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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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Harvested milkfish and mullet from coastal pond at Tuticorin. Ref: Article No. 2.

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Fishes, prawns and crabs harvested from a poly-culture farm at Tuticorin. Ref: Article No. 2.

AN INSTANCE OF MASS FISH MORTALITY AT MANDAPAM, SOUTH EAST COAST OF INDIA

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Location of mortality

A large number of dead and dying fishes and shellfishes was found washed ashore along the beaches of Mandapam on the Palk Bay side in the early hours of 13th May, 1987. This mortality of fishes was restricted to the inshore sea of Palk Bay from Mandapam fish landing centre to about 6 km stretch of the coast towards west and between the seashore and the coral reef on the seaward side (Fig. 1). The open sea beyond the coral reef and the coastal waters east of Mandapam fish landing centre and west of the eastern border of Pillaimadam lagoon were not affected by this phenomenon. However, the dead fishes washed ashore and other organisms were found as far as about 12 km stretch of the coast from the Mandapam fish landing centre towards west upto Theedai fishing village (Fig. 1).

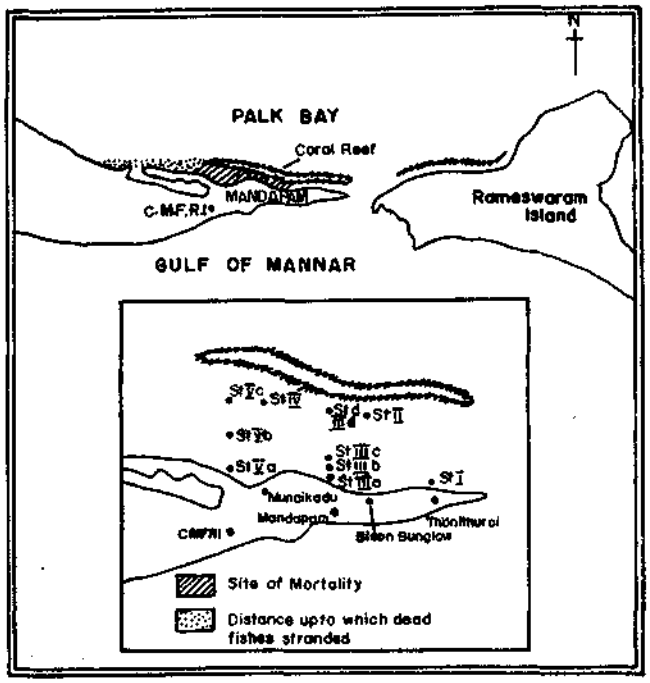

Fig. 1. Map showing the site of fish mortality and the stations from where data on hydrological parameters were collected.

The species involved and the impact of mortality

Although an accurate estimate of the quantity of dead fishes and shellfishes was not available due to the removal of dying or dead fishes by the local people immediately after the occurrence of the incidence, it was estimated that about 2–3 tonnes of fishes might have been killed by the phenomenon. About 20 species of important fishes (Figs. 2 & 3) including some of the commercial species, two species of crabs, molluscs such as *Sepia* spp., *Loligo* spp., *Aplysia* spp. and *Donax* sp., and alphied shrimps were found affected (Table 1). Among the dead fishes, *Epinephelus* spp., *Lethrinus* spp., *Siganus* spp., *Platycephalus* spp., *Psammoperca waigensis*, *Therapon* sp., *Apogon* sp., *Plotosus* sp., *Muraena* spp. and *Gobius* spp. were abundant and among crustaceans the blue swimming crab *Portunus pelagicus* was the principal species. Besides these fishes and shellfishes, an appreciable number of juveniles of *Siganus* spp., *Gerres* spp. and *Epinephelus* spp. was also found washed

Fig. 2. A view of the dead fishes washed ashore at Mandapam on 13–5–1987.

*CMFRI, Cochin.

ashore. The size range of the different species is given in Table 1.

Table 1. *List of dead fishes and shellfishes collected from the area of fish mortality at Mandapam during* 13–15 *May,* 1987

	Species	Size range (mm)
	FISHES	
* 1.	*Epinephelus* spp.	80–520
* 2.	*Psammoperca waigensis*	200–270
* 3.	*Platycephalus indicus*	300–400
* 4.	*Lethrinus* spp.	210–300
* 5.	*Hilsa kelee*	160–200
6.	*Holocentrus* spp.	120–160
7.	*Chaetodon* spp.	75–150
* 8.	*Plotosus* spp.	65–175
* 9.	*Siganus* spp. (adult)	200–300
10.	*Siganus* spp. (juveniles)	30– 45
11.	*Tetrodon* spp.	150–350
12.	*Muraena* spp.	600–700
13.	*Gobius* spp.	70–135
14.	*Sparus* spp.	20– 35
15.	*Apogon* spp.	45– 80
16.	*Diodon* spp.	300–350
17.	*Abudefduf* spp.	110–115
18.	*Chromis* spp.	90– 95
*19.	*Liza waigensis*	300–350
20.	*Pseudopristipoma niger*	100–150
*21.	*Arius dussumieri*	400–600
*22.	*Amphotistus kuhlii*	200–350
	CRUSTACEANS	
*23.	*Portunus pelagicus* (Measurement across carapace)	40–140
*24.	*Scylla serrata*	41–160
25.	*Alphaeus* spp.	80– 90
**26.	*Penaeus* spp.	—
	MOLLUSCS	
*27.	*Sepia* spp.	60–80
*28.	*Loligo* spp.	—
29.	*Aplysia* spp.	—
30.	*Donax* spp.	—

* Commercially important forms
** Very rare

The species composition of the dead fishes indicated that most of the species affected by the phenomenon were those inhabiting near the bottom or the reef-dwelling fishes. It was noteworthy that neither prawns nor the pelagic fishes were found among the affected population. Some of the fishes such as juveniles of *Epinephelus* and gobids and crabs were seen congregating near the shore in a semi-conscious state gasping for air, even after two days of the incidence. An examination of the gills of these fishes revealed that they were either light red or reddish. The gills of the dead fishes were covered with sand. No abnormal conditions such as excessive slimy

Fig. 3. Some of the principal species of fishes and shellfishes affected by the mortality reported on 13–5–'87 at Mandapam.

nature or blackish discolouration or parasitic infestation were observed. The stomach content analysis of the dead fishes such as *Epinephelus* sp., *Siganus* sp., *Lethrinus* sp., *Platycephalus* sp., *Holocentrus* sp. and *Chaetodon* sp. showed that the gut was devoid of any food in all the cases except in one specimen of *Epinephelus* sp , which contained an undigested *Therapon* sp.

The environmental features of the affected area

The inshore sea of Mandapam during the reported period of mortality was calm. There was also no strong wind normally prevalent in the area but the water in the affected area appeared turbid and murky. The bottom soil at patches was found to be black.

