher folks. Past studies were also referred to gather such information. *Anadaragranosa, Meretrixcasta, M. meretrix, Paphiamalabarica, Polymesodaerosa, Villoritacyprinoides* and oysters were present in the Uttara Kannada estuaries. In Sharavathi estuary only *Polymesodaerosa* and oysters were found. The distribution zones of edible bivalves, and

thereby their abundance, in the Kali estuary was less than the Aghanashini and Gangavali estuaries. The reasons for such disparity between the neighboring estuaries could be attributed to major human intervention in the form of construction of hydroelectric projects upstream that caused low salinity conditions in the downstream causing depletion of most estuarine bivalves, as is glaringly evident in the Sharavathi estuary.

Keywords: Bivalves, estuary, Uttara Kannada, Impact of dams

Introduction

The Molluscs are soft bodied invertebrates with or without an external protective shell. They inhabit usually water bodies, marine, estuarine, as well as fresh water; many are also terrestrial, often associated with moist shaded lands. If the body of the Molluscan taxa is enclosed by a pair of shells hinged in the middle it can be classified under the Class Bivalvia. Bivalves, which include clams and oysters contribute to the livelihoods of many people in India. The first Mollusc appeared at the end of the Pre-Cambrian period, approximately 550 million years ago (Sturm et al., 2006). It is the second largest phylum in the invertebrates comprising more than 100,000 species worldwide of which, 5070 species are present in India (Venkataraman and Wafar, 2005). Molluscs have been exploited worldwide for food, ornamentation, pearls, lime, and medicine (Nayar and Rao, 1985). Geologic evidence from South Africa indicates that systematic human exploitation of marine resources had started about 70,000 to 60,000 years ago (Volman, 1978).

Of the 5070 species of molluscs recorded from India, very few of them, especially of the bivalves, are exploited for food and other economic purposes. Three clam genera, *Meretrix*, *Paphia* and *Villorita*, and some oysters are used as food and sustain the livelihoods scores of people in the

estuarine villages of the Karnataka (Rao and Rao, 1985; Rao et al., 1989; Boominathan et al., 2008). Even these few edible bivalves are threatened in recent times due to shell and sand mining, over-exploitation, and salinity changes brought about in the estuaries due to constant releases of fresh water from hydroelectric projects upstream in the rivers. Earlier study in Kali estuary (Boominathan et al., 2012) revealed that the edible estuarine bivalves lost about 15 km of their occupational territory, pushed more westwards towards the Arabian Sea, due to water releases from upstream dams. This necessitated similar studies in all the estuaries of Uttara Kannada, which are getting subjected to ever increasing human pressures. The present study covered the situation of the edible bivalves, their diversity and its distribution, in Kali, Gangavali, Aghanashini, and Sharavathi estuarine areas.

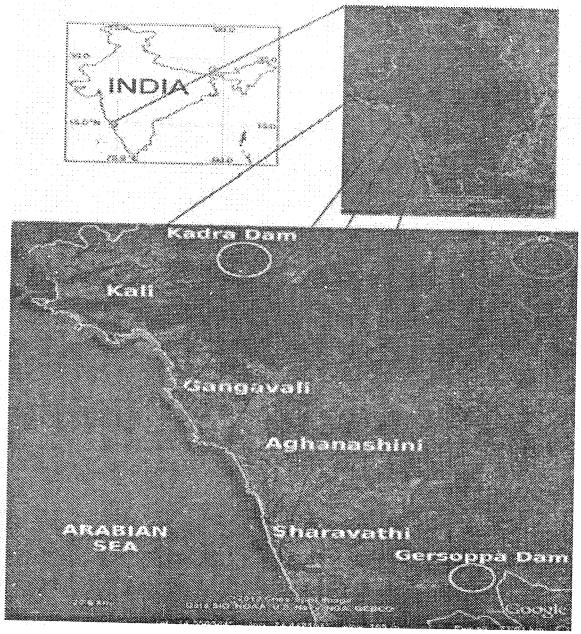

FIGURE 15.1 Estuaries of Uttara Kannada District viz. Kali, Gangavali, Aghanashini, and Sharavathi.

