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Critical marine habitat restoration programme - initiative on mangrove restoration in Kerala, India

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Introduction

Mangroves are unique habitats which function as nursery ground for several valuable species of finfishes and shellfishes and they play a vital role in supporting marine food chains, protecting coastal areas and in improving water quality. Mangroves in general have relatively high productivity and tend to create highly organic soil and also export organic matter to nearby marine environments. They are effective in stabilizing soils in intertidal areas. Some species of mangroves have been planted in the coastal areas as bio-protection shields to guard coastal households from wind and wave action. They provide shelter to several avian fauna which feed on its fruits and nest in the branches. Rare or endangered species of birds have also been documented in the mangroves.

During the last three to four decades, urbanization has increased the land value of coastal areas leading to felling of mangroves. This has directly affected the mangrove cover in most coastal regions. In an attempt to develop critical habitats in the coastal areas, an initiative was made to develop mangrove habitat in Kerala by the Central Marine Fisheries Research Institute, Kochi. This community based ecosystem restoration program was launched in June 2010.

The initiation

Three species of mangroves which are common mangrove vegetation of Kerala were selected for the restoration programme and for nursery development *viz., Rhizophora mucronata, Bruguiera gymnorrhiza* and *Bruguiera cylindrica.*

Rhizophora mucronata, locally known as *Valiya kandal* is globally popular as the Asiatic mangrove and this can grow up to 27-30 m height with 50-70 cm trunk diameter. This species usually has numerous lateral roots, developed from base of the trunk called stilt roots, hoop or pile-like, supporting the tree. Hanging air-roots are sometimes also produced from the lower branches. Fruits are edible and the fruit juice can be made into a light wine. The timber is heavy, difficult to saw and not durable unless it is dried for a long time. However, it can be used for construction, to make fish traps, house frames, pilings and poles. *Rhizophora* is used as firewood and to make charcoal. It is chipped and used for commercial paper and rayon production in Indonesia and East Malaysia. Tannins and dyes are extracted from the bark and a black to chestnut dye is obtained from the leaves. It is used in traditional medicines as an astringent and to treat angina, diarrhoea, diabetes, dysentery and hematuria. Old leaves and roots are used during childbirth while bark is used to treat blood in the urine. This species has been used for restoration programmes in India and several Asian countries.

Bruguiera gymnorrhiza is locally known as *Pena kandal*. This species can grow up to 30–35 m in height and typically develops knee roots. The propagule is edible and the wood is widely used for structural components of traditional homes and for other structures such as fishing stakes and spears. *Bruguiera* timber is harvested commercially for charcoal production in south-east Asia, although *Rhizophora* is preferred. This species has medicinal properties and has been used in traditional medicine. The bark is considered as an astringent and used to treat malaria, cure fish poisoning, treat diarrhoea and fever. In some areas, the fruit is used to treat eye problems and to stop bleeding. The leaves are used to control blood pressure. This species is common in the mangrove vegetation of Kerala.

Bruguiera cylindrica is locally known as *Cheriya kandal*. Young shoots and root tips are edible and considered as a vegetable and the bark is used as a cooking spice. The timber is heavy and tough and used in construction. It is also favoured as firewood and for conversion into charcoal. The bark produces a strange smell that scares fish away. In some countries essences are extracted by squeezing the pneumatophores and used to make perfumes. This species is common along both the coasts of India.

The propagule of these three species of mangroves were collected from southern part of Vypin Island located about 20 km from Moothakunnam which has a rich diversity of mangroves. During a function held in the village in connection with the World Environment Day (5th June, 2010), propagules were distributed to different groups of school children, women self help groups and other village youth who were interested to be partners in mangrove restoration (Fig.1). Of the nine groups who had initially volunteered to join the programme, only five continued the activity by developing mangrove nurseries at different locations in the village.

Fig. 1. Distribution of mangrove propagules to self help groups

The nursery reared seedlings were collected back from the respective groups by CMFRI after three months for further planting and restoration based experiments. The details of the growth and survival of the three species of seedlings during the nursery phase and other related aspects are presented here.

Mangrove nursery development

The propagules were planted in small garden nursery polybags, three fourth filled with clay dominated mud collected from the nearby estuary (Fig. 2). Necessary instructions as listed below for proper care of the seedlings for better survival and growth of the propagules were given to the village groups.

Fig. 2. Mangrove propagules planted by SHG in mud filled polybags

Protocol for development of mangrove nursery:

- Select propogules which are ripe.
- Do not expose the propogules to direct sunlight.
- If the propagules become dry before planting, sprinkle water on the propagules to moisten them.
- Prepare the planting container by punching small holes on the cover.
- Fill the bags three fourths with clayey mud.
- Do not use sand or sand dominated sediment.
- Insert 1/3 part of the propagule into the sediment and place in shade .
- Water the growing propagule daily or on alternate days preferably with estuarine water to avoid wilting and desiccation.
- If the leaves are attacked by worms, these should be removed and then herbal insecticides like neem oil or neem based pesticides such as Azadirectin or tobacco decoction should be sprayed on the leaves.

Peoples' participation

The propagules were reared by five different groups of villagers comprising youth (Group A) and school children (Groups B to E). The biological details regarding the growth observed in the five nurseries and for the three species are given below.

Group A, Village youth

Three village youth who were interested in rearing the seedlings, developed a mangrove nursery beside the estuary (Fig. 3). They planted the propagules in the small packets as instructed and placed them in a shaded area such that the growing propagules were not exposed to direct sunlight. They watered the plants using a small pump every alternate day in the evening after coming back from their respective work places. They were committed and took care of the growing seedlings.

Fig. 3. Mangrove seedlings in community nursery, ready for transplanting

Group B, C, D and E

These groups were school children and were supported by their teachers (Fig. 4). The children developed a mangrove nursery in a shaded area in the school premises. They watered the plants daily but had to discontinue during holidays which affected the survival of the seedlings. The details regarding the number of propagules distributed to each group and the survival of the seedlings after three months of rearing are given in Table 1.

Fig. 4. Growth observations of mangrove seedlings at the end of nursery stage

An analysis was made on the reasons for varied survival rates and these are listed in Table 2. The major cause for non-survival of seedlings was root decay due to inappropriate punching of holes in polybags containing mud which served as nursery raising medium. This was observed in all the nurseries. Improper planting of propagule in the polybags and lack of regular watering were also reasons for wilting and decay of propagule/sapling. Moreover, pest attack especially by the leaf eating caterpillar and desiccation of propagules owing to delayed planting were also reasons for poor growth performance in the nurseries. Wherever pest attack was observed, the leaves were sprayed with Azadirectin (neem based bio-pesticide) and the worms were manually removed and destroyed.

Survival and growth of different species of mangroves

R. mucronata was the main species selected for the restoration programme. An average of 78.8% survival (N=2013) was observed and the survival percentages ranged between 78.1 to 100% in the nurseries maintained by different groups.

Table 1. Details regarding the survival of mangrove seedlings reared by the different groups in the village

Group	Group members	Total no. of propagules reared	Percentage survival of propagules
A	Village youth, Moothakunnam	2948	80.9
B	Teachers Training Centre, Moothakunnam	58	67.2
C	Govt. Boys Lower Primary School, Moothakunnam	55	81.8
D	Govt. Girls Lower Primary School, Moothakunnam	125	65.6
E	SNMHS, Moothakunnam	173	72.8
	Total	3359	Average 79.7

Table 2. Reasons for varied survival percentages of the mangrove seedling reared by different village groups

	Reasons for wilting / lack of growth of seedling	A	B	C	D	E	Overall ranking
Root decay	Drainage holes not properly punched	4	3	2	3	3	3
Planting of propagule	The shoot end was inserted into the clay instead of the root end	4	0	1	4	3	2.4
Watering the propagules	Not done routinely as instructed	1	4	2	2	3	2.4
Attack by pests	Worm attack was seen on the leaves during the third month of rearing	2	0	0	0	2	1.2
Desiccation (wilting) of propagule before planting	The propagules could not be planted in time after removal from the parent plant	1	1	1	1	1	1

B. gymnorrhiza was the second dominant species (N=866) and the average survival was 77.1 %. The survival in the nurseries ranged between 27.8 and 82.3%. *B. cylindrica* (N=480) had comparatively high survival rate (average= 87.7%). Survival percentage (80.9%) was highest in the nursery of village youth who took care of a total of 2948 seedlings followed by Group E which recorded a survival of 72.8%.

Growth of the propagule

Rhizophora mucronata

The shoot length of *R. mucronata* (Rm) reared by the different groups varied and ranged between a minimum of 26 cm and a maximum of 57.5 cm. The average root collar diameter was 15.1 mm with a minimum of 10.3 mm and maximum of 21.52 mm. The shoot diameter ranged between 3.4 mm and 6.8 mm, with a mean of 4.7 mm. The number of nodes ranged between 2 and 3 and the inter nodal length ranged between 2 and 14 cm. The number of leaves reared by the groups showed wide variation ranging between a minimum of 2 leaves and a maximum of 7 numbers. The average leaf area was 29.1 cm^2 with a minimum of 16.7 and maximum of 49.31 cm^2. The leaf area per seedling was estimated as an overall mean of 116.7 cm^2 with a minimum of 43 cm^2 to a maximum of 229.68 m^2.

Bruguiera gymnorrhiza

The growth of this species was comparatively lower than *R. mucronata* but faster than *B. cylindrica*. The average shoot length was 22.3 cm with a minimum of 14 cm and a maximum of 37.5 cm. The seedlings had an average root collar diameter of 15.5 mm with a minimum of 11.6 and a maximum of 20.3 mm. The mean shoot diameter was 5.2 mm with a minimum of 2.8 mm and a maximum of 9.1 mm. The number of nodes was lowest (1 no.) in the nursery of Group C and highest of 6 nos. in Group A nursery. The inter-nodal length also showed wide variation ranging between a minimum of 3 cm and a maximum of 8 cm. The foliage of the seedlings varied with individual seedling. In some, there were only three leaves while in other seedlings there were nearly 10 leaves in three months. The average unit area of leaves was 18.7 cm^2. Individual variation in unit leaf area ranged between a minimum of 4.93 cm^2 and a maximum of 33.27 cm^2. The leaf cover area per seedling was estimated as an overall mean of 99.2 cm^2, with a minimum 18.42 and maximum of 266.16 cm^2.

Bruguiera cylindrica

The growth of *B. cylindrica* was slow compared to that of *R. mucronata* and *B. gymnorrhiza*. This species had grown to an average height (shoot length) of 15.1 cm which is much lower than other two species. The corresponding root collar diameter was also small (6.4 mm). The shoot diameter showed a mean of 3.2 mm. The number of nodes varied between 2 and 4, seedlings had about 4 to 7 leaves. The inter-nodal length ranged between 2.5 and 6.4 cm and the average leaf area was 7.1 cm^2 $leaf^{-1}$. The leaf cover area per seedling showed a mean of 34.8 cm^2 (Table 3).

Globally, mangrove restoration programmes have been initiated by several nations. Though mangrove seedlings grow fast, their survival rates

Table 3. Details of growth of *Rhizophora mucronata* (Rm), *Bruguiera gymnorrhiza* (Bg) and *Bruguiera cylindrica* (Bc) after rearing the propagule for a period of 3 months from June to September 2010 at Moothakunnam village nurseries

Species		No. of leaves	No. of nodes	Inter-nodal length (cm)	Shoot length (cm)	Shoot dia. (mm)	Root collar dia. (mm)	Leaf area (cm^2 $leaf^{-1}$)	Leaf cover area (cm^2)
Rm	Range of group average (overall mean)	3.2 - 4.8 (4)	2 - 2.4 (2.2)	3.8 – 8.79 (6.4)	33.9 – 46.13 (40.7)	4.0 – 5.66 (4.7)	12.11-18.46 (15.1)	23.02 – 36.21 (29.1)	92.1-145.86 (116.7)
	Overall minimum - maximum	2 - 7	2 - 3	2 – 12.7	30 - 57.5	3.4 – 6.8	10.3 - 21.52	16.7-49.31	50.1-229.68
Bg	Range of group average (overall mean)	4 - 6.4 (4.8)	2 – 5 (3.3)	4.5 - 6.77 (5.7)	18.3-28.62 (22.3)	3.01 – 8.58 (5.2)	12.74-18.17 (15.5)	9.414 – 27.73 (18.7)	60.25-177.5 (99.2)
	Overall minimum - maximum	3 - 10	1 - 5	3 - 8	14-37.5	3 – 9.1	11.6-18.96	6.14 – 33.27	18.42-266.16
Bc	Range of group average (overall mean)	4 – 6.4 (4.8)	2 – 3.4 (2.8)	3 – 5.36 (4.07)	13.5 – 17.1 (15.01)	2.27 – 4.62 (3.2)	4.3-7.7 (6.4)	5.37 - 8.2 (7.1)	21.48-51.09 (34.8)
`	Overall minimum - maximum	4-6	2-4	2.5 -6.4	11 - 19	1.86 - 8	4.3 – 7.87	5.35 – 9.98	21.48-78.82

have been generally low in restoration sites mainly because of unscientific method of project implementation and also due to lack of support from villagers residing near the restoration area. The present study indicates that with proper care, propagules of *R.mucronata*, *B. gymnorrhiza* and *B. cylindrica* can be grown as seedlings for planting at selected sites. Such seedlings can be used for developing selected areas for eco-tourism which will support growth of ecosystem services. This will also help bio-construction of ecosystem and the villagers can be partners in this programme. Such restoration would increase the suitability of these habitats as nursery grounds for commercially important resources which will increase the productivity of the coastal ecosystem. The increased mangrove foliage will also help in carbon sequestration and support mitigation measures for climate change.

The seedlings were planted in selected areas at Moothakunam with the involvement of villagers. The ground area of *R.mucronata* planted was estimated as 670 m^2, with a spacing of 0.75 x 0.75 m in triangular pattern of planting. Similar ground area for *B. gymnorhiza* and *B. cylindrica* were estimated as 167 m^2 and 105 m^2 respectively.

Mean leaf area cover per unit ground area (m^2 leaf area per m^2 ground area) was calculated as 0.045 for *R. mucronata*, 0.0397 for *B. gymnorhiza* and 0.014 for *B. cylindrica*. Net canopy photosynthesis for the planted mangroves was estimated as 0.029 g C h^{-1} for *R. mucronata* 0.026 g C h^{-1} for *B. gymnorhiza* and 0.0091g C h^{-1} for *B. cylindrica*.

This study indicates the potential to develop community based mangrove nurseries for restoration programmes. With proper planting of the saplings, the mangrove cover in Kerala State can be improved. This can also support development of nursery areas for seed of finfishes and shellfishes. The carbon sequestration by the mangrove leaves especially near urban areas which are close to the sea is of critical importance due to the present concern on global warming. The mangrove canopy serve as lungs purifying the urban atmosphere loaded with high carbon dioxide accumulation owing to fuel discharge and dense population. Studies on mangrove restoration have shown that mangroves from the 10^{th} year of planting can sequester carbon @ 46.9 t ha^{-1} $year^{-1}$.

Role of co-operative societies in black clam fishery and trade in Vembanad Lake

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Lime shells and live clams are distributed in large quantities in the backwaters and estuaries of Kerala. Vembanad, the largest lake of Kerala, also holds a vast resource of lime shells and live clam, comprising several species. The major species that account for the clam fishery of Vembanad Lake is the black clam *Villorita cyprinoides.* The lime shells that contribute to the fishery are broadly classified as the 'white shells' and the 'black shells'. The so-called 'white shells' are sub-soil deposits of fossilized shells and are known to extend upto 7 feet below the lake bottom. The black shells are obtained from the living population of *V. cyprinoides*, which contribute more than 90% of the clams from this lake.

The lime shell is mainly used for the manufacture of cement, calcium carbide and sand lime bricks. They are also used for lime burning, for construction, in paddy field / fish farms for neutralizing acid soil and as slaked lime. This is used as a raw material for the manufacture of distemper, glass, rayon, paper and sugar.