Data on hydrographic features such as temperature, pH, salinity, dissolved oxygen, phosphate, silicate, nitrite and nitrate collected from different regions of the affected and the adjacent unaffected areas during 13–22 May, 1987 are given in Table 2. The surface water temperature during 13–15 May following the incidence, varied between 31.5 and 31.8°C while the pH showed a range of 8.0 to 8.2. The salinity of the surface water

Table 2. *Ecological features of the inshore area of Mandapam on the Palk Bay side during* 13–22 *May,* 1987 *immediately after report of mass mortality of fish*

Date	Station	Distance from the shore (km) and depth of the station (m)	Surface temp. (°C)	Salinity (‰)	Dissolved oxygen (ml/l)	pH	Phosphate (μg-at/l)	Silicate (μg-at/l)	Nitrate (μg-at/l)	Nitrite (μg-at/l)
13-5-'87	I	Intertidal	—	S 33.79	5.82	8.2	0.05	18.0	1.75	0.74
	III a	0.03	31.8	S 33.28	0.94	8.0	0.05	21.0	1.0	0.84
	V a	Intertidal	—	S 34.81	3.58	8.0	0.05	18.0	1.0	0.84
14-5-'87	II	1/4	31.5	S 33.29	2.28	8.0	0.05	21.0	0.25	3.15
				B 32.51	1.50	8.0	0.13	22.0	7.75	6.30
	III d	1/4	31.8	S 32.02	1.09	8.0	0.18	24.0	6.50	1.05
				B 33.79	0.78	8.0	—	—	—	—
	IV	1/4	31.5	S 33.79	1.71	8.0	0.05	30.0	0.25	1.89
				B 32.76	1.91	8.0	0.05	25.0	0.50	0.21
	V c	1/4	—	S 33.54	2.34	8.0	0.07	21.0	0.25	0.21
15-5-'87	III b	0.2/1	31.5	S 31.70–32.00	0.21–0.26	8.0	0.75–1.50	14.0–17.0	4.25–9.78	5.88–12.18
					B 0.00	8.0	—	—	—	—
	V b	0.5/3	—	S 34.87	2.60	8.0	0.70	18.0	9.25	12.39
					B 2.08	—	—	—	—	—
20-5-'87	III a	0.5	—	S 32.00	0.94–1.18	7.79–8.00	0.40–0.45	9.0–16.0	0.25–1.00	0.84–1.68
	b	1.0	—	S 31.5–32.00	1.23–1.30	7.76	0.40–0.48	21.0	0.25–0.37	0.63–1.89
	c	2.0	—	S 31.5–32.0	1.43–1.58	7.63–7.79	0.35–0.43	14.0–24.0	0.25–1.00	0.42–0.63
22-5-'87	III a	0.5	—	S 31.5–32.0	1.79–3.32	8.0	0.40	4.0–6.0	0.25–0.37	0.21–0.32
	b	1.0	—	S 31.5–32.0	3.06–3.37	8.0	0.40	5.0–5.5	0.25	0.21
	c	2.0	—	S 32.0	3.12–3.17	8.0	0.40–0.45	4.0	0.25	0.21

Station 1: off Thonithurai; II: off Bison Bungalow; III: off Mandapam fish landing centre – Marakayar Boat Yard; IV: off Munaikadu; V: off Fish Farm of RC of CMFRI.

at different stations ranged between 31.7 and 34.8‰. The dissolved oxygen values of the surface water in the affected area were found between 0.21 and 3.58 ml/l, while near the bottom, it varied from nil to 2.08 ml/l. In the open sea (about 1 km from the shore) and also in the unaffected area (Station 1), however, the dissolved oxygen was at 4.37 ml/l (off Dhargavalasai) and 5.82 ml/l respectively.

While there was not much variation in the temperature and salinity values during 13–15th May and the following days, the dissolved oxygen values of the seawater in the affected area showed gradual improvement and reached normal conditions by about 22-5-'87, *i.e.* after a week of the report of mass mortality of fishes.

The data on phosphate, silicate, nitrite and nitrate concentration of the seawater during the affected days (13–15 May) showed variation between 0.05 and 1.50; 14.00 and 30.00; 0.25 and 9.78 and 0.21 and 12.39μg at/l respectively (Table 2). Relatively higher values of these nutrients were observed immediately after the incidence.

The above ecological features indicated that while the temperature, pH and salinity of the waters in the affected area were within the normal range reported earlier, the dissolved oxygen was found highly depleted registering nil values, particularly in the inshore region between the coral reef and the shore. Similarly, although higher values of nutrients were recorded in the water samples collected on 14th and 15th May, the data were found comparable with those recorded in the corresponding period of the previous year and those of the previous month from the adjacent region.

The phytoplankton samples collected on 13-5-'87 from the affected and the adjacent unaffected areas showed the common diatoms such as *Nitzchia* sp., *Pleurosigma* sp. and a few filaments of *Oscillatoria salinarum*. Toxic forms were not present. The sample collected on 14-5-'87 showed the dominance of diatoms represented by the species of *Coscinodiscus, Chaetoceros, Rhizosolenia, Nitzschia, Asterionella, Pleurosigma* and *Synedra*. A few forms of dinoflagellates such as *Ceratium* spp., *Peridinium* spp., *Diplopsalis* spp. and *Prorocentrum* spp. were also present. *Trichodesmium thiebautii* formed the exclusive species of the phytoplankton collected on 15-5-'87. Similarly, the pennate diatom *Nitzschia sigma* var. *indica*, constituted the principal species of the phytoplankton of 19-5-'87. These observations indicated that although no actual phytoplankton bloom was observed on 13th May when the incidence was first reported, blooming of *T. thiebautii* and *Nitzschia sigma* var. *indica* respectively were seen on 15th and 19th May in the affected area. Further, isolated observations on phytoplankton blooms near Mandapam on the Gulf of Mannar side in the last week of April showed blooms of *Trichodesmium* sp. on 6-5-'87 in the inshore waters off Keelakarai and discolouration of seawater from the normal from off Mandapam and Devipattinam on 9th and 10th May. However, there was no record of any fish mortality on these days. Zooplankton biomass was generally poor. It was composed of copepods, *Evadne* sp., fish larvae and a few fish eggs.

The possible causes of the fish mortality

Although no large scale industrial or domestic effluents polluting the sea were observed in this region, the disposal of unsold and rejected fishes and washings from the fish curing tanks into the sea at the Mandapam fish landing centre on the Palk Bay side where over 250 mechanised vessels are based and land their catches, were found to affect the water quality of the sea at this centre. During the period of the incidence, the inshore sea at this centre was found murky, emanating constant bad smell of hydrogen sulphide. The bottom soil was also found to be black. This polluted water was found to get mixed up with the adjoining open sea water. Besides, it was reported that small quantities of untreated effluent were also occasionally discharged into the sea by the Pamban road bridge construction authorities.