Uttara Kannada Estuaries

The Uttara Kannada District has four major estuaries viz. Kali, Gangavali, Aghanashini, and Sharavathi (Figure 15.1). The Kali estuary is located in the northern most part of the district, the Bedthi or Gangavali about 32 km south from Kali river-mouth, the Aghanashini or Tadri estuary, about 10 km south of Gangavali, and the Sharavathi estuary is about 24 km south of the Aghanashini estuarine mouth.

Kali Estuary: The Kalinadi originates near the village Diggi in the Joidataluk of Uttara Kannada, and has many tributaries. It is also known as Karihole and as Dagi in its upper reaches. Its total length is 184 km and meets the sea, three km north of Karwar. It has four major dams with hydroelectric power stations viz. Supa, Nagjhari power house, Kodashalli, and Kadra (Figure 15.2).

Gangavali Estuary: The Bedthi or Gangavaliriveroriginates at two places; one is near Someswara temple, south of Dharwad and another is near Hubli, both join near Kalghatgi. The total length of the river is 161 km, and it has no dam or hydroelectric power station. It joins the Arabian Sea at Gangavali near Ankola. The estuarine part starts near the village Gundbale (about 15 km interior) and the area of the estuary is 640 ha (Gazetteer 1984; Rao et al. 1989).

Aghanashini Estuary: The Aghanashini or Tadri (total length 121 km) river rises at Manjguni near Sirsi. It has two sources, the Bakurhole rising in a pond at Manjguni about 25 km west of Sirsi and the Donihalla whose source is close to Sirsi. These streams meet near Mutthalli about 16 km south of Sirsi. At Uppinapattana the river meets the tide and it winds south-west and then north-west together about 13 km to Mirjan. From Mirjan it runs parallel to the coast for about 13 km and meets the Arabian Sea at Aghanashini or Tadri. This river has no dam or hydroelectric power station in it (Gazetteer, 1984).

Sharavathi Estuary: Sharavathi originates at Ambutirtha in Tirthahallitaluk of Shimoga district and flows for 128 km to join the Arabian Sea near Honnavar. Traditionally the estuarine portion extended from the river mouth to the village of Gersoppa, about 27 km interior, towards the base of the Western Ghats. The total area of the estuarine portion was stated to be 1600 ha (Gazetteer, 1984; Rao et al., 1989). This river has two major dams with hydroelectric power stations, first one built at Linganamakki in Shimoga district and the second dam at Gersoppa (www.karnatakapower.com). These dams have caused substantial changes in the estuarine characteristics, primarily by reducing its salinity (Figure 15.3).