Shell Control Act

The Government of India has listed lime shell as a minor mineral under the Mineral Concession Rules, 1949, Section 5 of the Mines and Minerals. The acquisition, sale, supply and distribution of lime shell in the State are at present controlled by the Kerala Lime Shells Control Act, 1958. According to this act, licenses for collection of lime shells should be issued only in favor of co-operative societies formed exclusively of lime shell fishermen. Though the first co-operative society started functioning in 1945, all the black clam co-operative societies were brought under the provisions of the Act after 1958. At present, there are 11 lime shell industrial co- operative societies in the Vembanad area, out of which eight organize black clam lime shell fishery (Fig. 1) and three white shell fishery. This article concentrates only on the functioning and activities of black clam lime shell co-operative societies.

Fig. 1. Location of black clam lime shell industrial co-operative societies

Black clam lime shell industrial co-operative societies

The black clam lime shell industrial co-operative societies are located in Kottayam and Alappuzha districts that flank Vembanad Lake. Almost four to five clam fishing villages come under the jurisdiction of each society. The area allotted for each society and other details, obtained from the records maintained by the societies are given in Table 1.

Though a total of 4,163 licenses were issued for black lime shell fishing, only 2,980 are actually recorded as engaged in fishing. The societies collect the shell from clam fishermen at the rate of

Table 1. Details on black clam lime shell industrial co-operative societies

Name of the society	Year of establi-shment	Regis-tration No.	No. of staff	No. of average members		Annual shell produ-ction (tonnes)	Value (in Rs. lakhs)		Area covered	Establish-ment cost (in lakhs)
				Registered	Functioning		Purchase	Sale		
Vechoor Black Clam Lime Shell Industrial Co-operative Society	1945	2407	1	250	110	2189	31.74	37.21	Vechoor Thalayazham Kumarakom	2.20
Aaryad Black Clam Lime Shell Industrial Co-operative Society	1946	2462	2	583	560	3236	49.99	58.11	Mannanchery Komalapuram Aaryad North Aaryad South	2.53
Muhamma Black Clam Lime Shell Industrial Co-operative Society	1948	2551	2	525	474	22000	152.01	168.94	Thanneermukkom South Thanneermukkom North Cherthala Kokkothamangalam	3.39
Pallippurathussery Black Clam Lime Shell Industrial Co-operative Society	1951	3145	2	428	190	5456	73.29	82.66	Vaikom Naduvilepakuthi Vadakkemuri Kulasekharamangalam Chempu	3.61
Thycauttussery Black Clam Lime Shell Industrial Co-operative Society	1968	A239	2	855	600	2963	44.45	58.34	Pallippuram Thycauttussery Panavally Vayalar	3.30
Kuthiathode Black Clam Lime Shell Industrial Co-operative Society	1969	A193	2	745	560	5960	79.0	96.30	Aroor Kodamthuruthu Ezhupunna Thuravoor North Thuravoor South	3.33
Kavalam Black Clam Lime Shell Industrial Co-operative Society	1994	A886	1	252	76	700	9.67	11.98	Kavalam Kainakary Pulimkunnu Kunnumma	1.68
Muhamma Clam Marketing, Processing and General Marketing Co-operative Society	2002	A1078	1	525	410	3688	48.50	56.57	Thanneermukkom South Thanneermukkom North Cherthala Kokkothamangalam	2.11
Total			13	4163	2980	46192	488.65	570.11		22.15

Rs. 28-31 per kg. A total of 46,192 t of black clam shells were sold, mainly to the carbide factories of Tamil Nadu through the societies during 2008-09, which is worth a total sale value of Rs. 570 lakhs. The societies earn a margin from the sale of shells which forms the working capital for the society. Few societies also sell the shells to agriculturists through Krishi Bhavans at a price of Rs. 26-28 per kg.

Benefits to fishermen from society

The societies are involved in the implementation of welfare schemes for the members based on their fishing output. During lean period, when fishing is not possible, the society supplies 4 kg rice to fishermen per tonne of clam sold during the fishing season to the society. The society gives a maximum credit facility of Rs. 5,000 to the members at an interest rate of 4.5% per month to purchase fishing craft or gear or for the maintenance of canoes. The society has a welfare fund, from which members can avail financial assistance during emergencies such as medical treatment, marriage or death. There is a provision for festival allowance also. A bonus of Rs. 1.50 to 2.00 is given to the members for each 20 kg of lime shell sold to the society. The society also takes initiatives in motivating them to join in saving and insurance schemes of Government agencies. The installment for the same is deducted out of the earning of each fisherman from the sale of shell and the balance is handed over. Societies provide merit scholarships for the children of its members. After a considerable period of selfless service, recently these societies got a grant of Rupees 1 Crore sanctioned from the Government of Kerala, which would be utilized for purchase of canoes, utensils and initiation of re-laying practices in demarked areas.

Problems of fishermen/societies

It was observed from a survey conducted among the clam fishermen of the Vembanad Lake, that only 65% of the respondents were satisfied with the present functioning style of the society. Almost 27% were moderately satisfied and 13% were not satisfied. The dissatisfaction among the members is mainly due to the low staff strength in the societies, which affects its regular and effective functioning. The respondents also expressed their concern over the illegal fishing by non-licensed persons, indiscriminate fishing of juveniles and also the illegal excavation of white shells. Hence, as a management measure for the sustainable development of black clam fishery, more number of black clam lime shell co-operative societies with sufficient staff strength need to be started. It is desirable for the benefit of members that the lime shell co-operative societies pay attention to the whole business of collecting the lime shell, burning it to lime, transporting, marketing and also in making handcrafted curios out of these shells for catering to the tourism industry.

Production and growth of cultchless oyster spat of *Crassostrea madrasensis* (Preston) for single oyster culture

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In India, edible oyster (*Crassostrea madrasensis*) farming is being practised by several farmers in central Kerala employing the rack and ren method in the estuaries and backwaters. However, farmed oysters do not find ready marketability due to the high labour costs involved in handling and shucking. The Central Marine Fisheries Research Institute, Cochin, Kerala, has developed the hatchery technology for edible oyster spat production, both cultched and cultchless. Nevertheless, these have not been commercialised due to the fact that spat collection from wild is still the most feasible option in oyster farming. The aim of the present study was to produce cultchless spat in the farm site itself and rear it to commercial size for harvesting uniform sized regular, rounded single oysters.

Cultchless oysters have several advantages over attached oysters for both commercial and research applications. Advantages include superior shape, uniformity, ease of transportation and shucking and elimination of costs of handling cultch materials (Dupuy and Rivkin, 1972). In hatcheries/ laboratories, cultchless oysters can be easily handled and measurements are not hampered by the attached cultch. Uniformly shaped and rounded single oysters have great aesthetic appeal and are in great demand in European and south-east Asian cuisines.

The edible oyster (*C. madrasensis*) spat production and farming were carried out in the Moorad Estuary. The Moorad Estuary is located between 11° 32' N 11° 35' and 75° 35' to 75° 40' S along north Kerala. It is a small estuary with a water spread area of about 1.4 km^2 supporting a vibrant fishery of finfish and bivalves.

In a preliminary experiment, clam shells (*Meretrix casta*) were stocked in netlon cages (1 mm mesh) and suspended in the rack in the Moorad Estuary during January 2004. Spat fall began in February and profuse spat fall occurred in March. The clamshells served as very good cultch for the edible oyster spat and profuse spat settlement occurred on these shells. After nearly three weeks of growth, the clam shell invariably gets dislodged, the spat therefore become cultchless (Fig. 1).

The growth of these spat was rapid and regular rounded oysters could be grown to marketable size.

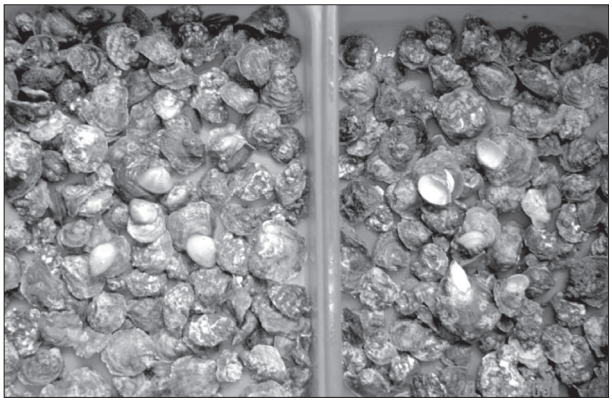

Fig. 1. Cultchless oyster spat produced on clamshells in the CMFRI Integrated bivalve research cum demonstration farm

The average total length of the spat in April was 26.76 cm. They attained average total length and weight of 70.04 mm and 70.94 g respectively in January. The instantaneous growth was 43.13 mm in 8 months with a growth rate of 5.41 m per month; the instantaneous growth in terms of weight was 62.5 mm in 7 months with weight gain of 8.93 g per month. The growth of the oysters was rapid during May - June attaining 11.7 mm and 15.1 g in June. However, during July-August, the growth declined due to drop in salinity. Growth recovered after monsoon and in November, the growth increments were 12.2 mm and l9.3 g in January, while the growth in terms of length stabilised, the weight gain was tremendous with total weight increment of 14.9 g. The oysters had attained perfectly round and regular edges and significant weight for the marketable size as those preferred in European countries (Fig. 2).

Fig. 2. Single oysters grown in the integrated bivalve research cum demonstration farm of CMFRI

The experiment was repeated using different spat collectors in 2006. Four substrates were stocked at 200 numbers per 0.5 m^2 netlon cages *viz*.,

1) Clam shells (*M. casta*) of medium size having average length of 25 mm
2) Clam shells (*M. casta*) of small size having average length of 15 mm
3) Lime coated clam shells of 25 mm size and
4) Broken shell pieces of green mussels

These were suspended in the integrated bivalve farm set up in Moorad Estuary in January 2006 and examined every month for spat settlement.

It was observed that medium sized clam shells of *M. casta* of average size 25 mm gave best results in terms of percentage of settlement compared to small clam shells, lime coated shells and mussel shell bits (Table 1). Also, in all cases, except in lime coated shells, percentage of settlement of spat was higher on the inner side of the shell. In lime coated shells also, it was only marginally higher on the outer surface of the clam shells, probably due to the lime coating.

A total of 485 oyster spats were thus collected during the experiment. The spats were further transferred to specially designed wooden cages for single oyster culture. A three tier cage was fabricated using netlon (>10 mm) as the base and also with wooden panel support. Three such trays were stocked with the cultchless spat and tied together to form one unit and suspended in the farm for further rearing. Four such units were stocked with cultchless spat for further rearing. The growth was monitored. The details of the growth of single oysters are given in Table 1.

Table 1. Experiments for spat collection for single oyster culture: Moorad Estuary 2006

A. Small clam shells (15 mm)

	No. of shells	No. of spat on inner side	No. of spat on outer side	Total no. of spat	% settlement	% settlement on inner side	% settlement on outerside
1	200	10	6	16	8.0	62.5	37.5
2	200	9	12	21	10.5	42.9	57.1
3	80	16	5	21	26.3	76.2	23.8
4	178	19	8	27	15.2	70.4	29.6
5	177	18	3	21	11.9	85.7	14.3
Total / Mean	835	72	34	106	14.4	67.5	32.5

B. Medium sized clam shells (25 mm)

	No. of shells	No. of spat on inner side	No. of spat on outer side	Total no. of spat	% settlement	% settlement on inner side	% settlement on outerside
1	88	1	13	14	15.9	7.1	92.9
2	57	30	8	38	66.7	78.9	21.1
3	57	47	8	55	96.5	85.5	14.5
4	26	8	7	15	57.7	53.3	46.7
5	200	28	27	55	27.5	50.9	49.1
6	155	7	7	14	9.0	50.0	50.0
Total / Mean	583	121	70	191	45.5	54.3	45.7

C. Lime coated clam shells (25 mm)

	No. of shells	No. of spat on inner side	No. of spat on outer side	Total no. of spat	% settlement	% settlement on inner side	% settlement on outerside
1	200	2	3	5	2.5	40.0	60.0
2	200	24	16	40	20.0	60.0	40.0
3	200	10	18	28	14.0	35.7	64.3
4	200	16	12	28	14.0	57.1	42.9
5	192	5	7	12	6.3	41.7	58.3
6	194	7	7	14	7.2	50.0	50.0
7	180	10	8	18	10.0	55.6	44.4
Total/ Mean	1366	74	71	145	10.6	48.6	51.4

D. Mussel shell bits

	No. of shells	No. of spat on inner side	No. of spat on outer side	Total No. of spat	% settlement	% settlement on inner side	% settlement on outerside
1	100	31	12	43	43.0	72.1	27.9

E. Growth of single oysters in wooden cage

Cages	Avg TL mm	Avg T Wt g	Meat %	Max TL mm	Min TL mm	Total nos.	% Mortality
1	64.1	52.5	8	84	36	61	35.7
2	64.4	48.7	-	85	48	45	49.0
3	59.1	37.2	-	76	44	55	44.6
4	58.5	39.0	-	79	32	21	76.0

A total of 373 single oysters were reared in the farm. However, 182 single oysters of regular rounded shape were harvested at the end of the experiment. The experiment had to be terminated in June due to the onset of monsoons. There was heavy mortality with the drop in salinity in June. The single oysters attained an average total length of 62 mm and average total weight of 44 g.The maximum length recorded was 85 mm and minimum length 32 mm. The meat content was 8%. The mortality recorded was 51%.

The salinity at the farm site during the culture period ranged from 32 ppt in February to 38 ppt in March – April. The pH ranged from 7.14 in May to 8.26 in January, gross productivity ranged from 2.56 g C m^{-3} day^{-1} in February to 6.52 g C m^{-3} day^{-1} in March and the net productivity ranged from 0.25 g C m^{-3} day^{-1} in May to 1.88 g C m^{-3} day^{-1} in January.

Further experiments to standardise and upgrade this system for large-scale production of single oysters are necessary. This will significantly enhance production and provide uniform sized, regular shaped single oysters for the "half shell" raw oyster market. Further, value addition of these can be done to supply "flash frozen, half shell" products for the International Pacific Rim markets. Farmers are certainly looking forward to a simplified farming technology wherein handling of oysters during shucking, transportation and processing is less arduous and more economical besides providing an appealing product.

Finfish diversity in the trawl fisheries of southern Kerala

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Among the maritime states of India, Kerala with a coastline of 590 km and 39,139 sq km of continental shelf area enjoys the distinction of being the foremost marine producer and exporter. The potential yield of the area up to 200 m depth has been estimated to be about 8 lakh tonnes.

Kerala records an average production of 5,74,984 t of fish annually (1995-2004). The estimated marine fish landing of Kerala during 2006 was 5.92 lakh tonnes which highlights an enhanced rate of over 10% caught in 2005 against the total production of 2.71 million tonnes recorded in India during 2006. Normally the catch is harvested by a variety of craft and gear combinations. Marine fishing using artisanal gears is an age-old tradition and in Kerala there are 9,522 such units in operation. Motorisation with the outboard engines was the next phase of development and it played a vital role in the process of progress in fisheries. There are 14,151 units operating at present in Kerala. The next phase is mechanisation with inboard engines and there are 5,504 boats engaged in fishing. The trawlers constitute 72% (3,982) of the mechanised boats in Kerala.

The value of the annual marine fish catch in the domestic market realised at primary level (landing centre) is Rs.2,901 crores and at secondary level Rs. 4,855 crores. During the year 2006, India earned 1,479 million US $ (Rs.6, 647 crores) as foreign exchange by exporting 4, 61,229 mt of marine products and Kerala contributed 17% (87,378 mt) in terms of 257million US $ (Rs. 1,158 crores).

The fisherfolk population of the state is 6, 02,234 living in 1, 20,486 families spread over 222 fishing villages, of which 3, 04,308 are males and 2,97,926 are females. The literacy rate among the population is 73% as per the Marine Census 2005. There are 178 fish landing centers in Kerala. A total of 1, 24,103 fishers are engaged in fishing full time; 10,488 part time and 5,631 as occasional workers.

Marine fish catches of southern Kerala are mainly landed at Cochin and Sakthikulangara-Neendakara fisheries harbours. Apart from these two, there are a number of small harbours where mechanised boats land their catch such as Munambam, Azhikkal, Ponnani and Beypore. Other than these, there are 178 fish landing centers and many small landing jetties used by the mechnised boats to land their catch.

The marine fishery of Kerala is dominated by trawls. The trawl fishery contributes to the major share of the marine fish catch and the landing is composed of more fish varieties when compared to any other fishing gear. Trawl landings are concentrated at Quilon, Ernakulam and Calicut districts due to the availability of harbour facilities.