On the basis of the above information and the data, it appears that the cause of fish mortality observed between 13th and 15th May, 1987 at the Palk Bay side of Mandapam was mainly due to the natural phenomenon resulted by the ecological changes restricted to an area of about 3-4 km^2 between the shore and the coral reef. It was possible that the phytoplankton blooms reported just before the phenomenon and its isolated occurrence immediately after the incidence, and the associated changes in the water quality, the mixing up of the polluted water drained from the Mandapam fish landing centre and its subsequent spread within the reef area due to the prevailing water current would have triggered off an anoxic condition in the water column causing stress in the environment and consequent mortality of the fishes. Such occasional mortality of fishes and ecological disturbances have been reported from this region earlier by Chacko (1942), Chidambaram and Unni (1944), Chidambaram and Kurien (1952), Prasad (1953), Chacko and Mahadevan (1956), James (1972) and Nammalwar and Narayanan (1979). The facts that only the reef dwelling and bottom living fishes were affected by the phenomenon and that there was no mortality of either the pelagic fishes or the fishes living outside the reef indicated that the impact of the incidence was confined within the reef and the shore. The same reason rules out the possibility of mortality caused by the incursion of oxygen depleted waters into the area. Further, the absence of any physical and biological symptoms as revealed by the examination of the dead fishes, their gills and the gut contents, and the absence of any report of untoward incidents on the consumption of the dead fishes excluded the possibility of the cause of the reported mortality due to poisoning, pollution or the use of explosives.

Remarks

There was an initial hesitation among the local people to collect the gasping fishes near the shore and those washed ashore for consumption/marketing due to the suspected cause of the mortality by poisoning. Subsequent to the allay of this fear, however, both fishermen and local people gathered these fishes, sun dried or used for fish meal. As there was little

demand locally, an appreciable quantity was transported for marketing elsewhere in places such as Madurai, Trichi and Kerala.

It is interesting to note that the recovery of the affected area to the normal condition took nearly a week. This might be due to the reef-protected nature of the area, weak water movement within the reef and absence of strong wind during the period.

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CULTURE OF FIN FISHES ALONG THE COAST OF TAMIL NADU

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Introduction

Countries bordering the Indian Ocean have had a long history of experience in the cultivation of aquatic organisms and thus form important centres of aquaculture in the world. In India too such traditional culture practices have been well established in many maritime States. While in many states, these have undergone rapid development, in Tamil Nadu the coastal aquaculture remained largely at subsistence level almost as it was in the distant past though the potentials for its development are great. Small-scale experiments at various centres have demonstrated the possibilities of successful salt water fish farming.

As early as in 1911, Hornell proposed the possible conversion of various types of coastal areas like lagoons, mudflats and hypersaline channels for fish production. Possibilities for coastal fish farming have been revealed by the pioneering works of Tampi (1960), Chacko and Abraham (1962), Evangeline (1967) and Nair *et al.* (1974) with the culture experiments carried out at Mandapam. In recent years the research centres of Central Marine Fisheries Research Institute and the Fisheries Department, Tamil Nadu have made series of attempts in different parts of the State to improve the existing culture practices in the country and to develop new indigenous techniques to establish fish farming on scientific and modern lines. Considerable progress has been achieved in this direction. Mention has to be made to the works of Dorairaj *et al.* (1980), James *et al.* (1980a, 1980 b), Marichamy and Rajapackiam (1982), Marichamy *et al.* (1980), Venkataraman *et al.* (1980) and Shanmugam and Bensam (1980) which were carried out in the marine environment. The problems and prospects of salt water fish culture in Tamil Nadu were reviewed by Tampi (1967, 1969, 1972), Krishnamurthy (1972), James (1980) and Srinivasan *et al.* (1980). In the coastal aquaculture sector, the main objective is to achieve high production through improved culture practices involving selective stocking and intensive culture including the practice of polyculture, and development of hatcheries for high priced species. The present account compiles the information now available with regard to resource potential, site development, methods of culture and

management techniques and examines the scope for large scale expansion of this sector.

Resources

Tamil Nadu possesses the essential basic resources of water, land and cultivable species required for immediate development of mariculture. A variety of marine fishes possessing high reproductive capacity, short larval development, fast rate of growth and physiological features to adjust to wide changes in the environment are available along the coast of the state. The sources for the collection of seed of most of the important groups have been studied and the potential grounds identified (Renganathan and Ganapathy, 1949; Panikkar *et al.*, 1952 ; Krishnamurthy, 1972). Tampi (1973) while listing the fry collection centres and seasons of collection, estimated that a total of at least ten million fry and fingerlings of *Chanos* could be collected from coast of Tamil Nadu in a year More recently, the Central Marine Fisheries Research Institute carried out a project on the survey of seed resources of southeast coast of India. The fisheries department of the state had organised special collection drives in certain years besides the regular fry collection centres. All these have revealed the potential and possibilities for better exploitation, eventhough a quantitative assessment in terms of effort expended is yet to be prepared for a more precise picture.

Fig. 1. The CMFRI fish farm at Karapad, Tuticorin.

Among the culturable marine fishes the milkfish *Chanos chanos* is widely selected and the best period for large scale collection of their fry is generally the summer months March–July, although a secondary spawning of this species during September—November has also been reported in some parts. Next to milkfish, mullets constitute a group of great importance in coastal fish culture, particularly the species *Mugil cephalus, M. waigiensis, M. seheli, Liza parsia* and *L. macrolepis*. They occur in the same habitats along the coast with *Chanos* fry and have a peak season during northeast monsoon period. The potential grounds for the collection of fry of these fishes are the areas of Pulicat, Ennore, Adayar, Muttukad, Kadappakkam, Marakkanam, Cuddalore, Parangipettai, Killai, Thirumalaivasal, Tranquebar, Nagore - Nagappattinam, Point Calimere, Muthupet, Adirampatnam, Theedai lagoon in Mandapam Camp, Chinnapalam creek of Pamban islands near Mandapam, Valinokkam, Tuticorin, Pullavahi, Palayakayal, Pinnakayal, Tiruchendur and Colachel. Besides these promising species, culture of the pearl spot *(Etroplus suratensis)*, bhekti *(Lates calcarifer)*, threadfins *(Polynemus indicus, Eleutheronema tetradactylum)* and *Anguilla bicolor bicolor* has gained importance in recent years.

Fig. 2. Harvesting the cultured fishes after draining.

Experimental culture of sandwhiting *Sillago sihama* has indicated that it is a good species with good potential. The other cultivable species are *Elops indicus, Therapon* spp., *Epinephelus* spp., *Siganus* spp., *Megalops cyprinoides* and *Tilapia* sp. The occurrence of fingerlings of *Sillago sihama* in good quantities in May and October in the tidal reaches of Pillaimadam area near Mandapam has been reported by the scientists of Central Marine Fisheries Research Institute (James *et al.*, 1980 c). Several collection grounds of elvers in the river mouths along the southeast coast have been located.