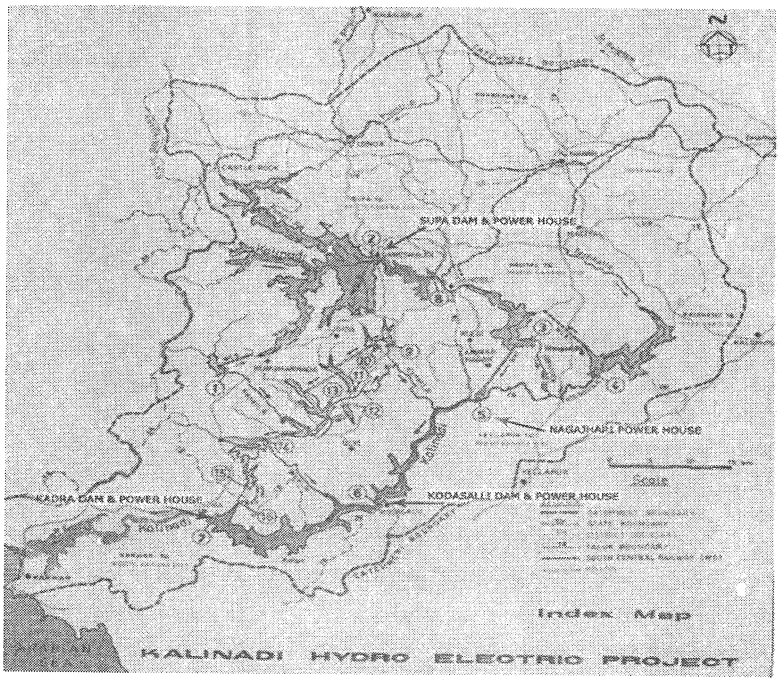

FIGURE 15.2: Kali River with Dams.

Source: www.karnatakapower.com [accessed on 10 February 2012]

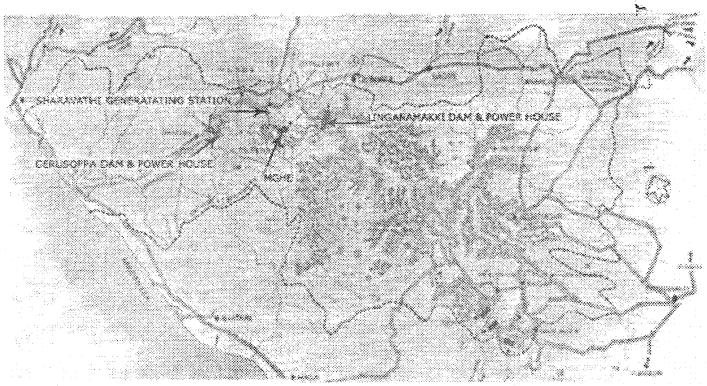

FIGURE 15.3: Sharavathi River with dams

Source: www.karnatakapower.com [accessed on 10 February 2012]

Livelihood Resources - Edible Bivalves of Uttara Kannada Estuaries

There are six edible clams, viz. *Anadaragranosa, Meretrixcasta, Meretrixmeretrix, Paphiamalabarica, Polymesodaerosa, Villoritacyprinoides* and some oysters present in all the estuaries of Uttara Kannada district (table 15.1), except in Sharavathi estuary where only one clam *Polymesodaerosa* occurs today and the oysters can be seen on rocks close to the river mouth with higher salinity. Among these edible bivalves the genus *Meretrix*, *Paphia*, and *Villorita,* and oysters contributes to the livelihoods of many peoples (Rao and Rao, 1985; Rao et al., 1989; Boominathan et al., 2008).

Table 15.1 Edible Bivales of Uttara Kannada estuaries. P = Present, A = Absent.

Species	Kali	Aghanashini	Sharavathi	Gangavali
Anadaragranosa	P	P	A	P
Meretrixcasta	P	P	A	P
Meretrixmeretrix	P	P	A	P
Paphiamalabarica	P	P	A	P
Polymesodaerosa	P	P	P	P
Villoritacyprinoides	P	P	A	P
Oysters	P	P	P	P