Due to the ever increasing pressure to maximize their returns trawl operators have recently, expanded their trawl fishing grounds to deeper areas by equipping their vessels with electronic fishing aids such as fish finders and Global Positioning Systems.

Craft and gear

Trawl net is the most effective gear to exploit demersal resources. Mostly medium sized vessels (8-20 m with 100-120 HP engines) operate trawl net to exploit the marine crustaceans, cephalopods and demersal finfishes from inshore to deeper sea grounds in Kerala. Generally, the trawlers use two-seam and four-seam trawl net with the head rope of 30-40 m length and 3-5 m vertical opening, with the cod end mesh size of 18-30 mm. Right from the mid-eighties, most of the trawl units switched over to multiday fishing operations, extending up to 80-120 m depth to exploit the mid-shelf grounds and the operational cost is reduced to a certain extent by using a combination of both day and night fishing.

Since the year 2000, the fishermen of Kerala have been engaged in deep sea trawling up to 450 m depth employing vessels of 14-19 m overall length (OAL) equipped with 100-180 HP engines. The winch drum has been changed to accommodate up to 1,800 m of wire rope. The thickness of the wire rope has been increased to about 10 mm and the head rope length to 40 m. By minimizing the number of floats on the head rope and by reducing the trawling speed, these vessels are able to operate the net at greater depths.

Generally, 6-8 crew members go for fishing in each trip which lasts up to 2-3 days in the beginning of the season. As the season advances, the fishing vessels stay away from the harbours even up to 5-6 days. Some of the small sized vessels still conduct single day fishing.

Fishing areas

The trawlers conduct targeted fishery for prawns off Kanyakumari in the south and Beypore (Calicut) in the north during peak prawn season (November to March) up to 400 m. The rest of the period they do trawling in the coastal inshore and offshore waters up to the depth zone of 200 m.

The trawlers from Neendakara area generally do the fishing in the grounds lying between Kayamkulam and Anjuthengu and off Cape Comorin region.

Quilon Bank

The more productive fishing area in the south-west coast is the "Quilon Bank" lying between 08° N and 09° N lat. in the depth range of 275-375 m off Quilon- Alappuzha, covering an area of 3,300 sq. km. The depth zones off Kerala coast are shown in Fig. 1.

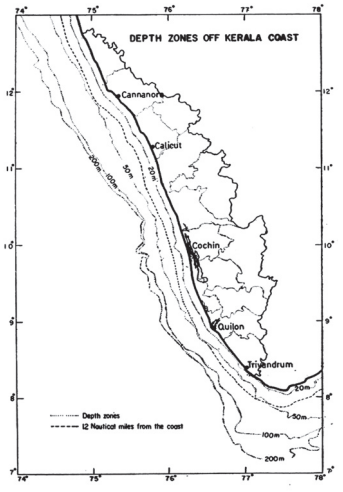

Fig. 1. Depth zones off Kerala coast (CMFRI, 1986)

Wadge Bank

The existence of good fishing ground in the "Wadge Bank" off Cape Comorin coast is well known to the fishermen of Kerala.

Perch grounds

The productive fishing ground for Kalava (Perches) is observed towards the north-west of Cochin off Chettuwa and Ponnani in the depth zone of 70-200 m.

Fishing season

The trawl fishery usually commences by September or October immediately after the south-west monsoon and extends throughout the year except during the mandatory fishing ban period.

Methodology

The present study was conducted for one year (*i.e.*, from January to December, 2006) in four major trawl landing centres *viz*., Cochin, Munambam, Kalamukku and Neendakara along the south-west coast of India. Fortnightly field observations were made to collect species composition of finfishes landed by trawlers and monthly and annual estimates of total landings were following the Stratified Multi-stage Random Sampling Technique formulated by Central Marine Fisheries Research Institute (Sreenath *et al*., 2005).

The diversity of finfishes was calculated following Shannon-Weiner (J1) and Pielou's evenness indices (J'). Since individual size of fish species differed greatly, the indices were expressed in terms of biomass and not in terms of number of individuals. Hill's abundance (N2) was used to examine the variation in the number of dominant species. Species richness was calculated following Margalef's index (d). The similarity in species composition was studied by calculating the Bray-Curtis Coeficient (Cluster analysis). The taxonomic distinctness (TD) was calculated for total species from presence/absence data. As these indices are helpful in finding out statistical deviation in biodiversity between the four centres, these were calculated for plotting 95% funnel and ellipse plots. However, all the diversity indices were done using the PRIMER V.5 analytical package developed by Plymouth marine Laboratory, UK.

Finfish catch from the trawl landing centers

The trawl landings of finfishes related to the in-house Project of the Marine Biodiversity Division, Code No. MBD/02 "Species diversity of the exploited marine finfish resources along the Indian coasts" were collected and the diversity studies were conducted mainly from four fish landing centers of southern Kerala, Sakthikulangara, Neendakara, Cochin and Munambam fisheries harbours and Kalamukku landing centre. The major fish landing centers of Kerala are marked in Fig. 2.

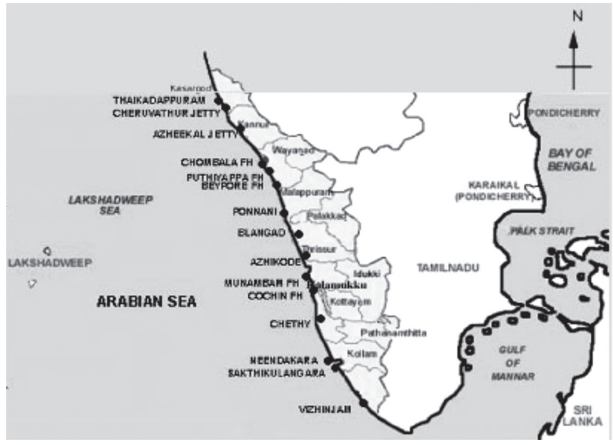

Fig. 2. Major fish landing centers of Kerala (CMFRI, 2007)

During the year 2006, the trawlers operated in the four centers landed a total catch of 70,788 t, of which the finfish resources constituted 81.6% (57,785 t). The Sakthikulangara- Neendakara centre landed 44.4% (25,635 t) of finfish catch followed by Munambam 28.3% (16,332 t), Kalamukku 16.1% (9,293 t) and Cochin 11.3% (6525 t).

Month-wise finfish catch in all the centers showed that finfishes were abundant during September-October (29.3%) and April-May (29.3%). The month-wise landings of finfishes are showed in Fig. 3.

Finfish family-wise distribution

The family Nemipteridae formed the major catch constituting 20.4% (11,801 t) followed by Carangidae 18.9% (10914 t), Trichiuridae 17.0% (9795 t), Engraulidae 10.2% (5903 t), Synodontidae 7.7% (4457 t). Other families contributing to over 1000 t are Cynoglossidae, Scombridae, Sciaenidae, Serranidae, Sphyraenidae, Clupeidae, Elasmobranchs

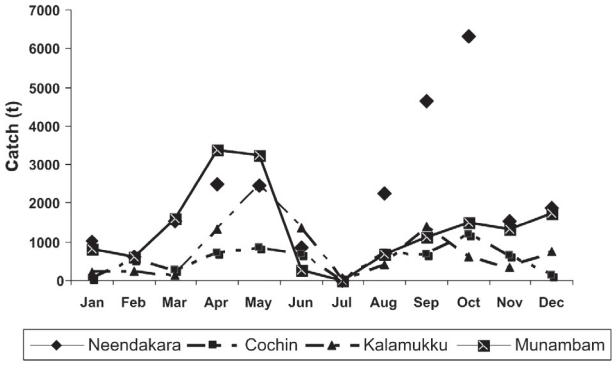

Fig. 3. Monthly catch of finfish in tonnes from four trawl landing centers of southern Kerala

and Leiognathidae. The family-wise catch is depicted in Fig. 4, 5a and 5b.

Center-wise trawl net catch composition

Finfishes from the trawl catches of Munambam were mainly composed of 12 families constituting 97.2% of the total. Nemipteridae formed 27.4% followed by Carangidae (19.5%), Engraulidae

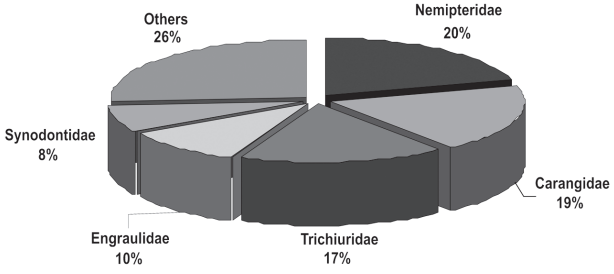

Fig. 4. Abundance of dominant families in the trawl landings

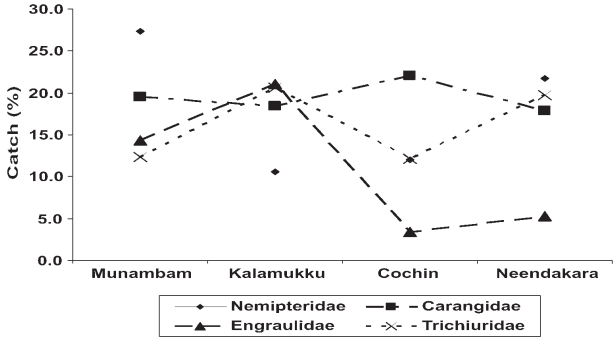

Fig. 5a. Catch percentage of major families in the four trawl landing centers

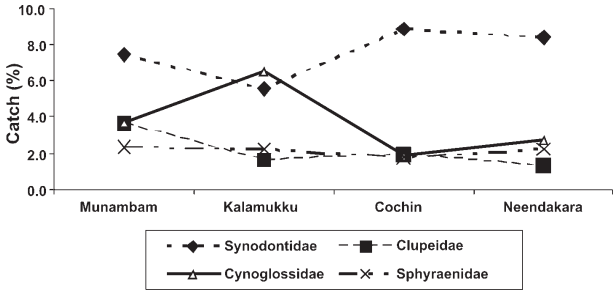

Fig. 5b. Catch percentage of major families in the four trawl landing centers

(14.4%), Trichiuridae (12.4%) and Scombridae (7.4 %) and the rest by other families.

Engraulidae, Trichiuridae, Carangidae and Nemipteridae were the four families, which contributed to 70% of the catch of Kalamukku. The other families such as Cynoglossidae, Synodontidae, Scombridae, Sciaenidae, Serranidae, Clupeidae and Leiognathidae formed more than 1% of the total finfish catch landed.

At Cochin Fisheries Harbour, 13 families constituted 83% of the total finfish catch in the trawl landings. Members of Carangidae contributed to (22.0%) followed by Trichiuridae and Scombridae (12.2% each) and Nemipteridae (12.0%) while the rest of the landings were by other families.

The major catch (73%) of Neendakara was formed by 5 families namely, Nemipteridae (21.7%), Trichiuridae (19.8%), Carangidae (17.8%), Synodontidae (8.4%) and Engraulidae (5.3%). Elasmobranchs and other 11 families were also significant in the trawl landings.

Diversity of finfish species

Finfishes landed by the trawlers in the four landing centers showed a wide diversity with 301 species belonging to 96 families. Neendakara exhibited the highest diversity with 223 species spread out in 81 families.

The highest number of species was represented in the family Carangidae with 28 species followed by Serranidae (17), Engraulidae (12), Leiognathidae (12), Lutjanidae (10) Sciaenidae (9), Nemipteridae (8), Bothidae (7) and Soleidae (7), Six families were recorded with 6 species each in Cynoglossidae, Gerreidae,

Mullidae, Platycephalidae and Scombridae. An equal number of 5 species was present in Dasyatidae, Rhinobatidae, Callionymidae and Clupeidae. Similarly, 4 species each in six families, 3 species in 12 families and 1 or 2 species in the rest of the families were observed.

Species diversity at Munambam was found to be higher in the family Carangidae with 21 species. Engraulidae and Sciaenidae were represented by 9 species each; Leiognathidae with 8, Serranidae with 7 and Nemipteridae with 6 species. The families with 4 species were Clupeidae, Mullidae and Scombridae. Three species each occurred in 5 families, 2 species in 12 families and only a single species in 33 families.

The number of species observed at Kalamukku was higher in the family Carangidae with 19 species followed by Engraulidae (11 species); Leiognathidae (8 species); Cynoglossidae (6 species), Clupeidae and Sciaenidae (5 species each). The families represented by 4 species were Nemipteridae Platycephalidae and Scombridae. Three species each occurred in 5 families, 2 species in 12 families and only a single species was encountered in 34 families.

At Cochin Fisheries Harbour, species diversity was observed to be higher in the family Carangidae with 18 species; Engraulidae 10 species; Lutjanidae, Scombridae and Serranidae with 7 species each and Nemipteridae with 6 species. The families represented by 5 species were Clupeidae, Leiognathidae, Platycephalidae and Sciaenidae while Rhinobatidae was composed of 4 species. Three species of each was recorded in 8 families, 2 species in 12 families and only a single species in 20 families.

At Neendakara, species diversity was higher in the Family Carangidae with 15 species followed by Engraulidae and Serranidae with 10 species each; 9 species per family in Leiognathidae and Lutjanidae and 8 species in Nemipteridae. The families with 6 species were Mullidae and Soleidae. There were 5 families each with 5 species and 2 families by 4 species. Three species were encountered in 15 families and 2 species each by twenty one families followed by a single species in 30 families (Fig. 6).

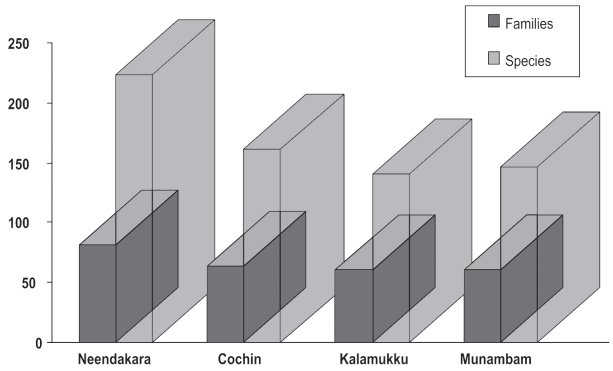

Fig. 6. Species diversity of finfish landed by trawlers in four trawl landing centers

Dominant species

In the trawl fishery the major species occurred were *Nemipterus randalli* with a catch of 9,729 t followed by *Lepturacanthus savala* with 8,277 t and *Decapterus russelli* with 8,083 t. Among dominant species, those which recorded catches of 500 t and above are given in Table 1. The species which occurred sporadically in the catches are listed in Table 2.