The potential coastal waters available for culture in the State, estimated to be 0.080 million ha include estuaries, creeks, canals, tidal flats, backwaters, brackishwaters, lakes and saline swamps besides the productive space in inshore waters for open sea farming. The most important consideration is the location of the site in relation to the tidal amplitude. The tidal amplitude is poor in most parts of the State and therefore the location of the farm should take maximum advantage as regards the level of the ponds and supply channels. Availability of a source of freshwater would be an added

advantage in controlling wide variations in salinity and temperature. The soil of the pond has a direct bearing on the productivity of the ponds. A clayey soil rich in organic matter encourages the growth of various micro-organisms which become the food of fishes. Such soil is impermeable to water and can be used to form a firm, leakproof bund which is not easily eroded by wave or tidal action. The vast tidal mud flats available in Valinokkam, Tuticorin, Pullavahi, Palayakayal and Pinnakayal are such grounds in Tirunelveli District available for immediate development, and already farming works are in progress in certain spots.

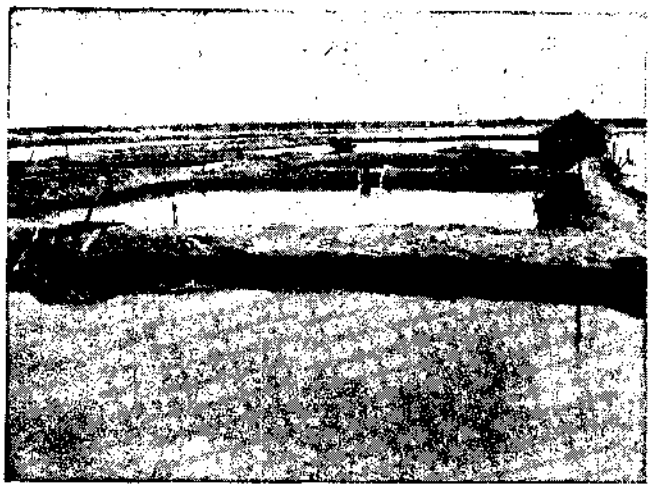

Fig. 3. Fish culture ponds in salt pan area at Veppalodai, Tuticorin.

Besides the development of such derelict areas for coastal aquaculture, another system of culturing also can be developed in salt pan reservoirs around Tuticorin and Manakudy. Some private farmers have already initiated culture projects in these areas.

Varma *et al.* (1963), Nair *et al.* (1974) and Marichamy *et al.* (1980) have described the optimum hydrological factors required for the different culture systems. According to them the salinity of the rearing media in the range 10–40 ‰ would be ideal for the fast growth of various fishes. Higher and lower pH are detrimental to the health of fishes and the optimum value would be around 8.00. Dissolved oxygen content at the level of 3.5 ml/l and above is the required condition.

Present status of culture practices

Mariculture of fin fishes can be broadly classified into two categories *viz.*, extensive and intensive methods, chiefly according to the ecosystem and species selected for culture. Extensive fish farming consists of just holding, growing and harvesting fishes in impoundments, whereas intensive culture involves selective stocking of the ponds with fish fry obtained from natural sources or hatcheries and raising them under controlled conditions. The extensive system of culture is represented by the traditional coastal aquaculture practices of the country, such as 'Bheries' of Sunderbans in West Bengal, 'Pokkali' fields of Kerala and 'Gazan' of Karnataka. In Tamil Nadu, the existing system of culture practices followed in low saline salt pan reservoirs of Tuticorin and Manakudy, though not prominant, may come under the extensive category. Realising the great scope for salt water fish farming, a series of experiments are now being carried out at different places of the State.

Intensive culture practices vary widely. Floating rafts with net or cages are preferred for the culture of large sized fishes like *Lates calcarifer, Polynemus* spp., *Epinephelus* spp. and *Caranx* spp. The Fisheries College, Tuticorin has started a project on this and the work is in progress. In places where the coastal currents are poor, net enclosures and pen impoundements in shallow regions of the coastal zone are other choices of mariculture. Preliminary experiments have been carried out at Mandapam Camp and Tuticorin by the Central Marine Fisheries Research Institute with different species. Combined culture of compatible species of fin fishes is gaining considerable importance as a means of effective utilisation of all the available ecological niches of the culture system. The mullets, milkfish and prawns together were profitably cultured in ponds. The growth and survival rates were good in the combination of mud crab *Scylla serrata* and *Chanos chanos* in ponds. The period of culture varies from 8–10 months. The development of coastal fish farm including the site selection, pond construction, water characteristics, farm management and results have been described by Marichamy *et al.* (1980).

The results of the culture operations carried out along the southeast coast of India in the marine environment are presented in Table 1. Variations with respect to growth, survival and production rates have been noticed and attributed to ecological and biological factors. Better results were attained in polyculture systems. Although the cultured species are euryhaline, the higher salinity retards the growth of the stock. Unfertilised ponds and the predation problems also cause poor production rate.

As regards eel culture, elvers have been found to grow fast under controlled conditions in running fresh water systems and attain marketable size at the end of one year. They feed on a variety of fishes and clam

Table 1. *Results of fish culture experiments carried out along the coast of Tamil Nadu*

Place	Culture System	Culture Methods	Species	Growth rate (mm)	Survival (%)	Production (kg/ha/yr)	Authors
Krusadai	Monoculture	Ponds	*C. chanos*	235-240/yr	—	—	Chacko and Mahadevan (1956)
	Monoculture	Ponds	*C. chanos*	240-250/yr	—	—	Menon *et al.* (1959)
Mandapam	Monoculture	Ponds	*C. chanos*	300 ,,	9-11	212-455	Tampi (1960)
Veppalodai	Polyculture	Ponds	*C. chanos*	333 ,,	50	192	Marichamy and Rajapackiam (1982)
			M. cephalus	420 ,,	20	362	
Tuticorin	Polyculture	Ponds	*C. chanos*	300-378 ,,	5	324	Marichamy *et al.* (1980)
			L. macrolepis	211-240 ,,	67	630	
			S. serrata	130-175 ,,	26	690	
Mandapam	Monoculture	Tanks	*A. bicolor bicolor*	23/m	98	22/m	Dorairaj *et al.* (1980)
Mandapam	Monoculture	Cages	*S. canaliculatus*	8.5 ,,	60	—	James *et al.* (1980b)
			S. javus	6.2 ,,	40	—	
			E. tauvina	25 ,,	75	—	
			S. sihama	10 ,,	—	—	
Mandapam	Monoculture	Pen	*V. seheli*	25 ,,	—	—	James *et al.* (1980a)
	Polyculture	Ponds	*L. macrolepis*	13 ,,	—	—	
			C. chanos	17 ,,	—	—	
			P. indicus	9.4 ,,	—	—	
			S. sihama	11.4 ,,	—	—	
Mandapam	Polyculture	Pen	*Mugil* sp.	18 ,,	70	—	Venkataraman *et al.* (1980)
			C. chanos	50 ,,	50	—	
Tuticorin	Polyculture	Pen	*C. chanos*	27 ,,	5-48	damaged	Shanmugam and Bensam (1982)
			Mullet	23 ,,	—	—	
Tuticorin	Monoculture	Ponds	*C. chanos*	44 ,,	318-857	—	Bensam and Marichamy (1982)

meat. A pilot project covering survey of elver resources, collection and transportation of elvers, exportation of live elvers and culture of eels was completed by the Central Marine Fisheries Research Institute with the financial assistance of the Marine Products Export Development Authority. A number of private fish farmers have already started small-scale marine fish culture along the coast of Tamil Nadu. The CMFRI has started projects for large-scale development of fish farming in 90 ha area at Muthukad and 500 ha in Theedai lagoon at Mandapam Camp.