Anadaragranosa is present in all the estuaries except, Sharavathi. The distribution of *A. granosa*is restricted to one kilometer range from river-mouthin Kali, Gangavali, and Aghanashini (Table 15.2.1). It prefers soft intertidal muds bordering mangrove swamp forest (Pathansali, 1966) and salinity range of 13.69 – 34.40 ppt (Narasimham, 1988). Hence, *A. granosa*occurs only at the river-mouth where the salinity is usually high. This species was previously reported from Kali (Boominathan et al., 2012), Aghanashini (Boominathan et al., 2008, 2012), and Venkatapur (Rao and Rao, 1985) estuaries of Uttara Kannada District. *Meretrixcasta* is distributed in Aghanashini and Gangavali (without any dams) estuaries from the river-mouth to six km interior. Compared to this, *M. casta* is distributed in Kali (with dam) only for three km range from the river-mouth (table 15.2.2) and its distribution area is now reduced due to the influx of fresh water releases from the hydroelectric projects at upstream. *M. casta* is a euryhaline species (adapted to a wide range of salinity) (Rao et al., 1989) with a greater degree of physiological adaptation in the salinity range of 25.00 to 56.00 ppt (Durve, 1963). *M. casta* is distributed only up to three kilometer distance from river-mouthas the salinity of Kali estuary is very low. Whereas in Sharavathi estuary *M. casta* is absent, probably because of extremely low salinity due to dam water releases. *M. casta* was reported earlier by various authors from Kali, Gangavali, Aghanashini, Sharavathi, and Venkatapur estuaries (Alagarswami and Narasimham, 1973; Harkantra, 1975a, 1975b; Rao and Rao, 1985; Rao et al., 1989; Bhat, 2003; Boominathan et al., 2008, 2012). Whereas the distribution of *Meretrixmeretrix* in the undammed Aghanashini and Gangavali estuaries range from river-mouth to three kms inside, in Kali (with dams) *M. meretrix* has only a one km range from river-mouth (table 15.2.3). *M. meretrix* prefers high salinity (Rao et al., 1989) and hence its presence closer to the river mouth can be justified. In the Sharavathi estuary *M. meretrix* was present earlier (Alagarswami and Narasimham, 1973; Rao and Rao, 1985), but seems to have vanished today,

due to the decline in salinity caused by release of fresh water from hydroelectric projects. *M. meretrix* is present to this day in all the other estuaries (Alagarswami and Narasimham, 1973; Rao and Rao, 1985; Rao et al., 1989; Bhat, 2003; Boominathan et al., 2008, 2012). *Paphiamalabarica* occurs closer to the river mouths (Rao et al., 1989) with salinities of 20 to 30 ppt (Mohan and Velayudhan, 1998). It occurs to this day in the high salinity regions of Kali, Gangavali, and Aghanashini estuaries (table 15.2.4). However, in Sharavathi estuary *P. malabarica* was not reported earlier nor it occurs currently. The species occurs in all the other estuaries viz. Kali Gangavali, Aghanashini, and Venkatapur (Alagarswami and Narasimham, 1973; Harkantra, 1975a; Rao and Rao, 1985; Rao et al., 1989; Bhat, 2003; Boominathan et al., 2008, 2012).

Table 15.2: Current distribution of bivalves in the Kali, Gangavali, Aghanashini, and Sharavathi estuaries. P = Present.

Table 15.2.1: Current distribution of *Anadaragranosa*.

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P																						
Gangavali	P																						
Aghanashini	P																						
Sharavathi (dammed)																							

Table 15.2.2: Current distribution of *Meretrixcasta*.

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P	P	P																				
Gangavali	P	P	P	P	P	P																	
Aghanashini	P	P	P	P	P	P																	
Sharavathi (dammed)																							

Table 15.2.3: Current distribution of *Meretrixmeretrix.*

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P																						
Gangavali	P	P	P																				
Aghanashini	P	P	P																				
Sharavathi (dammed)																							

Table 15.2.4: Current distribution of *Paphiamalabarica.*

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P																						
Gangavali	P	P	P																				
Aghanashini	P	P	P																				
Sharavathi (dammed)																							

Polymesodaerosa prefers salinity of 7 to 22 ppt (Modassir, 2000) and is present in all four estuaries (table 15.2.5). Even though, it is present in Kali, Gangavali, Aghanashini, and Sharavathi estuaries, the population is high in Sharavathi estuary than the other estuaries and also it is the only species of edible clam present to this day. *P. erosa* was earlier reported by Ingole et al., (2002) from Sharavathi estuary where it is still present. Boominathan et al., (2012), for the first time, reported its occurrence in Kali and Aghanashini estuaries. *Villoritacyprinoides*associated with medium salinity conditions is known to withstand freshwater conditions (Nair et al., 1984; Rao et al., 1989; Boominathan et al., 2012). It was reported from Kali (Rao et al., 1989; Boominathan et al., 2012), Aghanashini (Rao et al., 1989; Bhat, 2003; Boominathan et al., 2008, 2012), and Venkatapur (Alagarswami and Narasimham, 1973)