Table 1. Dominant species and their catches from trawl landing centers

Species	Catch (t)	%
Nemipterus randalli, Russell, 1986	9729	16.8
Lepturacanthus savala (Cuvier, 1829)	8277	14.3
Decapterus russelli (Rupell, 1830)	8083	14.0
Saurida tumbil (Bloch, 1795)	2519	4.4
Nemipterus japonicus (Bloch, 1791)	2045	3.5
Saurida undosquamis (Richardson, 1848)	1927	3.3
Cynoglossus macrostomus Norman, 1928	1782	3.1
Trichiurus lepturus Linnaeus, 1758	1518	2.6
Epinephelus diacanthus (Valenciennes, 1828)	1387	2.4
Sardinella longiceps Valenciennes, 1847	1157	2.0
Stolephorus commersonnii, (Lacepède, 1803)	1107	1.9
Stolephorus indicus (van Hasselt, 1823)	977	1.7
Encrasicholina devisi (Whitley, 1940)	951	1.6
Stolephorus waitei Jordan & Seale, 1926	947	1.6
Priacanthus hamrur (Forsskål, 1775)	946	1.6
Stolephorus insularis Hardenberg, 1933	896	1.6
Rastrelliger kanagurta (Cuvier, 1816)	832	1.4
Sphyraena obtusata Cuvier, 1829	795	1.4
Selar crumenophthalmus (Bloch, 1793)	653	1.1
Megalaspis cordyla (Linnaeus, 1758)	644	1.1
Other tunnies	635	1.1
Leiognathus daura (Cuvier, 1829)	584	1.0
Thryssa mystax (Bloch & Schneider, 1801)	536	0.9
Johnius glaucus (Day, 1876)	500	0.9

Table 2. Occurrence of species sporadically or rarely in the catches

Neoharriotta pinnata (Schnakenbeck, 1931)
Rhina ancylostoma Bloch & Schneider, 1801
Rhinobatos annandalei Norman, 1926
Torpedo marmorata Risso, 1810
Centrophorus granulosus (Bloch & Schneider, 1801)
Acanthurus sp.
Apistus sp.
*Apistus carinatus (*Bloch & Schneider, 1801)
Erisphex pottii (Steindachner, 1896)
Apogon kiensis Jordan and Snyder 1901
Apogon quadrifasciatus Cuvier, 1828
Arius thalassinus (Rüppell, 1837)
Arius subrostratus Valenciennes, 1840
Arius jello Day, 1877
Sufflamen fraenatus (Latreille, 1804)
Sufflamen sp.
Odonus niger (Ruppell, 1840)
Chascanopsetta lugubris Alcock, 1894
*Bothus pantherinus (*Rüppell, 1830)
Pseudorhombus natalensis Gilchrist, 1904
Bregmaceros mcclellandi Thompson, 1840
Dipterygonotus balteatus (Valenciennes, 1830)
Callionymus gardineri Regan, 1908
Callionymus marleyi Regan, 1919
Callionymus beniteguri Jordan & Snyder, 1900
Callionymus sp.
Callionymus carebares Alcock, 1890
Atule mate (Cuvier, 1833)
Carangoides uii / Carangoides coeruleopinnatus (Rüppell, 1830)
Carangoides armatus (Rüppell, 1830)
Carangoides ferdau (Forsskål, 1775)
*Carangoides talamparoides (*Bleeker,1852)
Ulua mentalis (Cuvier, 1833)
Uraspis secunda (Poey, 1860)
Trachinotus mookalee Cuvier, 1832
Psenopsis cyanea (Alcock, 1890)
Carangoides coeruleopinnatus (Rüppell, 1830)
Acanthocepola limbata (Valenciennes, 1835)
Chaetodon modestus Temminck & Schlegel, 1844
Chaetodon marleyi Regan, 1921
Heniochus diphreutes Jordan, 1903
Chlorophthalmus puncatatus Gilchrist, 1904
Chlorophthalmus agassizi Bonaparte, 1840
Chloropthalmus bicornis Norman, 1939
Cirrhitus sp.
Sardinella gibbosa (Bleeker, 1849)
Conger cinereus Rüppell, 1830
Cynoglossus puncticeps (Richardson, 1846)
Paraplagusia sp.
Dactyloptena orientalis (Cuvier, 1829)
Dactyloptena peterseni (Nyström, 1887)
Drepane punctata (Linnaeus, 1758)
Echeneis naucrates Linnaeus, 1758
Stolephorus baganensis Hardenberg, 1933
Thryssa dussumieri (Valenciennes, 1848)
Emmelichthys nitidus nitidus Richardson, 1845
Erythrocles schlegelii (Richardson,1846)
Platax teira (Forsskål, 1775)
Platax orbicularis (Forsskål, 1775)
Cypselurus poecilopterus (Valenciennes, 1847)
Fistularia petimba Lacepède, 1803
Fistularia commersonii Rüppell, 1838
Neoepinnula orientalis (Gilchrist and von Bonde, 1924)
Rexea prometheoides (Bleeker, 1856)
Gerres limbatus Cuvier, 1830
Gerres oyena (Forsskål, 1775)
Gerres longirostris (Lacepède, 1801)
Pentaprion longimanus (Cantor, 1849)
Caffrogobius sp.
Taenioides cirratus (Blyth, 1860)
Plectorhinchus albovittatus (Rüppell, 1838)
Sargocentron melanospilos (Bleeker, 1858)
Sargocentron rubrum (Forsskål, 1775)
Hologymnosus annulatus (Lacepède, 1801*)*
Xyrichtys pentadactylus (Linnaeus, 1758)
Leiognathus leuciscus (Gunther, 1860)
Lobotes surinamensis (Bloch, 1790)
Lophiodes mutilus (Alcock, 1894)
Lutjanus johnii (Bloch, 1792)
Lutjanus kasmira (Forsskål, 1775)
Pinjalo pinjalo (Bleeker, 1850)
Lipocheilus carnolabrum (Chan, 1970)
Lutjanus lutjanus Bloch, 1790
Megalops cyprinoides (Broussonet, 1782)
Gymnothorax enigmaticus Mc Coster & Randall, 1982
Scolopsis vosmeri (Bloch, 1792)
Scolopsis bimaculatus Rüppell, 1828
Scolopsis aurata (Park, 1797)
Pisodonophis cancrivorus (Richardson, 1848)
Brotula multibarbata Temminck &Schlegel,1846
Pseudorhombus elevatus Ogilby, 1912
Histiopterus typus Temminck & Schlegel, 1844
Chrionema chlorotaenia McKay, 1971
Satyrichthys adeni (Lloyd, 1907)
Parapercis nebulosa (Quoy & Gaimard, 1825)
Parapercis punctulata (Cuvier, 1829)

Parapercis robinsoni Fowler, 1929
Parapercis hexophthalma (Cuvier, 1829)
Cociella crocodila (Tilesius, 1812)
Plotosus canius Hamilton, 1822
Plotosus lineatus (Thunberg, 1787)
Neopomacentrus nemurus (Bleeker, 1857)
Pristigenys niphonia (Cuvier, 1829)/
Pronotogrammus multifasciatus Gill, 1863
Pellona ditchela(Valenciennes, 1847)
Samaris cristatus Gray, 1831
Samaris macrolepis Norman, 1927
Samaris sp.
Johnius carutta Bloch, 1793
Johnius aneus (Bloch, 1793)
Umbrina canariensis Valenciennes, 1843
Otolithoides biauritus (Cantor, 1849)
Dendrochirus zebra (Cuvier, 1829)
Dendrochirus brachypterus (Cuvier, 1829)
Scorpaena neglecta Temminck & Schlegel, 1843
Pterois sp.
Epinephelus bleekeri (Vaillant, 1878)
Epinephelus chlorostigma (Valenciennes, 1828)
E*pinephelus longispinis* (Kner, 1864)
Epinephelus undulosus (Quoy and Gaimard, 1824)
Epinephelus quoyanus (Valenciennes, 1830)
Holanthias rhodopeplus (Gunther, 1872)
Pseudanthias fasciatus (Kamohara, 1954)
Pseudanthias sp.
Sacura boulengeri (Heemstra, 1973)
Anthias sp.
Variola louti (Forsskål, 1775)
Brachirus annularis Fowler, 1934
Aesopia cornuta Kaup, 1858
Solea bleekeri Boulenger, 1898
Minous monodactylus (Bloch & Schneider, 1801)
Terapon puta Cuvier, 1829
Pelates quadrilineatus (Bloch, 1790)
Lagocephalus inermis (Temminck & Schlegel, 1850)
Lagocephalus lagocephalus lagocephalus (Linnaeus, 1758)
Lagocephalus lunaris (Bloch & Schneider, 1801)
Chelonodon laticeps Smith, 1948
Triacanthus biaculeatus (Bloch, 1786)
Triacanthus nieuhofii Bleeker, 1852
Pseudotriacanthus strigilifer (Cantor, 1849)
Uranoscopus archionema Regan, 1921
Zanclus cornutus (Linnaeus, 1758)
Zenopsis conchifera (Lowe, 1852)

Diversity indices

The results of various diversity indices calculated are given in Table 3, 4 and 5. In line with the higher number of species and their abundance, Shannon diversity (H'($\log_e$) was more in Cochin (3.31) than in Munambam (2.91). Therefore, the Shannon–Weiner diversity, which is widely used for comparing diversity between various habitats, clearly showed the diverse nature of these centres (2.9-3.3). Similarly, the evenness (J') of species was also more in Cochin (0.70). However, Margalef's species richness (d) showed clear differences between the centres. Further, the variations in taxonomic distinctness (ϕ+) and in the number of dominant species (N_2) were more in Cochin. The dendrogram (Fig. 7) drawn, clearly revealed the separate grouping of these centres with Munambam and Kalamukku forming a distinct group. The similarity in species composition and abundance among centres was in the range 55.88-72.34 (Table 5). The 95% confidence funnel generated for the variation in taxonomic distinctness values of all centres is shown in Fig. 8 and 9. This reveals that the centres *viz*., Kalamukku and Munambam fell within the confidence funnel showing no deviation from normal distribution while Cochin and Neendakara with exploitation of more numbers of species have shown deviation from the normal distribution. The ellipse plot also has clearly shown significant departure of centres such as Munambam and Kalamukku from those at Neendakara and Cochin. Therefore, samples of Cochin and Neendakara fell away from 95% contours, showing significant statistical deviations. The 95% funnel drawn and the ellipse plot also clearly separated the samples of Cochin and Neendakara from the Munambam and Kalamukku group.

As per the Marine Fisheries Census 2005, the number of trawlers operated off Quilon area is 1259.

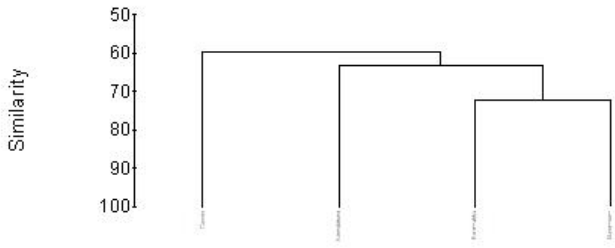

Fig. 7. Dendrogram of finfishes recorded in various trawl landing centres of Kerala showing grouping of centres.

Table 3. Month-wise diversity indices of finfish in different trawl landing centres of Kerala during 2006

Munambam

Month	Species	Quantity	Species richness	Pielou's evenness	Shannon	Simpson	Hill's abundance	
	S	N	d	J'	H'	1-Lambda'	N1	N2
Jan	39	803	5.68	0.80	2.93	0.91	18.65	11.39
Feb	22	630	3.26	0.72	2.22	0.84	9.23	6.15
Mar	32	1593	4.20	0.74	2.55	0.87	12.86	7.45
Apr	35	3385	4.18	0.68	2.43	0.85	11.36	6.64
May	37	3252	4.45	0.57	2.05	0.73	7.77	3.76
Jun	14	280	2.31	0.60	1.59	0.68	4.93	3.09
Aug	9	683	1.23	0.39	0.86	0.40	2.36	1.66
Sep	11	1117	1.42	0.61	1.46	0.73	4.29	3.66
Oct	30	1507	3.96	0.38	1.30	0.53	3.65	2.13
Nov	40	1339	5.42	0.72	2.65	0.90	14.22	9.93
Dec	55	1741	7.24	0.66	2.66	0.85	14.34	6.58

Kalamukku

Month	Species	Quantity	Species richness	Pielou's evenness	Shannon	Simpson	Hill's abundance	
	S	N	d	J'	H'	1-Lambda'	N1	N2
Jan	28	248	4.90	0.85	2.83	0.92	17.03	11.74
Feb	35	228.6	6.26	0.66	2.33	0.83	10.28	5.87
Mar	32	128.3	6.39	0.73	2.54	0.88	12.65	8.01
Apr	33	1329	4.45	0.56	1.97	0.68	7.20	3.08
May	44	2452	5.51	0.70	2.65	0.88	14.13	8.47
Jun	23	1379	3.04	0.61	1.91	0.76	6.78	4.22
Aug	11	426	1.65	0.49	1.18	0.55	3.24	2.21
Sep	18	1414.5	2.34	0.14	0.42	0.16	1.52	1.19
Oct	31	612	4.68	0.54	1.87	0.71	6.48	3.47
Nov	41	339.5	6.86	0.77	2.86	0.91	17.49	10.74
Dec	37	736	5.45	0.75	2.69	0.86	14.73	6.99

Cochin Fisheries Harbour

Month	Species	Quantity	Species richness	Pielou's evenness	Shannon	Simpson	Hill's abundance	
	S	N	d	J'	H'	1-Lambda'	N1	N2
Jan	31	73.8	6.97	0.76	2.59	0.91	13.39	9.35
Feb	37	549.5	5.71	0.77	2.76	0.91	15.85	11.34
Mar	41	262.7	7.18	0.76	2.81	0.90	16.62	9.52
Apr	62	713.6	9.28	0.64	2.66	0.81	14.24	5.26
May	49	853.45	7.11	0.57	2.23	0.81	9.28	5.36
Jun	48	671	7.22	0.65	2.52	0.79	12.40	4.72
Aug	19	723	2.73	0.57	1.67	0.68	5.31	3.10
Sep	31	692.5	4.59	0.53	1.83	0.65	6.25	2.83
Oct	47	1201	6.49	0.73	2.80	0.89	16.37	8.90
Nov	46	644.5	6.96	0.68	2.60	0.84	13.48	6.31
Dec	51	138	10.15	0.83	3.27	0.94	26.26	16.10

Neendakara

Month	Species	Quantity	Species richness	Pielou's evenness	Shannon	Simpson	Hill's abundance	
	S	N	d	J'	H'	1-Lambda'	N1	N2
Jan	44	1011	6.22	0.70	2.66	0.87	14.28	7.68
Feb	50	631	7.60	0.78	3.06	0.90	21.29	10.17
Mar	57	1528.2	7.64	0.74	2.99	0.91	19.93	10.77
Apr	61	2486	7.67	0.72	2.96	0.92	19.22	12.14
May	58	2459.5	7.30	0.69	2.79	0.88	16.25	8.57
Jun	45	864.2	6.51	0.68	2.58	0.84	13.15	6.10
Aug	22	2240	2.72	0.56	1.74	0.72	5.72	3.58
Sep	39	4658	4.50	0.54	1.99	0.70	7.35	3.37
Oct	59	6315	6.63	0.69	2.81	0.89	16.58	8.81
Nov	50	1550	6.67	0.83	3.26	0.95	26.13	18.41
Dec	52	1888	6.76	0.82	3.22	0.94	25.13	15.80

Table 4. Diversity indices of finfish in various trawl landing centres of Kerala

Centre	Species	Quantity	Species richness	Pielou's evenness	Shannon	Simpson	Hill's abundance	
	S	N	d	J'	H'(loge)	1-Lambda'	N1	N2
Neendakara	131	25633.7	12.8057	0.6550	3.1936	0.9126	24.3763	11.4473
Cochin	108	6220	12.2488	0.7082	3.3159	0.9326	27.5484	14.8169
Kalamukku	80	9299	8.6455	0.6835	2.9951	0.9105	19.9881	11.1693
Munambam	87	16330	8.86528	0.6528	2.9156	0.9006	18.4612	10.0574

Table 5. Bray - Curtis similarity for finfish collected from different trawl centres in Kerala

	Neendakara	Cochin	Kalamukku	Munambam
Neendakara	0	0	0	0
Cochin	55.88106264	0	0	0
Kalamukku	58.86174983	63.32622	0	0
Munambam	67.57236321	59.95855	72.34073281	0

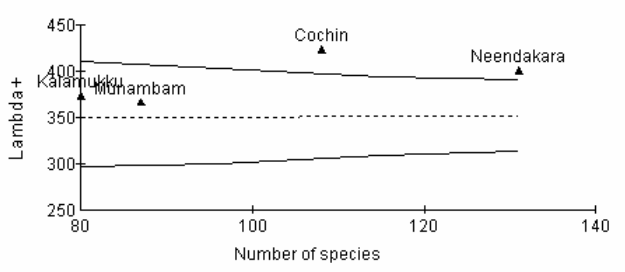

Fig. 8. The 95% confidence funnel for variation in taxonomic distinctness values (lambda +) showing diversity of finfishes and deviation from normal distribution.

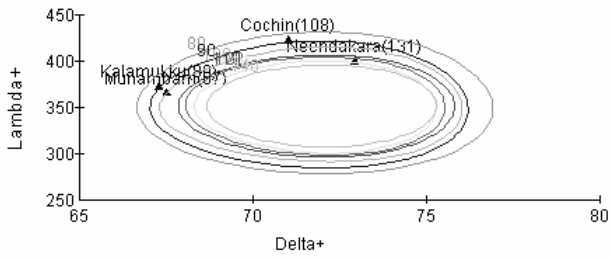

Fig. 9. 95% probability contour of average taxonomic distinctness (delta+) and variation in taxonomic distinctness (lambda+), showing statistically significant deviation in fish diversity between centres.