Culture management

The results of the culture experiments are encouraging. The areas which require further research inputs have also been identified, particularly in respect to the development of hatcheries for large scale production of fish seed, nutrition of culture fishes, control of diseases and predators, induced maturation in captivity, methods of culture and coastal farm engineering. All these need-based intensive programmes have been started by the central and state fisheries departments located in different centres of the State.

Careful considerations on the following aspects are necessary before farming the sea edge such as (1) the topography and tidal regime of the area, (2) soil and water characteristics, (3) presence of required seed resources in the surroundings, (4) the fauna and flora as well as environmental parameters of the area and (5) legal regulations and the socio-economic conditions of the locality. Efficient farm management involves the preparation of pond, maintenance of water condition, fish population management, production and maintenance of natural food, supplemental feeding, control of pests and predators and effective harvesting.

The development of such sea-farming largely depends upon the effective transfer of the technology developed and this can be effected through training programmes, including demonstrations, special courses of summer institutes, consultancy services and regular courses of Krishi Vigyan Kendra, on such aspects of mariculture techniques regarding seed production, farm operations, simple harvest technology, farm management, marketing and economics.

Future lines of work

Mariculture has gained importance and as such the schemes relating to its development are included in the current five year plan. The employment potential in seafarming is enormous as Tamil Nadu is endowed with several protected bays, lagoons, vast estuarine and brackishwater areas which could be converted to fish farms. Developmental supports should be made available for converting these areas into fish farms. Farm engineering for marine aquaculture is a new field and it is essential to develop new designs and innovative techniques for constructing bunds, sluices and feeder canals to suit the local conditions. Continued investigations are needed for the development of low-cost technology for intensive culture of more suitable species in different ecological systems as well as the survey of seed resources in new sites. Formulation of suitable feed mixtures using low-cost ingredients with high conversion ratios will be another priority area of research for expansion of the industry. The methods developed in recent years have been largely empirically determined and can probably be improved. The methods of fertilization should be tailored to soil and water chemistry. Extensive experimental studies in using organic and inorganic fertilisers for enriching the ponds is a line of work to pursue. The practice of continuous stocking and harvesting with a year-round growing season as done in Taiwan will result in good yield. The venture of fish culture should be organised on co-operative basis at cottage industry level. A practical system to produce the seed of desirable species on a large scale under controlled conditions has not been developed so far. Improvement of present collection methods could be made based on the behavioural characteristics of the species. The use of scare-line in shallow tidal creeks would be the effective gear for good catches. Also, conservation measures should be introduced since a lot of *Chanos* fry are collected and spoiled by children in coastal villages without realising the immense value of this resource. Besides exploring the unexploited stocks, the ultimate solution must be the breeding of milkfish and mullets in captivity.

With such high seed production, there could be chances to export the *Chanos* fry and develop fry trading centres. Fish fry collection and fry trade can develop into a very profitable supporting industry. Government must make derelict marshy areas and coastal lagoons available to enterprising societies of fish farmers on long-term lease, besides the development of credit and marketing schemes. Provision of model farms and extension services by Government departments on modern scientific lines as technical guidance and training will promote this growing industry. Schemes on the pattern of Fish Farmers Development Agencies established in Tanjore District, should be set up for the implementation of fish culture in sea-base, involving local fishermen. Full support from Government in the beginning can be given particularly to train the fish farmers. Local fishermen may prefer this part-time avocation. The National Commission on Agriculture has recommended that maritime states should undertake a detailed survey of brackishwater fish farming and establish pilot commercial fish farms. Future work should be centred around this scheme for further extension.

Problems

The land leasing policies do not permit long term aquaculture practices. Credit facilities for commercial scale expansion are lacking. Constraints on technological inputs are many. Reclamation of saline water areas is an arduous task. Fast industrial advancements along the shore, particularly the chemical and fertilizer plants, may pose a problem with their discharges, and it would adversely affect the development of coastal aquaculture. The need for protecting aquaculture areas from the effects of pollution is stressed for the trouble free progress of culture projects. The preparation of inexpensive supplementary or complete feeds from locally available ingredients is another development

that is required for intensifying culture operations. Reliable techniques for the proper improvement of derelict lands and management of farming along the sea shore are other problems to be solved.

Remarks and conclusions

It is understood from our planning reports that if our brackishwaters are fully utilised, about 31 lakh tonnes of fish could be produced every year and about 28 lakhs people will be able to get employment opportunities. This will be increased if the edge of the sea is farmed for fish culture practices. The species used in culture system have high unit value, besides other benefits. Even if 10% of area of the available coastal lands is brought under culture by scientific methods, the production can be increased considerably.

Fish farming along the coast has a direct bearing on the coastal rural economy, in that it will provide opportunities for self employment, increase production of cultivable marine fishes several-fold, support a number of ancillary small-scale industries, provide material for export and bring about an overall improvement in the socio-economic conditions of coastal fishermen and farmers. The fishermen have plenty of leisure time during off season which could be effectively utilised in farming work. The mariculture system combining with traditional fisheries must be selected on consideration of several factors relating to the technical aspects of culture as well as socio-economic aspects of the fishermen community. Culture methods of proven techno-economic feasibility, developed by research institutes, have been transferred to some extent by different means like operational research projects and demonstration programmes in different parts of the country, including Tamil Nadu. Training programmes in coastal aquaculture have been developed through Krishi Vigyan Kendra of ICAR and the establishment of such centres in the State may benefit much. In the initial stages subsidies and loans will have to be provided as was done in the case of mechanised fishing. The service of the technical experts of the fisheries research institutes coupled with active participation of the planners, administrators, financial agencies and the fish farmers with the available basic resources is the urgent need for the rational development of farming the sea edge.