estuaries. Extremely low salinity of Sharavathi estuary might have caused its present elimination from here where according to elderly fisher-folks the species was present earlier. In Kali estuary, which has more salt water ingress, despite the dams, it is found in 6-12 km range. It occurs in 5-16 km zone in Gangavali, and 9-23 km zone in Aghanashini respectively (table 15.2.6).

Table 15.2.5: Current distribution of *Polymesodaerosa.*

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P	P	P	P	P	P																	
Gangavali	P	P	P	P	P																		
Aghanashini		P	P	P	P	P																	
Sharavathi (dammed)		P	P	P	P																		

Table 15.2.6: Current distribution of *Villoritacyprinoides.*

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)						P	P	P	P	P	P	P											
Gangavali					P	P	P	P	P	P	P	P	P	P	P	P							
Aghanashini									P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Sharavathi (dammed)																							

Oysters are present in all the estuaries (table 15.2.7), usually it occurs in moderate to high salinity regions in the estuary. They were also previously reported from Kali (Rao, 1974; Boominathan et al., 2012), Gangavali (Rao, 1974), Aghanashini (Rao, 1974; Boominathan et al., 2008, 2012), Sharavathi (Rao, 1974; Rao and Rao, 1985), and Venkatapur (Rao and Rao, 1985) estuaries.

Table 15.2.7: Current distribution of oysters.

Distance from river-mouth (km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Kali (dammed)	P	P	P																				
Gangavali	P	P	P	P	P	P																	
Aghanashini	P	P	P	P	P	P																	
Sharavathi (dammed)		P	P	P	P																		

Significant outcome of the current study are:

1. Six species of edible clam bivalves viz. *Anadaragranosa, Meretrixcasta, M. meretrix, Paphiamalabarica, Polymesodaerosa, Villoritacyprinoides*, and oysters are present in the Uttara Kannada estuaries.
2. According to historical data, five species of edible clam bivalves viz. *Meretrixmeretrix, M. casta, Anadaragranosa, Polymesodaerosa, Villoritacyprinoides* and oysters were present in the Sharavathi estuary. Out of them only *P. erosa* and oysters remain in the estuary; the rest are not traceable today.
3. In Kali estuary, the edible bivalves were distributed for about 27 km from river-mouth in 1978 whereas now it is distributed only for about 12 km from river-mouth, and the population of *Paphiamalabarica*has declined drastically.
4. The major reason for the low bivalve diversity in Sharavathi estuary and reduced distribution zones in Kali estuary could be attributed to the construction of hydroelectric projects causing continuous release of fresh water into the estuary, after power generation, even during the

summer months, resulting in very low salinity that is unable to sustain most bivalves.

5. The collection of edible bivalves is a major activity of fisher-folks and even others which contributes to the livelihood of many estuarine villages, but faded away in Sharavathi due to the disappearance of bivalves.
6. The hydroelectric projects have adverse impact on estuarine biodiversity, not only on bivalves but most of high salinity tolerant mangroves of Sharavathi also are not to be found, except in fringes very close to the river mouth.

Conclusion

Estuaries although are ranked among the highest productive ecosystems of the earth, and are of immense economic importance to the humans, they have not merited enough attention yet to safeguard their integrity from various kinds of anthropogenic interventions. The fact notwithstanding that estuarine productivity is sustained naturally without any inputs from humans, unlike in agricultural ecosystems or fish farming systems, the ecological conditions of the estuaries, particularly of the Indian west coast are under alterations by humans. Many of the Maharashtra estuaries are already heavily polluted due to industrial effluents and urban sewage (Quadros and Athalye, 2002; Quadros et al., 2002; Rathod et al., 2002). Sedimentation from mining waste is of high order in the north Goan estuaries, in addition to pollution from densely populated towns and villages. Estuaries of Dakshina Kannada and Cochin backwaters are also under high anthropogenic pressures challenging their biodiversity and productivity. We have seen here that in the Uttara Kannada district, which has some of the best preserved forest wealth and water bodies with minimal pollution levels, how alteration of an even single factor like salinity due to continuous water release from hydroelectric