The number of trawl nets stationed at Neendakara is 166 and in Sakthikulangara 178. During 2005, the number of MDT trawlers landed from August to September alone changed from 17 to 68 per day and the highest number of 68 observed was on 22nd August. Usually the observations were made for a day from 0600 to 1200 hrs in the morning and 1200 to 1800 h in the afternoon. The depth of operation

varied from 60 to 284 m and the approximate fishing hours estimated were 10-70. Single day trawl operations were very high during August constituting 189-192 per day and the largest number 192 was landed on 29th August. Trawl fishing was done in a depth zone ranging from 20 to 96 m for an average duration of 4-10 h. It is observed that the capacity of the MDTN is approximately, 6000-7000 kg while that of the MTN is 1000 kg (Table 6).

Table 6. Trawlers landed at the main centres

Details	Landing centres			
	NDK	CFH	KAL	MBM
No. of trawlers	1,259		——1,403 ——	
No. of trawl operations per day	160-200	About 100	Below 100	Above 100
Main fishing grounds –Depth (m)	MDTN - 40-284	24-300	30-320	40-270
	MTN - 16-100	-	10-22	12-22
Storage capacity (kg)	MDTN – 6,000-7,000 kg.	——7000 kg. ——		
	MTN - 1,000 kg.		——1000 kg.——	
Range of HP	MDTN – 9-160	100-16	00-120	100-120
	MTN - 90-160	90	190	90

The number of trawl operations was entirely different in 2006 with the highest number of 134 multiday trawlers landed per day in September (8th Sept. 2006) and the number fluctuated from 14 per day to over 130. In the case of single day trawlers, the biggest number 152 was recorded in August (23rd August) from a mere total of 33 per day observed during the second week of September. The depth of operation for multiday trawlers varied from 40 to 256 m and the duration showed approximately 8 to 48 h. While in the case of single day trawlers, the depth zone never went beyond 20 to 100 m for a fishing duration of 4 to 10 hrs. However, it is very significant to note that a staggering number of 221 trawlers comprising of both MDTN and MTN were landed on a single day in September 2006 (26th Sept. 2006: 89 MDTN + 132 MTN) at Neendakara. The number of trawlers landed showed a change from 49 per day onwards.

At Cochin Fisheries Harbour, during 2005 the number of MDTN operated in the fishing grounds off Cochin varied from 4 to 81 at CFH, 2-17 at Munambam and 3-35 at Kalamukku landing centres per day and the average depth zone of fishing varied from a shallow region of 30 m upto a deeper zone of 320 m. In the year 2006, the trawlers employed were comparatively more at CFH, from 20 to 63 per day. The landing from the MDTN of the other centers remained more or less the same recording 4 - 20 and 10 - 28 respectively for a similar depth range of 24-320 m.

The present findings agree with the resource characteristics of the major groups of finfishes reported from the bottom trawling operations conducted along the south-west coast of India in terms of seasonality and abundance of the species. The resource appraisal surveys off Kerala shows the predominance of threadfin breams in the depth zone of 100-200 m between December and April, however, the stocks move into the areas below 100 m during July-October in great abundance resulting in high catch and catch rates (Nair and Jayaprakash, 1986; Murty *et al*., 1992; Nair *et al*., 1996). Commercially exploitable demersal resources including lizard fishes are confined mainly to the continental shelf region within 100 m (James, 1989). High concentration of Carangidae is observed during monsoon from July/August onwards especially along the Kerala/SW coast (Rao *et al*., 1977; Sivakami *et al*., 1996). Lazarus *et al*. (1992) and Nair *et al*. (1996) reported the peak period of occurrence for ribbon fishes as the monsoon season along the coast. Movements of fish as observed previously are influenced by water movements dependent on temperature, salinity gradient, plankton blooms and wind action rather than dissolved oxygen.

It has been observed that certain species *Nemipterus randalli*, Russell, 1986, *Lepturacanthus savala* (Cuvier, 1829) and *Decapterus russelli*

(Rupell, 1830) are found dominant along with the emergence of a few rare species and new records indicating the presence of the unexploited and unexplored marine finfish resources along the southern Kerala coast. Perhaps the mechanisation of the fishing crafts, with the use of modern equipments, high enduring capacity as well as catching efficiency achieved by the gears would have brought in the rare and new resources. Some of the new records to the Indian seas like *Pristigenys niphonia* (Cuvier, 1829), *Brachirus annularis*, *Apogon kiensis*, *Callionymus gardineri* and *Sacura boulengeri* are the added features of this investigation. The full details of all the new records are yet to be confirmed waiting for further literature. Juveniles of *E. diacanthus* were observed in large numbers during the post-monsoon season at Kalamukku and Cochin Fisheries Harbour. Among the by-catches of finfishes from the four trawling centres, Callionymidae was the dominant family apart from Leiognathidae and Gobidae. The species of Callionymidae are reported infrequently from the west coast especially, Kerala. *C. carebares* and *C. marleyi* are found more in numbers along the Kerala coast, particularly from Neendakara, though they were not reported earlier.

Integrated farming of mussel and edible oyster by self help groups in Sathar Island, Ernakulam District, Kerala

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The Central Marine Fisheries Research Institute (CMFRI), Kochi had successfully demonstrated mussel farming in the estuarine areas of Kerala, especially north Malabar. This resulted in a positive socio-economic impact on the coastal fishers especially among women. In the same way CMFRI had conducted a preliminary survey in the estuarine areas around Sathar Island (Fig. 1) adjacent to Munambam Fishing Harbour in the northern part of Ernakulam District, during 2003.

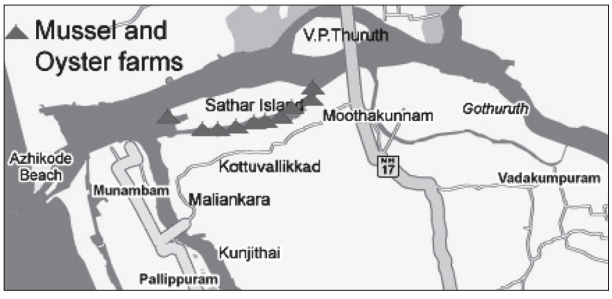

Fig. 1. Map of Sathar Island showing areas with mussel and edible oyster farms

The nearby areas were also surveyed towards downstream to find out, to what extend the salinity profile is suited for mussel and oyster farming. After the survey, a training programme was organized by Molluscan Fisheries Division of CMFRI at Govt. L.P. School, Kottuvallikkad on 3rd August 2003. In the training programme, 150 people participated and they were given training in oyster culture techniques (Fig. 2).

Fig. 2. Farmers attending the training programme at Kottuvallikkad L. P. School

As a follow up of this, the CMFRI constructed a demonstration farm in the brackishwater area of Sathar Island and suspended 500 rens. Parallel to CMFRI farms, 6 self help groups (SHG's) also started oyster farming with the financial help (25% subsidy) from Brackishwater Fish Farmers Development Agency (BFFDA).

The farmers were satisfied seeing the spat settled on the oyster shell rens and the weight of each ren increased to 3.5 - 5 kg. Within a period of 7 months, the oysters were harvested and they could obtain 10% meat weight. To popularize the programme, BFFDA organized a public function and the total production amounted to 2.2 t of oysters in 2004. From the next year onwards, the number of farms and farmers increased (Table 1). In the light of the initial success, several training programmes were organized by the state development agencies, (Table 2). The technical classes for these training programmes were given by CMFRI (Fig. 3). From the year 2005 onwards SHG's started adopting mussel farming using the same oyster rack and now most of the farmers are doing integrated farming with mussel and oysters (Fig. 4, 5, 6). The present annual production amounts to 8.6 t of oysters and 28 t of mussels (Fig. 7).

Some of the farmers were trained by NIFPHATT (National Institute of Fisheries Post Harvest Technology and Training) for producing value added products like frozen meat and pickles from both

Table 1. Trend in mussel and edible oyster farming in Sathar Island

Year	No. of farms	No. of SHG's involved		No. of beneficiaries	Production (t)	
		Women	Men		Oyster	Mussel
2003	6	3	-	26	*FS	
2004	9	8	-	45	2.2	*FS
2005	11	14	-	52	4.2	4.172
2006	23	15	-	68	13.3	6.0
2007	30	17	2	102	11.23	18.28
2008	32	21	3	153	8.6	28

*Farming started

Table 2. Training programmes on bivalve farming organized by different organizations in Sathar Island

Year	No. of training	No. of participants	Name of Organizing agency
2003	1	150	CMFRI/MFD
2004	1	45	BFFDA
2005	3	265	BFFDA
2006	3	260	BFFDA/ADAK/TEAP
2007	1	53	TEAP/ADAK
2008	1	32	ADAK

BFFDA : Brackishwater Fish Farmers Development Agency
ADAK : Agency for Development Aquaculture of Kerala
TEAP : Tsunami Emergency Assistance Programme

Fig. 3. Women seeding mussels using PVC pipe covered with mosquito net

Fig. 4. Panchayath president visiting a women SHG's farm

Fig. 5. SHG member examining the mussel grown on rope

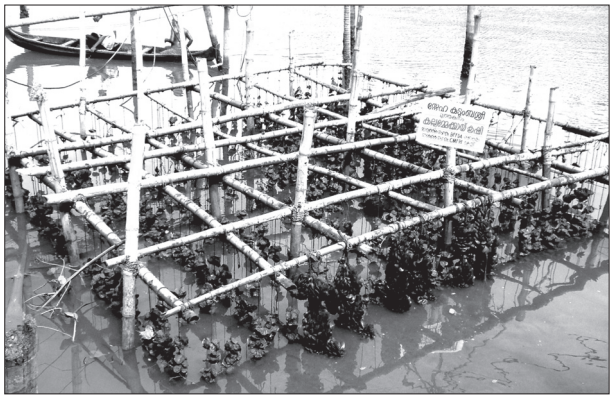

Fig. 6. Edible oyster and mussels farmed on the same rack

Fig. 7. Harvested oysters along with ren in canoes

Fig. 8. Training at NIFPHATT on value added products from mussels and oysters

mussels and oysters (Fig. 8). High income was obtained within 5-7 months. In addition, many people are getting additional income through ancillary works related to farming process, harvest, post-harvest, shucking and marketing (Table 3).

Table 3. Details of revenue generated for a model integrated farm of mussel and edible oyster (5 x 5 m)

Activity	Rate	Income as wage/ labour (Rs.)	
		Mussel	Oyster
Shell ren making	@ Rs.1 per ren		100
Farming	@ Rs.300 /day	300	300
Seeding	@ Rs.200/day	1600	
Harvest	@ Rs.200 /day	200	200
Post-harvest	@ Rs. 2 / Kg	200	300
Canoe hire charge	@ Rs. 100/trip	100	200
Shucking	@ Rs. 10 / Kg	2,500	400
Marketing	@ Rs. 5 / kg	1,250	200
Byproducts (pickle)	@ Rs.200/day	800	200
	Total	7,250	1,600
Total Revenue generated by sale of heat shucked meat	@ Rs.80/ kg	20,000	3,200

Number of ropes : 100

Number of ren : 100

Bivalve resources of Moorad Estuary, north Kerala

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A bivalve resource survey of Moorad estuary in Badagara District of north Kerala was carried out during February 2004 to assess the bivalve species, their distribution and potential stock.

Sampling sites were fixed within five main zones of the Moorad estuary based on the clam fishery activities and local enquiries. The bivalve distribution in a unit area was taken by demarking the area of clam bed with a quadrant. Observations on the area of clam bed, water clarity, depth and temperature were recorded at each site. Surface and bottom water samples were collected and hydrographic parameters like salinity, temperature, pH and dissolved oxygen content, productivity, nitrate, phosphate and silicate were recorded. Sediment samples were collected to analyse the grain size and organic content of the clam beds. All samples were analysed within 24 h except sediment samples. Average density of bivalve per square metre area was analysed and the potential stock was estimated for each bivalve species in the estuary.

Ecology of the bed

The hydrographic parameters showed wide variations within the five zones. The average depth of the estuary was 1.55 m. The maximum depth of 2.77 m was recorded in Zone V and least in (0.6 m) in Zone I. The clarity of water was highest in Zone V (1.23 m) and lowest in Zone (0.48 m). The average clarity of water in the estuary was 0.87 m.

The surface temperature did not show much variation and it ranged from 28.1 °C to 30.5 °C reflecting an average surface temperature of 29 °C across the estuary. The surface salinity of the Moorad estuary showed almost a uniform pattern recording a high value of 34.6 ‰ in Zone I and a minimum of 23.2 ‰ in Zone V. The average surface salinity of the estuary was 31.4 ‰ indicating a uniform saline water influx upto the upper reaches of the estuary. High salinities were recorded in Zones I to III wherein direct tidal influx of seawater occurs at the barmouth. The average bottom water salinities also exhibited a similar trend and ranged from 24.2 ‰ in Zone V to 34.9 ‰ in Zone I. The average surface pH of the estuary was 7.7 with little variation from a low of 7.43 in Zone V to a high of 7.8 in Zone II. The soil pH recorded an average value of 7.2, ranging from 7.16 in Zone V to 7.37 in Zone IV.

The dissolved oxygen content of the surface water was high (3.5 ml l^{-1}) in Zone III indicating good mixing in this Zone and the minimum was 2.42 ml l^{-1} in Zone II. The average surface dissolved oxygen content in the estuary was 3.00 ml l^{-1}. The average surface water dissolved oxygen content of the bottom water was low (2.63 ml l^{-1}) in Zone I and a maximum of 3.38 ml l^{-1} was recorded in Zone III. The average bottom dissolved oxygen content in the estuary was 2.96 ml l^{-1}.

The highest gross productivity was recorded in Zone II at 1.09 mg C m^{-3} day^{-1} and lowest in Zone IV at 0.31 mg C m^{-3} day^{-1}. The average productivity in the Moorad estuary was 0.61 mg C m^{-3} day^{-1}. The maximum net productivity was 0.63 mg C m^{-3} day^{-1} in Zone II and minimum of 0.24 mg C m^{3} day in Zones III and IV. The average net productivity was 0.36 mg C m^{3} day.

The average nitrate content in the estuary was 0.77 µg at 1^{-1} with a high of 1.16 µg at 1^{-1} in Zone I and low of 0.36 µg at 1^{-1} in Zone V. The average silicate content in the estuary was 0.53 µg at 1^{-1} with a high of 0.64 µg at 1^{-1} in Zone V and low of 0.45 µg at 1^{-1} in Zone IV.

Soil composition: The Moorad estuary has predominantly sandy bottom and heavy quarrying of sand was prevalent in most parts of the estuary. Zone I was clayey, Zones II, III and IV were sandy and Zone V rocky in some parts and clayey in the upper reaches.

Bivalve resource

The Moorad estuary has significant populations of edible oyster *Crassostrea madrasensis*, *Saccostrea cuculata* as well as clams *Meretrix casta* and *Meretrix meretrix.* The Moorad estuary is dominant in edible oyster. However, there is little exploitation of the stock. *M. casta* is the only exploited resource in the estuary and significant fishery for the clam occurs from October to March.

Edible oysters are distributed all along the sides of Zones I to IV while clam beds occur in Zones II and III only. Both clams and oysters are totally absent in Zone V.

The average density of *M casta* in bed area of 152 ha was 1096 No. m^{-2} (Table 1). The average density of *M meretrix* was 96 No. m^{-2}. The average density of *C. madrasensis* in an area of 2.71 ha was 1286 No. m^{-2}. The average density of *S cucullata* was 143 No. m^{-2}.

Biomass of clam and edible oyster

The total average biomass of bivalves in the Moorad estuary was 112 kg m^{-2}. The average biomass of *M. meretrix*, *C. madrasensis* and *S. cuculata* were 0.7 kg m^{-2}, 97.8 kg m^{-2} and 11 kg m^{-2}, respectively.

Estimated population of clams and edible oysters in the Moorad Estuary:

The total estimated number of bivalves in the Moorad estuary was 9210 lakh in a total estimated bed area of 155 ha. *M. casta* (8418 lakh m^{-2}) contributed highest to the total estimated number, followed by *M. meretrix* (635 lakh m^{-2}); *C. madrasensis* 141 lakh m^{-2} and *S. cucullata* 16 lakh m^{-2}.