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BEACH EROSION AT KOVALAM FISHING VILLAGE, TAMIL NADU, WITH SOME COMMENTS ON THE SEASONAL SHIFTS IN THE COASTLINE ALONG THE KOVALAM BAY*

Introduction

Kovalam village (Lat. 12°46′; Long. 80° 18′), 36 km south of Madras city, is a small hamlet overlooking the southern end of the picturesque bay (Fig. 1). The main settlement, consisting of thatched, as well as 'pukka' houses, is located very close to the sea on a sand mound of 2 m high. These houses were hidden behind a thick grove of coconut palms (Fig. 2) until calamity in the form of severe sea erosion struck the village during May–June, 1986. Over 150 coconut palms and 13 houses were destroyed (Fig. 3 & 4) and several others damaged severely, affecting the livelihood of many households. Temporary relief came in the form of piles of sand bags (Fig. 5) to prevent further damage. The sea receded by the last week of June and there was no further threat to the village.

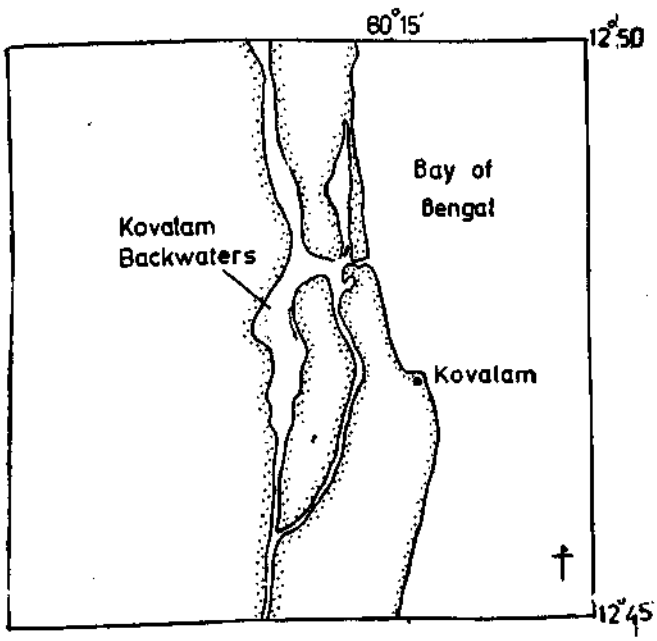

Fig. 1. The geographical position of Kovalam Bay and backwaters.

It is reported that eighteen years ago, in 1968, similiar erosion occurred here during which several palm trees and thatched huts as well as over ten 'pukka' houses further north were destroyed. The incursion of the sea at that time pushed back the village limit by about 50 m, as it has now been pushed back by another 60 m.

The Kovalam Bay

The general features of the Kovalam Bay are indicated in the map (Fig. 1). The shape of the bay is determined both by the crop of rocks located at the southern tip of the head-land and the Kovalam backwaters which drain into the bay 4 km north of these rocks. The coastline bordering the bay is a constantly

*Prepared by Geeta Bharathan and E. V. Radhakrishnan, Madras Research Centre of CMFRI, Madras.

Fig. 2. The Kovalam beach in July, 1985. Note the flat profile of the beach compared to the sand mound in Fig. 10.

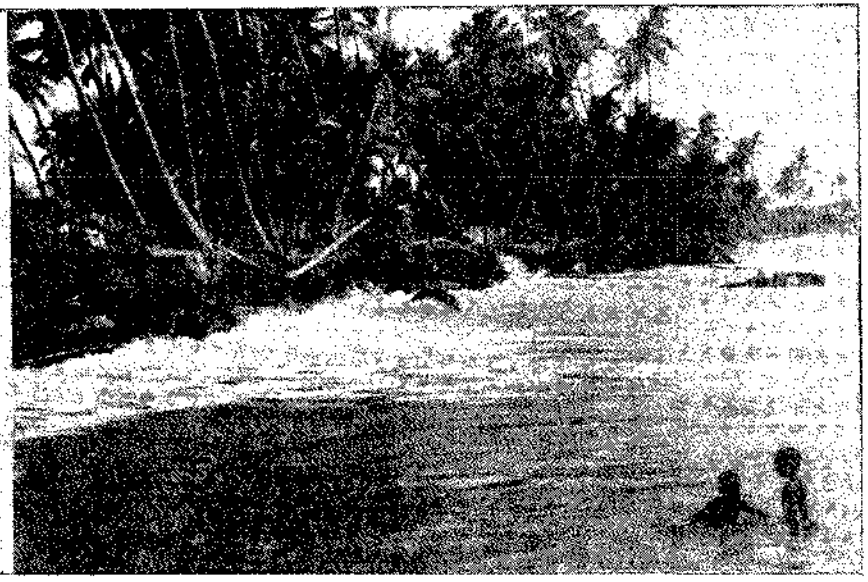

Fig. 3. View of erosion of palm grove as on 30th May, 1986.

Fig. 4. Close-up view of erosion, 30th May, 1986.

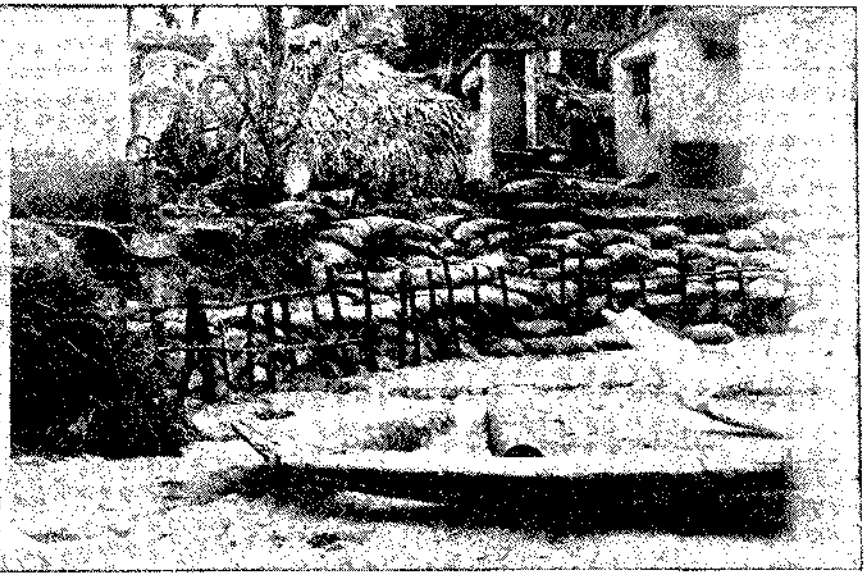

Fig. 5. Sand bags stacked on eroded beach infront of the houses for temporary protection.

shifting one which alters the contour and position in accordance with changes in the direction of current along the east coast.

No detailed studies have been conducted on current patterns in the Kovalam Bay, although hydrological features have been described by Muthusamy (*Indian J. Fish.*, **24**, 1980). The current pattern in the Bay of Bengal has been studied extensively and was reported to be southward during October and December, and northward during February and March (Ganapathy and Murthy, *Andhra Univ. Ser., No.* **49**, 1954). A similar pattern was reported by Srivastava and George (*J. mar. biol. Ass. India*, **18**, 1976).