projects, can upset their ecology as evident from the decline in abundance and changes in distributional ranges within these estuaries of the edible bivalves. Not only that where especially dams are constructed upstream for power generation, as in Kali and Sharavathi, even fisheries and mangroves are affected. The impact is of the highest order in Sharavathi where only a single species of moderate salinity tolerant clam *Polymesodaerosa* and some oysters are all that are left of the edible bivalves unlike in other estuaries where six species of clams and some oysters are still present. In Sharavathi most of the high and medium salinity tolerant mangroves have given way to low salinity preferring tree *Sonneratiacaseolaris*. Fresh water fishes from the upstream areas and low salinity tolerant fishes have occupied the zones where earlier marine fishes used to visit. The very case of the near local extinctions of most of the edible bivalve species from Sharavathi estuary and decrease in distribution range of edible bivalves in Kali estuary, as a consequence of dilution of salinity, is a classical instance highlighting the need for exercising greater caution before executing large-scale development projects like dams for power generation, upsetting ecology of tropical estuaries, rated among the highest productive ecosystems of the world. Recommendations to ensure the sustainability of the resources are:

1. Regulating the shell and sand mining in the estuarine region will have positive impact on the diversity and distribution of edible bivalves.
2. The lessons from serious human impacts caused to Sharavathi estuary ecosystem, in the form of massive disappearance of edible molluscs, decline of high salinity tolerant mangrove species and dislocations in associated biodiversity etc., the implications of which are yet uncounted, should teach us to be more cautious in future in dealing with developmental projects especially

affecting riverine systems. The role of estuary as breeding places and nurseries for several marine fishes of economic value has been totally ignored while executing such large river valley projects.

3. Maintenance of physico-chemical properties of estuaries need to be considered while executing any major river valley projects so that they can continue to be centres of diversity and productivity meeting the food and livelihood needs of thousands of families while also performing the vital ecological functions traditionally associated with estuaries.