The total biomass (standing stock) of bivalves in the Moorad estuary was estimated as 3368 t in an estimated bed area of 155 ha. The estimated biomass of *M. casta* was 2074 t ha^{-1}**,** contributing 62% to the total biomass and *M. meretrix* 552 t ha^{-1} forming. 16% to the total biomass**.** The estimated biomass of *C. madrasensis* was 668 t ha^{-1} forming 20% of the total estimated biomass and *S. cucullata* 74 t ha^{-1} forming 2% of the total estimated biomass.

The total clam biomass was estimated at 2626 t forming 78% of the total estimated biomass. The total edible oyster biomass was estimated at 742 t forming 22% of the total estimated biomass in the Moorad estuary (Table 1).

Table 1. Estimated density and biomass of bivalves in the various zones of Moorad Estuary

	Area of distribution (ha)			Average density (No. m^{-2})					Estimated number (Lakhs)					Average biomass (g m^{-2})					Estimated biomass (t)				
	Clam bed	Oyster bed	Total	M c	M m	C m	S c	Total	M c	M m	C m	S c	Total	M c	M m	C m	S c	Total	M c	M m	C m	S c	Total
Zone I	Nil	0.23	0.2	Nil	Nil	225.00	25.00	250.0	Nil	Nil	51.75	5.75	57.5	Nil	Nil	22961.13	2551.2	25512.4	Nil	Nil	52.81	5.87	58.7
Zone II	57.33	0.71	58.0	523.60	71.40	254.70	28.30	878.0	3001.97	409.36	17.96	2.00	3431.3	745.42	289.88	25992.00	2888.0	29915.3	427.37	166.20	183.24	20.36	797.2
Zone III	94.67	1.19	95.9	572.16	23.80	403.20	44.80	1044.0	5416.45	225.31	47.78	5.31	5694.8	1738.75	407.85	24408.00	2712.0	29266.6	1646.01	386.10	289.23	32.14	2353.5
Zone IV	Nil	0.59	0.6	0.00	0.00	403.20	44.80	448.0	0.00	0.00	23.59	2.62	26.2	0.00	0.00	24408.00	2712.0	27120.0	0.00	0.00	142.79	15.87	158.7
Zone V	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total	152.00	2.71	154.7	1095.76	95.20	1286.10	142.90	2620.0	8418.42	634.67	141.07	15.67	9209.8	2484.16	697.74	97769.13	10863.2	111814.3	2073.38	552.30	668.08	74.23	3367.99

M c: Meretrix casta; M m: Meretrix meretrix; C m: Crassostrea madrasensis, S c: Saccostrea cucullata

Migrant labourers in the marine fisheries sector

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It is now recognised that migration is an integral part of the survival strategies of the poor; especially where local economics offer limited livelihood alternatives. Intervention strategies should, therefore, be directed at reducing the vulnerability of migrants, not at reducing migration itself. Migration has become a key facet of today's world. Migrants living outside their country of birth are 191 million.

Migratory behaviour is of two types, outward migration and inward migration. Outward migration is defined as the movement of labourers outside their revenue villages to seek employment opportunities available elsewhere and inward migration is the movement of labourers into the native villages from any other place in search of any feasible work according to their capacity/ potential. However, the migration of labourers from the agricultural sector to the fisheries sector is a grave economic problem affecting both the agrarian and fisheries economy. On one hand it causes labour displacement in the agrarian sector and on the other it leads to labour gain in the fisheries sector. A phenomena of distress migration was observed in Bundur Harbour, Dakshina Kannada District wherein a population of 500 contract labourers including men and women migrated from Villupuram District of Tamil Nadu into Dakshina Kannnada District of Karnataka state to work as loading/unloading labourers at the Bundur Harbour. The term distress migration and migration for survival have often been used; explaining migration by the poor from their native villages in response to natural calamities and other shocks.

A sample of 35 migrant labourers was selected for the study. The responses were collected from the labourers using a well structured interview schedule. The data was tabulated and the results analysed. The findings revealed that, the labourers migrated form Villupuram District of Tamil Nadu. Villupuram is one of the poorest districts of Tamil Nadu ravaged by vast spells of drought causing losses to the agrarian economy of the district. Eighty six percent of the population depend on agriculture for a living. Owing to lack of perennial irrigation sources and deficit rainfall, drought conditions have become a regular phenomenon in these districts forcing a vast majority of its rural population to migrate to neighbouring states of Karnataka and Andhra Pradesh in search of employment opportunities.

The findings revealed that more than half the total number of respondents (54.28%) were young *i.e.,* less than 35 years of age, followed by 34.29% who were middle aged *i.e.*, between 36 and 45 years of age. Only 11.43% belonged to the old age group *i.e.,* above 45 years of age (Fig. 1). With respect to the educational status, it was observed that majority (82.85%) were illiterate, followed by those having primary level of education *i.e.*, 11.43 % and only 5.71% had undergone high school education (Fig. 2).

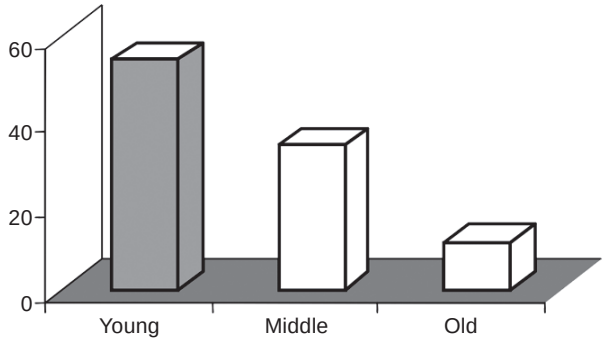

Fig. 1. Age distribution of respondents

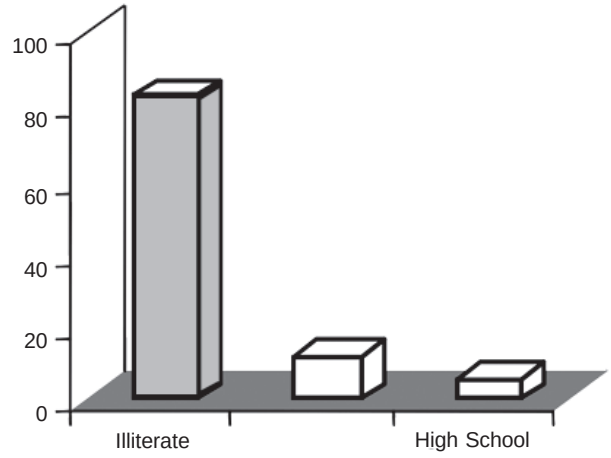

Fig. 2. Educational status of respondents

The peak period of employment for these migrant labourers was during October-December with an average of 25 days of employment in a month. The average wage of male labourers during the peak season was Rs. 300/- day for 14 h of work from 5 am to 7 pm and for female labourers Rs. 100-200/day for 13 h of work from 5 am to 6 pm. It could be observed that male labourers undertook heavy work such as unloading fish from boats, breaking ice and putting them in fish baskets as well as loading them into fish trucks. The women labourers carried the unloaded fish from the harbour into fish trucks. The medium season of employment was during August, September, October and November and the average wage during this season was Rs. 100-150 for male labourers and for females it was Rs. 50-60. The average work hours during this season for both male and female labourers were 13 h from 5 am to 6 pm. The lean period of employment was during June –July when the migrant labourers returned home to Villupuram in Tamilnadu. During the lean period, these labourers were employed as agricultural labourers with an average wage rate of Rs.100 /day for men and Rs 40/day for women. The women undertook works such as weeding, fertiliser application and irrigating crops manually, whereas men were involved in all operations from land preparation till harvest. The women worked from 7.30 am to 12 noon and men worked in the fields from 7.30 am to 2.30 pm.

Majority of the migrant labourers (71.43%) had joint families and 28.57% had nuclear families (Fig. 3). Most of the labourers migrated to Dakshina Kannnada District 2-3 decades back with their families. Another interesting observation was family labour was also utilised, to accentuate their income. The social participation *i.e.*, membership in co-operative societies, self-help groups and local bodies were nil. All the migrant families possessed Ration Cards and availed benefits of welfare programmes of the government in their native town. As far as the occupational experience of the respondents were considered, most of them had an average of 10 years of experience in their jobs with 34.28% of respondents with low and high level of experience and 31.44% with medium level of experience.

Though the migrant labourers contribute significantly to the marine fisheries development, their problems are numerous often not effectively addressed by the government and policy makers. They do not have ration cards or identity cards at the place of work, suffer from long working hours, lack hygienic working conditions, proper shelter and housing facilities, insurance facilities in instances of physical injuries endured during work, inadequate wage structure and are not eligible for benefits of welfare programmes of the State Fisheries Department.

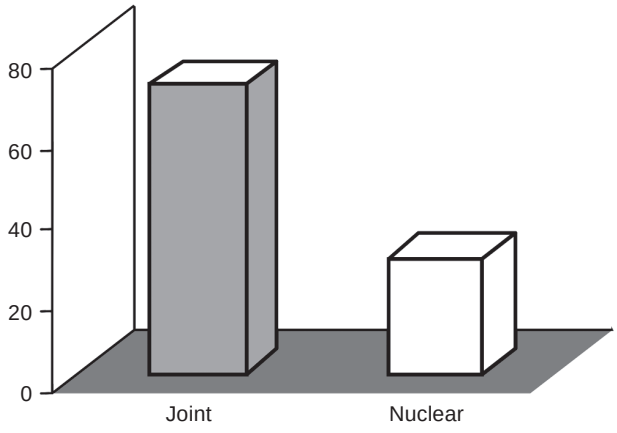

Fig. 3. Family type of respondents

Social safety measures such as targeted poverty alleviation programmes for migrants, issue of temporary identity cards at place of work, provision of insurance policies and ensuring remunerative wage policy for migrant labourers will give an integrated, multidimensional and holistic approach to enhance their livelihoods and mitigate the negative effects of distress migration.

Rising trend in the fishery of the octopus *Cistopus indicus* (Orbigny, 1840) by trawlers at Mumbai

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The world landings of octopus increased substantially from 35,800 t in 1950 to 3,17,200 t in 2001 (Jereb *et al*., 2005). Major species of octopus that contribute to the world fishery come under the genera *Octopus, Cistopus* and *Eledone*. As many as 200 species of Octopodidae are known to occur in the world Oceans (Worms, 1983) of which about 60 are reported from the Indian Ocean (Roper e*t al*., 1984).

Studies on the fishery of octopods from Indian waters are very few. Varghese (1981) reported the status of small-scale octopus fisheries from Lakshadweep. Kripa and Joseph (1994) and Kripa *et al.* (2000) described landings of octopus from Kochi waters while Sundaram and Sarang (2004) gave an account from Mumbai waters.

Thirty-eight commercially important species of octopus have been reported from the Indian seas (Silas *et al.,* 1985) but a targeted fishery for octopus is lacking. In India octopuses are caught incidentally as by-catch in shrimp trawlers. In recent years, the export possibility of octopods has paved a way for the emergence of octopus fishery in India. There seems to be not much information on the octopus landings from Indian waters especially from the north-west coast. The present paper deals with the increasing trend in landings of *Cistopus indicus* (Fig. 1) by trawlers in Mumbai waters. *C. indicus* is a benthic species commonly called as 'old women octopus', occurring up to 50 m depth. The species is distributed in the Indo-Pacific; mostly Indo-Malayan region, the Philippines, China, Bangladesh, India and Pakistan (Roper *et al*., 1984).

Since Mumbai accounts for 60% of the total fish landings in Maharashtra (Annam and Sindhu, 2005), the catch statistics from Mumbai can be considered as representative for the state. The catch data was obtained from the commercial trawl landings at New Ferry Wharf, Sassoon docks and Versova in

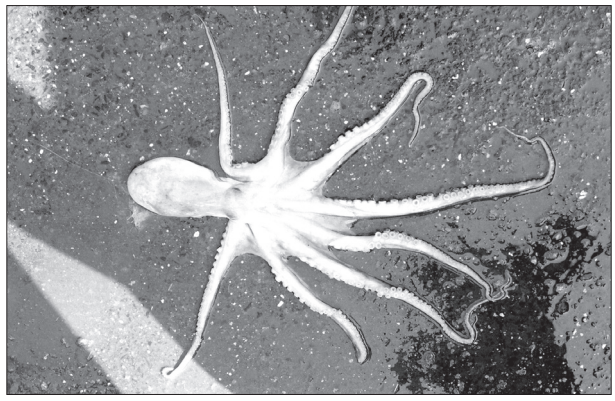

Fig. 1. *Cistopus indicus* (Orbigny, 1840)

Mumbai from 2001 to 2006. There were no landings in the month of July due to the monsoon ban on trawling.

The estimated annual catch and catch rate of *C. indicus* by trawl for the period 2001-2006 from all the three centers combined, showed an increasing trend (Fig. 2). The month-wise average catch rate data for the period 2001-2006 from all the three centres indicated a major peak period of abundance during March-April and a minor peak in October (Fig. 3).

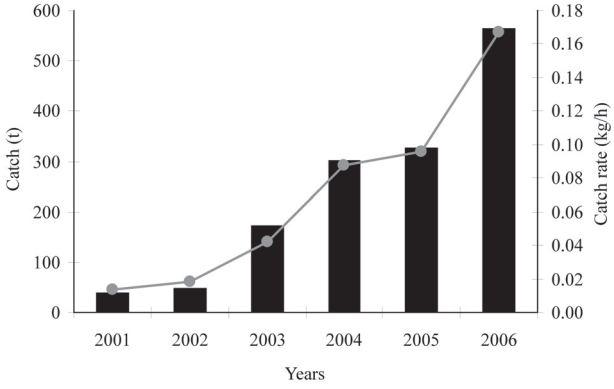

Fig. 2. Catch and catch rate of *Cistopus indicus* by trawlers at Mumbai

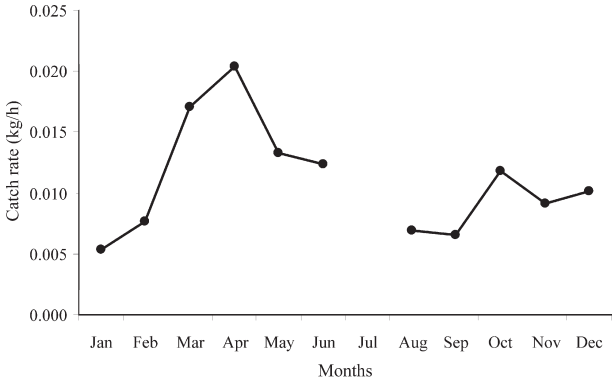

Fig. 3. Seasonal abundance of *C. indicus* by trawlers at Mumbai

The catch of *C. indicus* by trawlers at New Ferry Wharf ranged between 18.8 t (2001) to 324.5 t (2006). The percentage of this species in the cephalopod landings ranged between 0.3% (2001) to 6.3% (2006) with the catch rate ranging from 0.01 kg h^{-1} (2001) to 0.18 kg h^{-1} (2006). At Sassoon Docks, the catch ranged between 18.9 t (2001) to 199.2 t (2006). The percentage in cephalopod catch ranged between 0.2% (2001) to 2.7% (2006) with the catch rate ranging between 0.02 kg h^{-1} (2001) to 0.20 kg h^{-1} (2006). The landings at Versova ranged between 0.1 t (2001) to 39.9 t (2006) with percentage in cephalopod catch ranging between 0.01% (2001) to 13.1% (2006) and catch rate ranging from negligible in 2001 to 0.07 kg h^{-1} in 2006.

From the above observations it is very clear that the *C. indicus* landings are on the rise, increasing many folds and contributing substantially to the fishery in Mumbai. The octopuses are taken to the processing unit within 4-6 h, where they are degutted and are mainly exported, Europe and Japan being the main markets. The price of *C. indicus* increased from Rs.13/kg in 2001 (Sundaram and Sarang, 2004) to Rs.70/kg in 2007 at the landing centre.

The dorsal mantle length of *C. indicus* in Mumbai waters during 2001-2006 ranged between 50-140 mm (in trawl catches) and from 15-40 mm (in dol catches). Sivasubramanium (1991) reported the total length of this species as 600 mm from the Bay of Bengal and according to Roper *et al.* (1984) the maximum mantle length attained by this species is 180 mm. *C. indicus* is the dominant octopus species in Mumbai waters contributing about 95% towards the octopus fishery.