Observations of local fishermen conform broadly to the above pattern. Daily records maintained at the Field Laboratory, Kovalam during 1979–'80, revealed that the current was southward during the period October–January. A short period of transition towards the end of January was followed by a reversal, the current then flowing in a northward direction from February until October.

Shifts in the coastline parallel these changes in current pattern. This annual cyclical shift in the coastline is represented in Fig. 6. Thus the sea retreats after April, and until October is at an approximate distance of 180–200 m from the road. During this period the prevailing current is northward. After October the sea starts moving southward into the land, eroding a large portion of the beach and by January–February it is at a distance of 100–120 m from the road. During this period the current is mostly southward.

There was a slight change in the above pattern during 1985–'86 when compared with the seven year period 1977–'84. The sea came very close to the road (upto 20 m) during early February, 1985 and receded after March. It started moving again in November, 1985 and was only 10 m from the road in March, 1986 (Fig. 7). Such close proximity of the sea had been observed by the authors only during the cyclone of May, 1979. The other time the sea came so close in the recent past was in 1968 when erosion occurred. At that time the road itself is said to have been submerged.

Sea erosion

In 1986 the sea did not retreat in April as it normally does, but remained close-by until May, exposing a new crop of rocks on the shore and eroding away different parts of the beach (Fig. 8). Shore seines landed large quantities of anchovies (about 2 tonnes) during this period. The sea became very rough during the lunar eclipse on April 24, 1986 and erosion increased. A huge anchor, 2 m high and weighing nearly 2 tonnes was uncovered by the sea (Fig. 9). Subsequently, by the second week of May, the sea started receding and a small sand mound was built up parallel to the coast on the beach infront of the Field Laboratory (Fig. 10).

The sea again became rough on May 23, full moon night and then started the process of erosion of the village. Apparently, erosion was severe because of the newly formed sand mound which deflected the surging sea away from the direction of the road into the village (Fig. 11). A large palm grove at the southern end of the village was destroyed and by May 29, much of the sand in that area was eroded away and two ancient sculptures were uncovered (Fig. 12). Similar monoliths had been removed in 1968 too (Fig. 13). The sea then moved further north, and entered the village to a distance of nearly 60 m from the normal water line, destroying 10 huts and 3 'pukka' houses (Fig. 14). It became calm by June 28 when no more damage was caused and by July it had receded well back (Fig. 15).

Kovalam backwaters

The Kovalam backwater is connected to the sea for only part of the year, usually during the period October–May. The mouth closes because of long-shore drift and is cut open by the Buckingham Canal Authority (PWD) when the water level in the canal exceeds 6.3 m. Examination of the annual rainfall at Kovalam and the total period of closure of the bar-mouth reveals a negative correlation ($r = -0.85$) between the number of months of closure and the total rainfall during the previous year (Table 1).

Unusually heavy rains in Chinglepet District during October, 1985 resulted in heavy flooding of the backwater, consequent to which the bar-mouth was forced

open very wide and deep. By April, 1986 water flow at the mouth became much reduced. Rough sea conditions during the eclipse in the end of that month cut the bar wide open again and it remained so until November, 1986. This is quite unusual since the mouth normally closes by June (Table 1).

Table 1. *Total annual rainfall* (1979–'85) *and dates of closure and opening of barmouth of Kovalam backwaters with total period of closure*

Year	Total rainfall f(mm)	Sand bar		Period closed (months)
		Date of closure	Date of opening	
1979	1204	17–9–'79	4–11–'79	2
1980	1175	8–5–'80	13–11–'80	6
1981	1036	19–4–'81	2–11–'81	7
1982	796	3–2–'82	4–11–'82	9
1983	1356	11–2–'83	1–9–'83	7
1984	1397	15–6–'84	6–10–'84	4
1985	1858	10–6 –'85	24–9–'85	3
1986	1005	—	—	2

During May–June 1986, the period of erosion, low tides did not uncover intertidal land masses in the backwater, eventhough the bar mouth was wide open. This situation continued until June 28, afterwhich intertidal patches were once again uncovered during low tide.

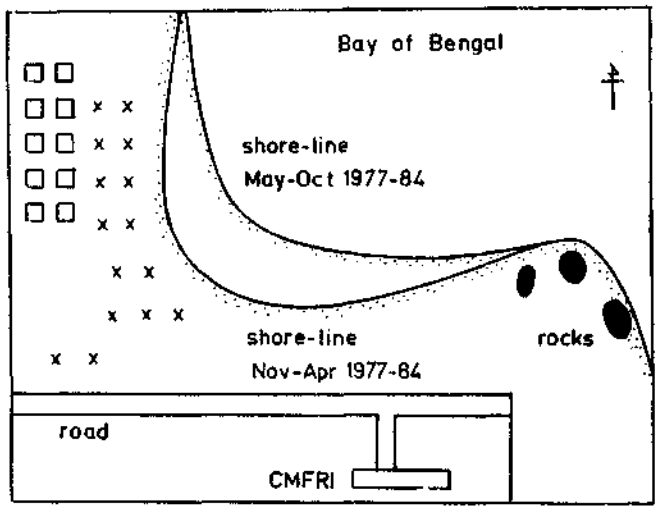

Fig. 6. Diagrammatic representation of southern end of bay showing seasonal shifts of coastline during 1977–'85. Lower line represents maximum limit of incursion and upper line shows extent of retreat by the sea (Not to scale).

These observations indicate heightened sea level during the period from April 24 to June 28.

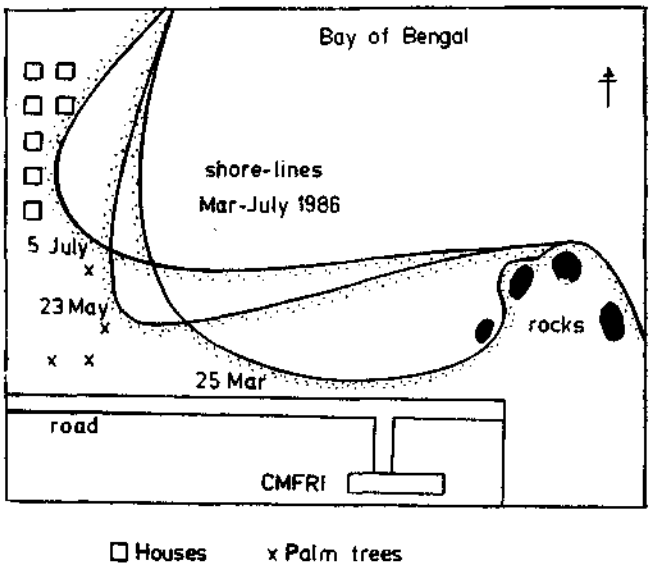

Fig. 7. Diagrammatic representation of southern end of bay showing shifting of coastline and erosion during 1986. The different lines indicate position of the sea on the dates depicted in the diagram. (Not to scale).