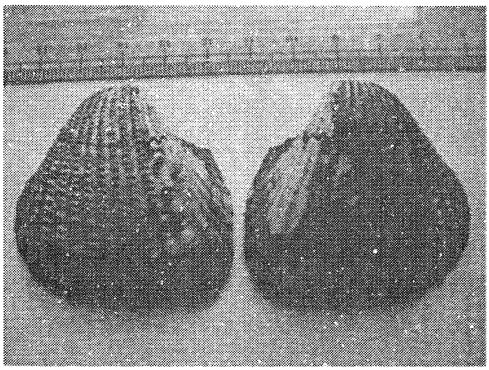

FIGURE 2: Anadara granosa

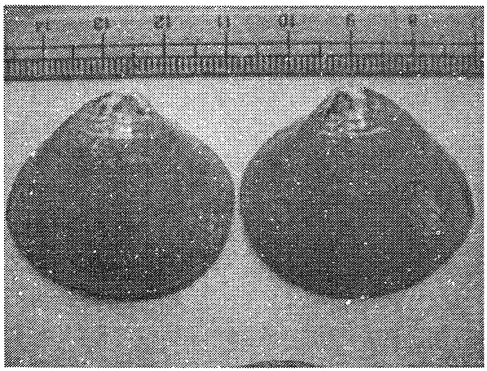

FIGURE 3: Meretrix casta

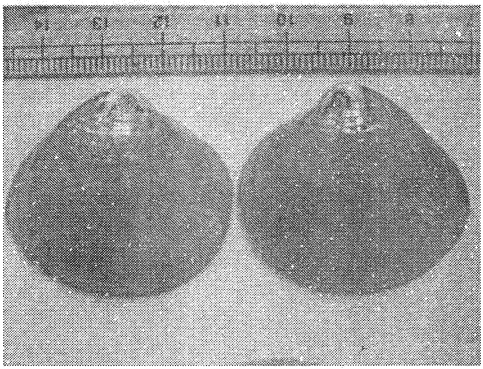

FIGURE 4: Meretrix meretrix

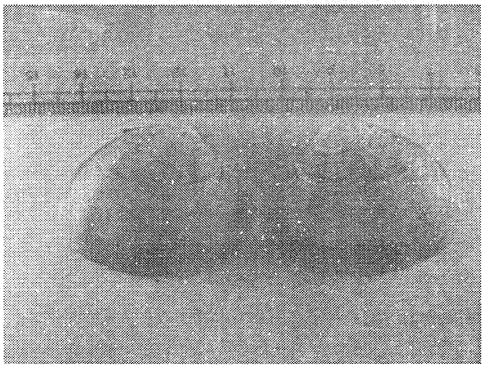

Figure 5: Paphia malabarica

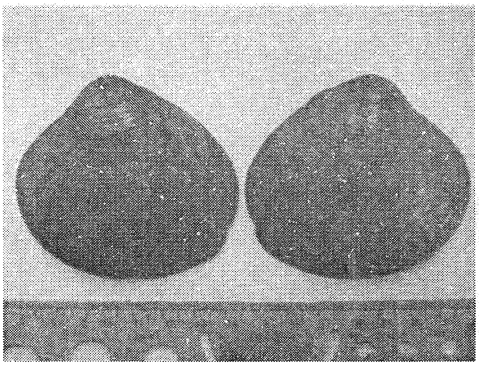

FIGURE 6: Polymesoda erosa

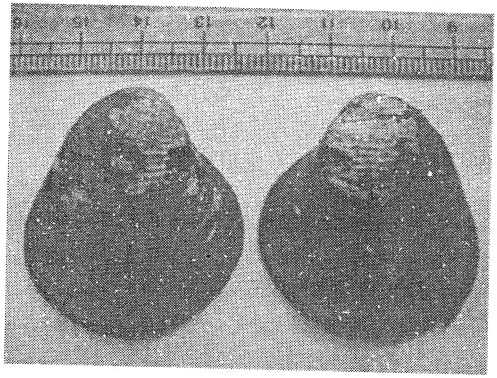

FIGURE 7: Villorita cyprinoides

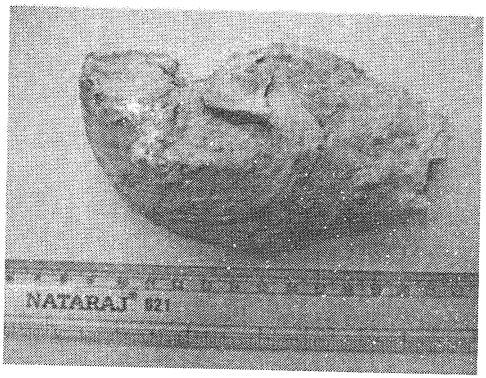

FIGURE 8: Crassostrea madrasensis

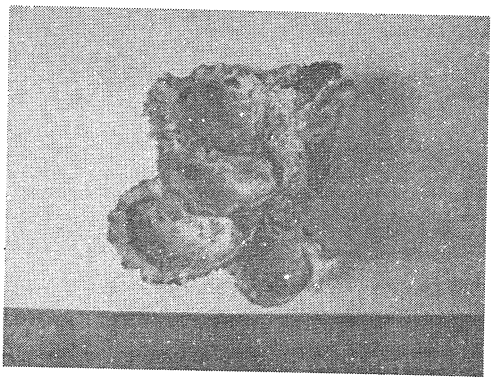

FIGURE 9: Saccostrea cucullata

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