Earlier this resource was discarded at sea because of poor demand, but due to the increasing export market octopus attract good demand. As the demand is increasing, overexploitation due to increased fishing pressure is possible, which may ultimately lead to stock depletion. It is suggested that measures should be taken at this stage itself for rational exploitation of this important resource. Detailed studies on the distribution, population dynamics and biology of *C. indicus* are essential to evolve effective fishery management measures.

Unprecedented trash fish landing at Mangalore Fisheries Harbour

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Trash fish landing at Mangalore Fisheries Harbour is mainly used for fish meal. The earlier practice was to take the trash to sandy areas near the sea and sun dry them. In the case of the catch brought by single day trawlers, the usual practice was to separate commercial groups from the entire catch and to sun dry the rest. During the year 2008, the average price of trash fish was Rs. 4/kg. Low value by-catch of multi-day operating vessels, pertaining to the last two days are brought to the shore for sun drying.

Bumper landing of oilsardine in 2007 lead to mushroom growth of fish oil plants and fish meal plants all along the coastline and the capacity of the existing plants was increased for boosting the production of fish oil and fish meal. However, since 2008, oilsardine catch is showing a reducing trend from 94,000 t in 2007 to 81,000 t in 2008. The data of 2009 also indicate a catch reduction of 20% compared to the previous year. This reduction in oilsardine landings resulted in a crisis wherein the fish meal plants found it difficult to meet the demand

for the raw material. Trash fish provided a viable alternative to oilsardine and multiday trawler operators who were already in an economic crisis decided to utilise this opportunity and started supplying trash fish for Rs. 8-10/kg. At present, multiday trawlers have started to carry the trash fish in their fish holds at an average rate of 2 t / trip from day one onwards. This trash fish in the trawlers is stored with minimum ice and is usually landed in a semi-rotten form. In the year 2009, trash fish formed 17% of the total landings and in 2008, it was only 13%. In the earlier years, the percentages was in single digits. The trash contained juveniles of all commercial species and the dominant groups were threadfin breams, flat heads and lizard fishes.

It has been observed that, the practice of buying trash fish from such trawlers was in vogue at Veraval Fishing Harbour of Gujarat state and some other fisheries harbours in the country for quite some time. Veraval Fishing Harbour and the surrounding areas have the characteristic stink because of the landed trash fish which was mostly in a semi-decomposed state. A similar crisis has arisen in the Mangalore City. Last year, most of the oilsardine landed at the harbour were transported through the city roads to the fish meal plants (Fig. 1 and 2). In view of the problems of hygiene, sanitation and upkeep of the city's aesthetic beauty, the municipal corporation has intervened and the purse-seiners were asked to land the oilsardines through sea route to the fish meal/ fish oil plants directly. This situation demands an amicable settlement wherein, there has to be an effective utilisation of the resources in terms of conservation of the biodiversity as well as contribution to the economy of the state, without having to compromise on health, hygiene and environment.

Fig. 1. Trash fish landed by multiday operating trawlers loaded into truck for transportation to fishmeal plants

Fig. 2. Composition of trash fish landed at Mangalore by multiday trawlers

Unusual landings of *Aluterus monoceros* (Linnaeus, 1758) along Vizhinjam coast

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On the13th of July 2009, unusual heavy landings of *Aluterus monoceros* (unicorn leather jacket) of the family Monacanthidae were observed along the coast, from Vizhinjam to Marianadu about 40 km north of Vizhinjam (Fig. 1). These fishes, locally known as "komban clathy" or "mara clathy" are rarely observed in large numbers in the landings at Vizhinjam which has become a subject of surprise to the fishermen. This has been the first incident of such a heavy landing of bigger sized unicorn leather jacket in this area.

A total of 450 t of fishes were caught in boatseines during 4 days from 12-7-2009 to

Fig. 1. Heavy landings of *Aluterus monoceros* at Vizhinjam Fishing Harbour

15-7-2009. The fishes had a highly compressed grey coloured body with faded brown round spots on their upper side, a protruding mouth with convex head and a single slender dorsal spine. The positions of their eyes are so characteristic that they are seen on the posterior portion of the head (Fig. 2).

Fig. 2. *A. monoceros* (Unicorn leather jacket)

It was also observed that almost the entire landings by each boat consisted of this fish. Small quantities of *Stolephorus indicus*, squids, cuttle fishes and non-edible crabs ranging from 1 to 5 kg were also present in the catch. The catch per unit ranged from a minimum of 10 kg to a maximum of 600 kg. The fishes were transported to fish processing/cold storage units. The price at the landing centre ranged from Rs. 25/- to Rs. 45/- for a single fish weighing 500 g to 1.2 kg.

Samples were randomly selected from the catches and measurements of body length, alimentary canal, body weight, liver mass and weight of gonad were recorded. The fishes were examined for their sex and condition of gonads as well as stomach contents. The total length ranged from 43 to 67 cm and body weight from 500 g to 1.121 kg. In all the fishes, stomach was full with completely digested food particles. The length of the alimentary canal was found to be more than three times the length of fishes with an array of secae on their anterior part (Fig. 3). The fishes also possessed large liver mass weighing 65 to 95 g.

Fig. 3. *A. monoceros* showing long alimentary canal and fatty liver

The male gonads were in stage II while the females were in the post-spawning stage. The mean total length, body weight, liver weight, ovary weight, intestine length and gonadosomatic index in respect of females were 52 cm, 987 g, 69 g, 7.25 g, 163 cm and 0.759 whereas in males the average total length, body weight, liver weight and intestine length were 44 cm, 777 g, 65 g and 154 cm respectively.

First record of the goatfish, *Parupeneus heptacanthus* Lacepède, 1801 (Family: Mullidae) at Visakhapatnam Fisheries Harbour

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Visakhapatnam Regional Centre of CMFRI, Visakhapatnam

Goatfishes belonging to the family Mullidae are represented by several genera and species. The goatfish catch forms a significant component of the trawl landing at Visakhapatnam and contributed to as much as 9.36% of the total demersal catch and 2.25% of the total fish catch of Andhra Pradesh.

Regular observations made on the trawl landing have indicated that four species belonging to single genera, *Upeneus* (*U. vittatus*, *U. sulphureus*, *U. moluccensis* and *U. tragula*) contributed to the goatfish catch at Visakhapatnam. However, on 24th of November 2009, another species of goatfish identified as *Parupeneus heptacanthus* was collected from the trawl catch. The specimen was identified using the key provided in the species identification sheets for fishery purposes FAO – Eastern Indian Ocean, Fishing area 57 and Western Central Pacific fishing area 71- Vol. III. *Parupeneus heptacanthus* is distinguished from other species of goatfishes by the presence of a single row of well-spaced stout conical teeth in jaws, no teeth on the roof of the mouth, three vertical rows of scales in the space between the dorsal fins, nine vertical rows of scales along the upper part of caudal peduncle and a pale reddish spot just below seventh and eighth lateral line scales (Fig. 1). The fish popularly known as cinnabar goatfish was a stray specimen landed along with other goat fishes at Visakhapatnam but is known to have a wide distribution along both the coasts of India. This report on the occurrence of *P. heptacanthus* in the trawl catch is however, the first record of its availability in Visakhapatnam. *P. cinnabarinus, P. luteus, P. pleurospilos* and *P. seychellensis* are some of the other synonyms of *P. heptacanthus*. These synonyms are no longer valid presently (Fishbase). Morphometric measurements of the fish were taken (Table 1), the specimen photographed and preserved in the Marine Fish Museum of the Regional Centre of Central Marine Fisheries Research Institute, Visakhapatnam.

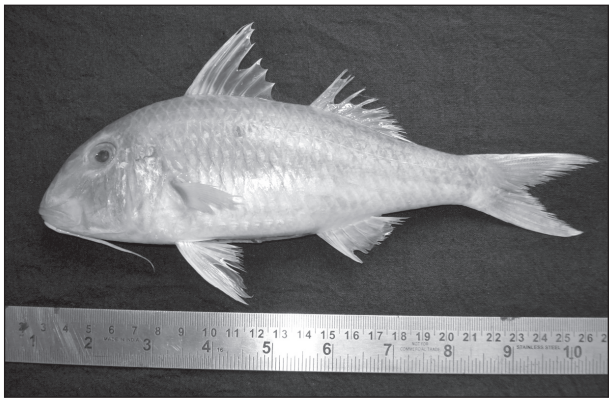

Fig. 1. *Parupeneus heptacanthus*

Table 1. Morphometric measurements of *P. heptacanthus* collected at Visakhapatnam Fisheries Harbour on 24th November 2009

Parameter	Measurements (mm)
Total length	241
Fork length	205
Standard length	189
Head length	62
Snout length	33
Body depth	64
Post-orbital length	20
Length of first dorsal fin base	37
Length of second dorsal fin base	33
Length of pelvic fin	39
Length of pectoral fin	37
Length of anal fin	26
Eye diameter	12
Peduncle height	23
Caudal fin length	59
Distance between first and second dorsal fin	16
Number of gill rakers	26
Wet weight	195 g
Sex and Maturity stage	Immature Male, Stage II

Heavy landings of *Sardinella longiceps* by purseseiners at Malpe Fisheries Harbour, Karnataka

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Mangalore Research Centre of CMFRI, Mangalore

Malabar coast is well known for oilsardine and mackerel fishery. The oilsardine fishery along the coast is characterised by annual fluctuations in landings (Fig.1). Mangalore and Malpe fisheries harbours are the major oilsardine landing centres of Karnataka. Malpe Fisheries Harbour contributes 40-65% to the total oilsardine landings in Karnataka. *S. logiceps* is exploited mainly from 10-25 m depth

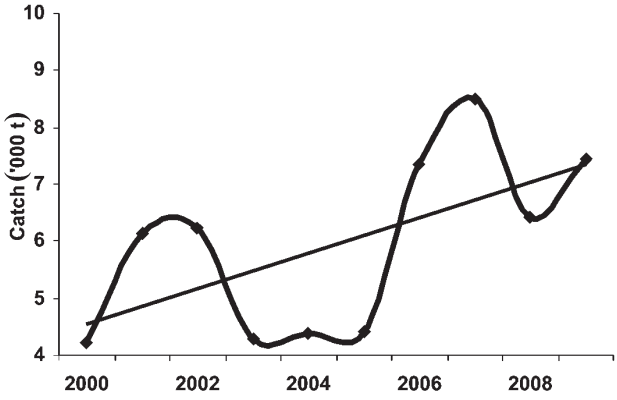

Fig. 1. Annual catch and catch trend of oilsardine at Malpe

by mechanised and motorised fishing boats. Purseseine is the major gear contributing 90-98% to the total oilsardine landings of the state. Besides purseseine, minor landings are observed in trawl, ringseine hand trawl *etc*. (Fig. 2).

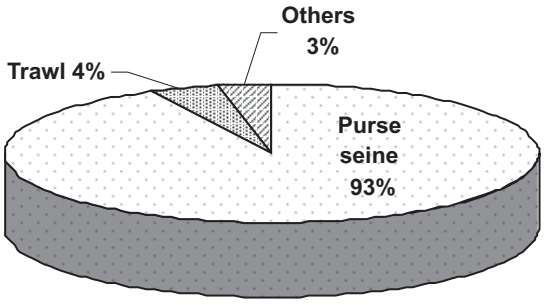

Fig. 2. Average gear-wise distribution of oilsardine landed at Malpe Fisheries Harbour during 2005-2009

Oilsardine fishery is generally observed throughout the year with peak landings from September to December extending even up to February in some season (Fig. 3). During December 2009, bumper catch of oilsardine in purseseine was observed on 9th and 29th at Malpe Fisheries Harbour. The catch rates of oilsardine in purseseine during the days varied from 5 to 15 t per unit (average of 7 t per unit), recording 2 to 6 fold increase in catch rates. The auction rate of the fish ranged from Rs. 4 to Rs. 8 per kg, yielding total revenue of 33 lakhs in two days. Since oilsardine was landed in bulk, the fish was used for fish meal production and transported to fish meal plants located at Udyavar, Thottam, Manoor kota and Pithrodi.

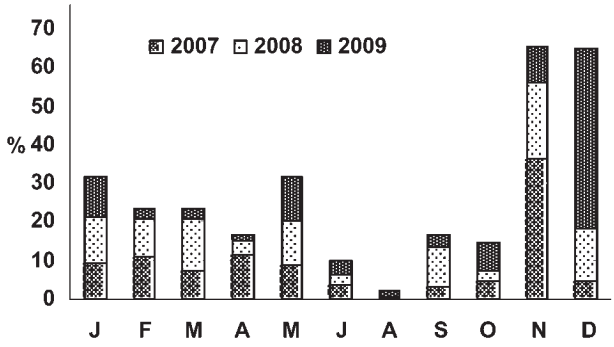

Fig. 3. Seasonal variations of oilsardine landings (%) at Malpe Fisheries Harbour

Through the occurrence of oilsardine shoals during post-monsoon months is a common phenomenon along the coast, 47% of the annual oilsardine landing was observed in December, 2009. More than 40% of the landing during this month comprised of 0 year class, suggesting inshore migration of recruits.

Length-weight relationship of green mussel *Perna viridis* (Linnaeus, 1758) from Versova creek, Mumbai

Sujit Sundaram, C. J. Josekutty and B. B. Chavan
Mumbai Research Centre of CMFRI, Mumbai

During monsoon trawl ban period (June-August), due to the non-availability of fish, fishermen at Versova village tend to exploit bivalves from the intertidal area along the creeks for their livelihood. It was observed that fishermen regularly collect the green mussel *Perna viridis* from Versova creek. Though this creek is one of the most polluted creeks in Mumbai, this species was found almost throughout the year.

Monthly samples were collected from the creek during lowtide days by hand-picking from the rock

crevices. The samples were brought to the laboratory for length-weight analysis. The shells had darker shade (Fig. 1). Shell length (L) was measured using a digital caliper and total weight (W) (+ 0.01 g) was determined using an electronic balance after the specimens were dried on blotting paper. A total of 675 specimens ranging in length from 14 to 89 mm with the corresponding weight ranging from 0.495 to 37.612 g were analysed over a period of four years from January 2005 to December 2008.

Fig. 1. Green mussel, *Perna viridis* (Linnaeus, 1758) from Versova creek

Length-weight relationships were obtained with regression analysis by the method of 'least squares' based on individual measurements. The relationship of the length and weight is expressed by Le Cren's (1951) equation and graphically represented (Fig. 2). The length-weight relationship of *P. viridis* from Versova creek is expressed as $W = 0.00035_{*} L^{2.67035}$ ($r^2 = 0.8836$).

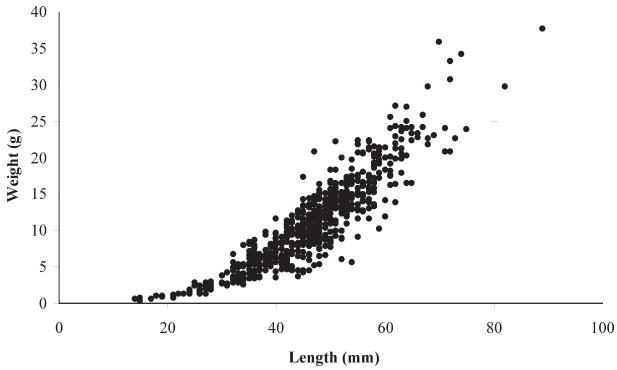

Fig. 2. Scatter plot of length-weight relationship of *Perna viridis* from Versova creek, Mumbai

P. viridis from Versova creek can be used as an indicator organism for pollution assessment and also to assess the stress caused by pollution on the ecosystem.

Record of inarticulate Brachiopoda, *Lingula* sp. from mangrove areas in Ratnagiri, Maharashtra and its unusual commercial exploitation

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Mumbai Research Centre of CMFRI, Mumbai

The Brachiopoda or 'lamp shells' belong to an ancient phylum of filter feeding marine worms. They live inside a pair of shells much like the bivalve; however, brachiopods differ from bivalves in many ways. Their shells have a definite dorsal and ventral (upper and lower) half, while bivalves, which are molluscs, have left and right halves to their shells. The brachiopods are so different internally that they have been grouped under separate phylum. *Lingula* is a genus of brachiopods with about eleven species within the family lingulidae.