Drift organisms

Many bottom-dwelling and sessile animals such as gorgonians, sponges, ophiuroids, asteroids and crabs were washed ashore during May, 1986, and this is very unusual. The only other time in the recent past when significant quantity of sea life drifted ashore was in 1985. During that year a large amount of *Sargassum* and gorgonians was observed in July. This phenomenon lasted for over one week and was accompanied by a very strong northward current. *Sargassum* is not reported from the flora of rocks at Kovalam or Mahabalipuram and it is likely that these algae came from somewhere further south.

Fishery

The fishery off Madras during the period March–July, 1986 appears to have been somewhat different from the normal pattern. Apart from the heavy anchovy catches in March, 1986 mentioned earlier, unusually heavy landings of lesser sardines were observed at Kovalam during the first half of July. Similarly, off Madras too, heavy catches of mackerel and *Doryteuthis* sp. took place during April–June which was, indicative of changes in the sea conditions, since both species form major fishery on the west coast but are rarer on the east coast.

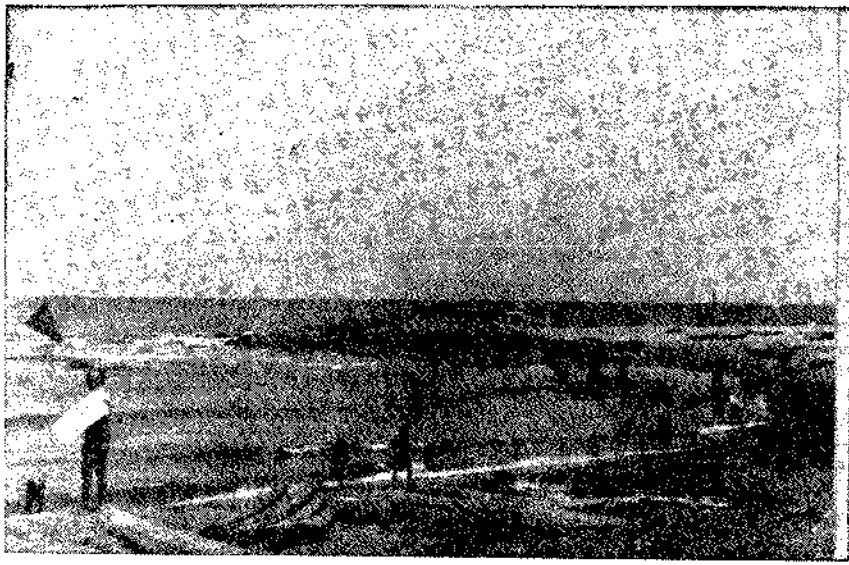

Fig. 8. Incursion of sea. Arrow indicates new crop of rocks exposed.

Fig. 9. Anchor recovered from sea bed in the eroded area, May, 1986.

Fig. 10. View of beach showing sand mound formed after retreat of sea, 30th May, 1986.

Fig. 11. Damages caused to the houses, 24th June, 1986

Fig. 12. Sculptures (Monoliths) recovered from sea bed in eroded area, 30th May, 1986.

Fig. 13. Sculptures recovered from sea bed during previous episode of erosion in 1968.

Fig. 14. A view of the village after destruction of houses and coconut palms taken place on 24th June, 1986. Compare the sparse stand of trees with the dense grove in Fig. 2.

Fig. 15. Retreat of sea and deposition of sand, covering rocks earlier exposed. Compare with Fig. 6. Arrow indicates portion of these rocks.

Table 2. *Monthly averages of tidal height (in metres) off Madras for the years* 1983–'87

Year	J	F	M	A	M	J	J	A	S	O	N	D
1983	1.31	1.16	1.12	1·18	1.23	1.25	1.22	1.22	1.26	1.32	1.44	1.40
1984	1.27	1.19	1.16	1.20	1.26	1.20	1.19	1.24	1.31	1.36	1.29	1.34
1985	1.26	1.19	1.15	1.19	1.29	1.27	1.17	1.18	1.26	1.43	1.51	1.44
1986	1.27	1.14	1.12	1.25	1.29	1.24	1.19	1.18	1.21	1.32	1.47	1.47
1987	1.35	1.17	1.10	1.15	1.23	1.23	1.22	1.22	1.26	1.36	1.42	1.35

Discussion

Sea erosion on the east coast of India is fairly common during the northeast monsoon and has been recorded as far back as 1859 (Ahmed, *Coastal Geomorphology of India,* Orient Longman, 1972). However, its occurrence during the period May-August, as occurred in a wide-spread manner during 1986 is unusual. Erosion was observed, for instance, at Elliott's Beach in Madras city and was reported from Cuddalore also.

Erosion that occurred at Foreshore Estate, Madras, during August, 1977 was said to be the consequence of the flooding of Adayar River during November, 1976, followed by the formation of a sand bar in the sea. This bar deflected the direction of waves, causing them to strike the shore head-on, thus leading to erosion (Meenakshisundaram, Superintending Engineer, Madras Port Trust, personal communication). General observations indicate that a combination of unusual events may have been responsible for the erosion at Kovalam. The cumulative effect of the flooding of the backwaters during October, 1985 and probable deposition of silt, the formation of a sand mound on the beach as described earlier, and the rough, heightened sea conditions during May–June, 1986 might have led to the events described here.

The following observations indicate an elevation of the sea level during April–June, 1986.

1. The submergence of normally exposed inter-tidal flats observed during April–June, 1986.

2. High water level during the period April–June, 1986 observed in the ponds at the Mariculture Centre, Muttukkad, when compared to the previous year (Annual Reports of Project MBO/MP/1.2, 1985–'86, '86–'87).

3. A steep rise in neap tide height during April, when it rose from 1.12 to 1.25 metre (Table 2). This rise was more steep and earlier in 1986, than during other years. The normal pattern of a rise during May–June, has been pointed out by Prasad and Reddy (*Indian J. Mar. Sci.*, **14**: 206-209, 1986).

Data of the Meteorological Department do not reveal any significant difference in the pattern of wind speed over the years, 1983–'86 (Jayanthi, Met. Dep. Madras, personal communication).

Conclusions

It is evident from our report that we need to have a fuller understanding of the hydrological parameters and current pattern of the Kovalam Bay than we have at present. The fishery and also the conditions in the farm of Mariculture Centre, Muttukkad are greatly influenced by events in the Bay. It is clear that a deep knowledge of conditions in the Bay would be of great value in studying the capture as well as culture fisheries of this area. Moreover, events like erosion could be predicted and preventive measures taken by the authorities concerned. The unearthening of old sculptures from the sea bed is of archaeological interest. Thus, extensive as well as intensive studies in this area would be of great value in the future.

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