During October 2009, on a field visit to Ratnagiri, Maharashtra, it was observed that in the local fish market *Lingula* sp. was being sold along with a host of other bivalve species. On enquiry, it was understood that this species is considered a delicacy by the locals and fetched a good price in the market. The meat inside the shell and the peduncle are both used for consumption. However, some people had some reservations on its consumption as it leads to some sort of acidic problems later. The local fishermen hand pick them from nearby mangrove areas during lowtide and market them in the local market in fresh condition.

Samples from the market were brought to the laboratory for further biological analysis. The length

was measured using a digital caliper and total body weight (±0.01 g) was determined using an electronic balance after the specimens were dried on blotting paper. The *Lingula* sp. was brown-bright green in colour (Fig. 1). Fifty three specimens were measured for individual length and weight. The length ranged from 45 mm to 58 mm with the corresponding total weight ranging from 4.251 g to 10.089 g with the maximum number of animals in 50-54 mm size group. Specimens were dissected to study the food items but could not ascertain them as they are filter feeders feeding exclusively on detritus from mangrove areas. Further investigations are to be undertaken on this important resource.

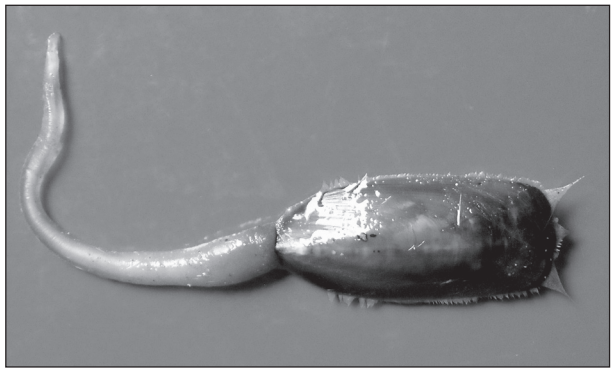

Fig. 1. Lamp shell *Lingula* sp.

Resurgence of whitefish in trawl landings of Mangalore

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Lactarius lactarius, commonly known as false trevally is exploited mainly by trawlers from the inshore waters (5-30 m depth) along the Karnataka coast. Bottom-set gillnets and purseseines also land minor quantities of whitefish, besides the indigenous gears operated during monsoon. The average annual production of false travelly from multiday trawls operated along Mangalore coast remained at 416 t during the period from 2000 to 2002. A declining trend in the fishery was noticed since the year 2000 consequent to reduction in catch rates and the production reached an all-time low of 117 t in 2004. Thereafter, the catch rates in multiday trawl improved significantly from 0.09 kgh^{-1} in 2004 to an annual average of 0.33 kgh^{-1} in 2008 (Fig. 1). During the year, 50% of the annual whitefish landing was observed in October-November months, when the catch rates increased from 0.6 to 0.8 kgh^{-1}. The recent spurt in the total production along the coast was consequent to the high catch rates in the bottom trawlers operated at 10-20 m depth. It is reported that 30-60 kg of whitefish was hauled per net by multi-day trawl in November. The trawl units landed 200-800 kg per trip during the month. The size range of the fishery during the period varied from 110-230 mm with modal length at 160 mm. Gravid and maturing fishes formed 85% during the post-monsoon period.

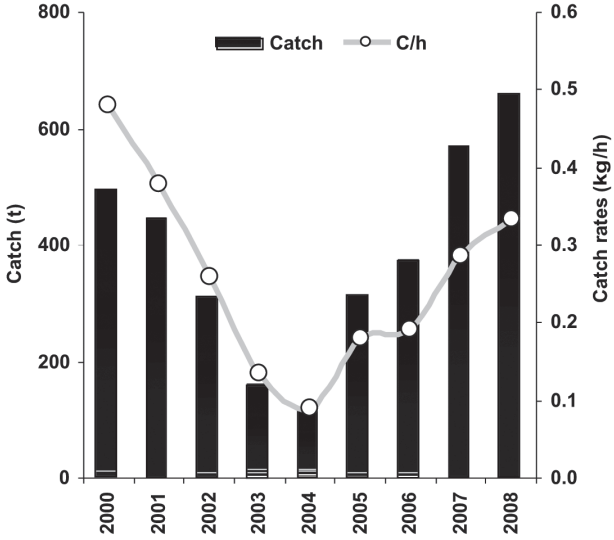

Fig. 1. Annual catch and catch rates of *Lactarius lactarius* in multiday trawlers at Mangalore

Rare occurrence of deepsea snake mackerel off Nagapattinam coast in the Bay of Bengal

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Lepidocybium flavobrunneum (Smith, 1843) has a wide distribution in tropical and temperate seas of the world. The species is considered to be benthopelagic in occurrence between 200 and 1000 m, depth, and probably not reported to occur in the northern Indian Ocean. Balasubramanian (2007) reported on the occurrence of this species during 2004-06 in the landings of large meshed gillnets operated off Tuticorin coast in the Gulf of Mannar. A catch of 4 specimens of *Lepidocybium flavobrunneum* (Fig. 1) belonging to the family Gempylidae (snake mackerels) were observed at Chennai Fisheries Harbour on 5.3.2009. The total length of these specimens varied between 423 and 581 mm with total weight ranging between 520 and 1320 g. These specimens formed part of the landings by Thangal (voyage fishing) trawlers operated at a depth of 150-250 m along the north- east coast of Nagapattinam at a distance of 250-300 km from Chennai. The morphological appearance of *L. flavobrunneum* is almost like seerfish but the colour is dark brown and becoming black with advancing age. Prominent lateral keel on caudal peduncle, flanked by smaller accessory keels above and below were observed. Its stomach was found to be empty and the gonad was immature. This species is found to migrate vertically at night. It is marketed in fresh condition with or without ice and sometimes as dried fish and sold at rates varying between Rs. 50 – 70 in the local markets.

Fig. 1. *Lepidocybium flavobrunneum*

First record of pompano dolphinfish, *Coryphaena equiselis* (Linnaeus, 1758) off Chennai coast in Bay of Bengal

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On 5.9.2009, a catch comprising 15 specimens of pompano dolphinfish, *Coryphaena equiselis* (Linnaeus, 1758) was landed at Chennai Fisheries Harbour by mechanised gillnet. The mechanised gillnets operated usually at a depth between 30 and 50 m at a distance of 30-40 km north of Chennai towards Andhra Pradesh. Since, trawlnets and mechanised gillnets are the main fishing gears operated off Chennai coast, fishes belonging to the family Coryphaenidae formed part of regular landings by these two gears. Normally common dolphinfish, *Coryphaena hippurus* formed regular fishery along this coast. *C. equiseli* (Fig. 1) is very rare and often the fishermen and the fishery biologists might have misidentified this species to the common dolphinfish *C. hippurus*. So far this species has not been recorded to occur along this coast, probably owing to its oceanic occurrence

Fig. 1. *Coryphaena equiselis*

which rarely frequent the inshore waters. This species is an important game fish in northern South America (Fishbase). Reported to attain a size of 75 cm, the adults of this species appear to be more strictly oceanic when compared to the common dolphinfish, *C. hippurus*. This species is observed to form schools, which follow the moving boats and sometimes found to occur under floating objects in the open sea. It is found to feed on small fishes and oceanic squids. Spawning occurs in oceanic waters and the eggs and larvae are pelagic. Always it is marketed in fresh condition and considered an excellent food fish.

Length measurements of the 15 specimens were taken. The total length ranged between 232 and 321 mm with an average size of 289.9 ± 26.36 mm and weighed between 137 and 251 g with an average weight of 202 g. Sex ratio of 25% for females and 75% for males were noticed. Most of the ovaries were observed to be in maturing stages.

First record of scalloped ribbonfish *Zu cristatus* (Bonelli, 1819) at Chennai

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A specimen of scalloped ribbonfish, *Zu cristatus* (Fig. 1.) was landed by trawlnet at Kasimedu Fish Landing Centre at Chennai on 25.02.2009. This is the first record of the species along the Chennai coast. This specimen measured 75 cm in total length and weighed 408 g. The dorsal soft rays were counted as 125. The colour of the fish was silver grey but comparatively paler along the ventral region, dorsal fin scarlet; caudal fin reddish black. The scalloped ribbonfish is reported to have a common distribution along the coasts of Eastern Atlantic, South Africa, Western Atlantic, Gulf of Mexico, Indo-Pacific and Eastern Pacific.

Fig. 1. *Zu cristatus*

Unusual catch rates of cuttlefish in a multiday trawler

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Cuttlefish is one of the commercially important group of cephalopods caught by multi-night trawlers along the coast of Karnataka. The catch rate of cuttlefish in multiday trawlers varies from <5 kg/haul during December-April period to 50-300 kg/haul during the peak fishing season in August-September. On December 8, 2008, a multi-night trawler (15 m overall length) landed record catch of

19.8 t of cuttlefish, *Sepia pharaonis* at Mangalore Fisheries Harbour with an average catch rate of 990 kg^{-1} haul. The trawling was done at a towing speed of 2.5 knot between 5 am and 6 pm. The resource was hauled from fishing grounds off Kaup from 55-60 m depth in rocky areas. The bottom trawl was modified by providing 90-100 numbers of rubber sinkers of 75 mm diameter in the footrope. The catch predominantly consisted of cuttlefish weighing above 1 kg (grade 1). Due to poor export demand, the cuttlefish auction rate was only Rs. 70/ kg earning a revenue of Rs. 13.8 lakhs for the catch.

Cuttlefish landings in multiday trawler at Mangalore Fisheries Harbour

Rare occurrence of the oilfish *Ruvettus pretiosus* along Chennai coast

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The oil fish, *Ruvettus pretiosus* (Cocco, 1833) has a distribution in Mediterranean Sea; Antalaya Bay and also seem to have a wide distribution in tropical and temperate seas of the world. The occurrence of this species is not so far reported from Chennai coast but, *Lepidocybium flavobrunneum* and *Ruvettus pretiosus* belonging to the family Gempylidae have been reported from large meshed gillnets along Tuticorin coast in the Gulf of Mannar during 2004-2006 by Balasubrmanian (2007). A specimen of *R. pretiosus* (Fig. 1 and 2) belonging to the family Gempylidae (snake mackerels), measuring 553 mm with a weight of 1030 g was recorded from trawl landings at Chennai Fisheries Harbour in the first week of March 2009. The trawler operated between 150 and 200 m depth, at a distance of 250 - 300 km along the north-east towards the Nagapattinam coast. The oil fish, *R. pretiosus* has a very rough skin, the scales are interspersed with spinous bony tubercles and its body is uniformly dark blue in colour. Its stomach was empty and the gonad was mature. The morphometric measurements of the specimen are given in Table 1.

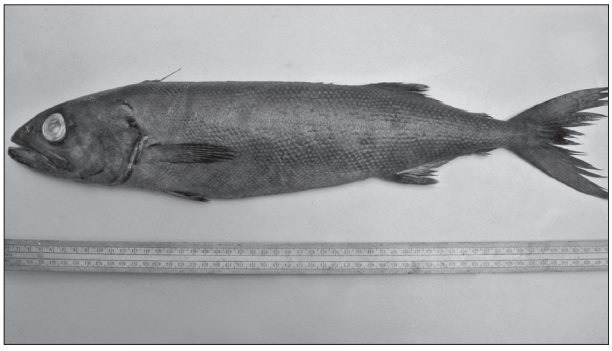

Fig. 1. *Ruvettus pretiosus*

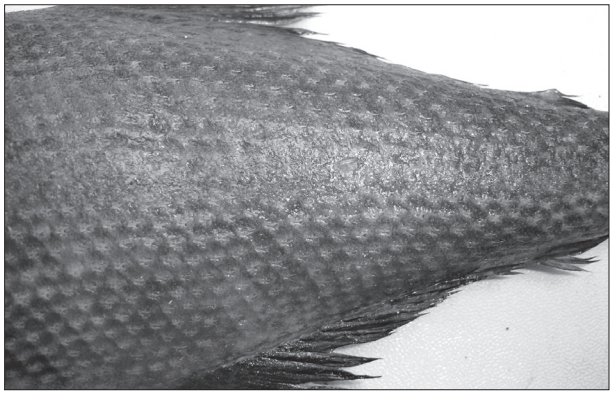

Fig. 2. Close up view of spine like scales of *R. pretiosus*

Table 1. Morphometric measurements (mm) of *Ruvettus pretiosus*

Total length	:	553
Standard length	:	440
Snout to origin of Ist dorsal	:	122
Length of Ist dorsal fin	:	185
Head length	:	133
Snout to pectoral	:	140
Pectoral length	:	73
Body depth	:	102
Eye diameter	:	25
Sex	:	Female
Total weight	:	1.030 kg.

Occurrence of baby turtles at Puthen Kadappuram Beach, Thrissur, Kerala

K. G. Baby
Central Marine Fisheries Research Institute, Kochi

A rare sight of crawling young ones of the marine Olive ridley turtle was seen at Puthen Kadappuram, Thrissur on 22-02-2010. There were 110 nesting eggs which were laid 47 days back in a two feet deep trench about 50 m away from the sea. These eggs were monitored by the local turtle conservation committee and 85 freshly hatched baby turtles were carefully released to the sea at sunrise.

Young ones of Olive ridley turtle observed at Puthen Kadappuram beach

Unusual landing of whale shark *Rhincodon typus* at Neendakara Fisheries Harbour, Kerala

P. T. Mani
Central Marine Fisheries Research Institute, Kochi

On 29-01-2010, a whale shark (*Rhincodon typus*) was landed at Neendakara Fisheries Harbour in Kollam District, Kerala. The shark was caught in Hooks and Line off Chavara. The specimen landed was a juvenile female shark measuring 4.15 m (TL) and 0.83 m (maximum body depth), weighing around 450 kg. The fish was hurriedly put in a lorry and taken away and hence detailed measurements could not be taken.

Whale shark (*Rhincodon typus*) landed at Neendakara Fisheries Harbour, Kollam

Blue whale washed ashore at Kuttayi Landing Centre, Malappuram, Kerala

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Central Marine Reasearch Institute, Kochi

On 27th February 2010, a blue whale, *Balaenoptera musculus,* measuring 31 feet in total length was washed ashore at Kuttayi Landing Centre in Malappuram District of Kerala.

Blue whale washed ashore at Kuttayi Landing Centre, Malappuram

E-prints@CMFRI: Open Access Institutional Repository of Central Marine Fisheries Research Institute

V. Edwin Joseph and P. Geetha
Central Marine Fisheries Research Institute, Kochi

CMFRI launches Open Access Institutional Repository

The Central Marine Fisheries Research Institute (CMFRI), is a pioneering Institute in the field of marine fisheries which conducts multidisciplinary researches on marine capture and culture fisheries. The Institute was established in 1947 by the Government of India under Ministry of Agriculture with headquarters at Madras. It was shifted to Mandapam Camp, Tamil Nadu in 1949. In 1967, the Institute was placed under the administrative control of the Indian Council of Agricultural Research, in the Department of Agricultural Research and Education, New Delhi and later in 1971, it was shifted to Kochi, Kerala.

The Institute carries out in-depth studies on all aspects of marine fisheries and marine aquaculture. For the execution of the research programmes, the Institute collaborates with various national and international organisations. It extends its activities through transfer of technology, dissemination of information through education, training, extension and consultancy services. The research output is published as scientific papers in various national and international journals. Going back to 1948 and up to the present, more than 8,500 scientific publications by the Institute's staff members published in journals, Institute publications, conferences, seminars, symposia, technical reports, theses, patents and related publications are now digitized and made available through 'E-prints@CMFRI', the Open Access Institutional Repository. The Institute's repository 'E-prints@CMFRI' was launched on 26th November 2010 by the Honourable Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR in the presence of Dr. G. Syda Rao, Director, CMFRI.

The repository can be accessed from the Institute website, 'www.cmfri.org.in' and users anywhere in the world can freely download the research outputs. Repository was created using open source software developed by the University of Southampton at UK. For global visibility, the metadata of the repository is made available to search engines like Google, Google Scholar, OAlister, Base, Scientific Common and Scirus. This Repository is listed in the Registry of Open Access Repository, UK, Open DOAR (Directory of Open Access Repository - http://www.opendoar.org/), UK and Avano OAI Harvester. This has placed CMFRI as the first ICAR Institute to reach this stage. CMFRI also ranks first at national level and fifth at global level among the open access repositories on marine sciences.

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