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Catch of juvenile Threadfin bream *Nemipterus* spp. landed by trawlers at Cochin Fisheries Harbour

A view of the fishing vessels operated along the Saurashtra coast, Gujarat

Ribbonfish juveniles landed by trawlers at Munambam Fisheries Harbour

Fish Market at Thoppumpady, Kochi

The Marine Fisheries Information Service *Technical and Extension Series* envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers, and transfer of technology from laboratory to field.

From the Editorial Board.....

The current issue of Marine Fisheries Information Service (MFIS) is published with a lead article on the application of minimum legal size (MLS) in capture fisheries. Recommendations put forth in this regard will help policy makers in managing the marine fishery resources of the country. It was one of the key issues addressed by CMFRI for the benefit of planners and administrators. A few reports on the rarely occurring marine fishes and sightings of marine mammals are included in this issue.

A study on the comparison on Marine fisheries census data and an article on the evolution of fishing crafts and gears from Saurashtra are informative. The regional market structure analysis provides insights into the existing marine marketing channels. An improvised means for satiating the demand is through mariculture. An article on oyster farming with fish highlights the importance of integrated multi-trophic aquaculture (IMTA) practices. Diverse articles on inter-tidal marine habitat of soldier crabs and seaweed *Porphyra* are also published.

With the seafood export earnings touching a record of about Rupees Twenty Thousand crores, there is lot of scope for the marine fisheries sector to contribute significantly to the national exchequer. Sustainable fishing activities and mariculture hold the key to achieving these goals.

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Minimum Legal Size (MLS) of capture to avoid growth overfishing of commercially exploited fish and shellfish species of Kerala

Sunil Mohamed, K., Zacharia, P. U., Maheswarudu, G., Sathianandan, T. V., Abdussamad, E. M., Ganga, U., Lakshmi Pillai, S., Sobhana, K. S., Rekha J. Nair, Josileen Jose, Rekha D. Chakraborty, Kizhakudan, S. and Najmudeen, T. M.
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Background

During the current fishing season, considerable amount of juveniles of small pelagics have been captured along Kerala coast in a targeted manner to meet the demand of fish meal plants. Exploitation of juvenile fish results in considerable economic loss, in terms of what could have been obtained had the fishers waited for a few months and allowed the animal to grow in size and weight. This phenomenon called as growth over-fishing also causes serious damage to the fish stock in terms of long-term sustainability of the resources. A minimum legal size (MLS) is seen as a fisheries management tool with the ability to protect juvenile fish, maintain spawning stocks and control the sizes of fish caught. The MLS sets the smallest size at which a particular species can be legally retained if caught. MLS could be used to protect immature fish ensuring that enough fish survive to grow and spawn, control the numbers and sizes of fish landed, maximize marketing and economic benefits and promote the aesthetic values of fish.

Setting a MLS and implementing the same would increase the economic efficiency of the fishery besides affording protection to juveniles and allowing them to grow in weight and length. Because of the relative fast growth rates in tropical species (as in Kerala), higher weights can be reached very quickly within a few months resulting in higher harvest biomass, and therefore, higher incomes to fishers.

Objective

- To prevent growth overfishing by prescribing MLS for major commercially exploited marine fish stocks of Kerala State.
- Maintain healthy stock of marine fishes off the coast of Kerala.
- Ensure better incomes to marine fishers of Kerala on a sustainable basis.

Treatment

Analyses were carried out with maturity data collected by scientists of capture fisheries divisions of CMFRI. SFM (size at first maturity or size at which

Decision Logic

CRITERIA	EXPLANATION	LOGIC
SSD	Size at sexual differentiation into male and female	This metric can be used to prevent juvenile exploitation and growth overfishing in those stocks which are very abundant, have high reproductive potential and whose biomasses are not affected by high fishing pressure.
MSM	Minimum size at maturity or size of smallest mature fish	This metric can be used to prevent growth overfishing in stocks which are moderately resilient to fishing pressure.
SFM	Size at first maturity or size at which 50% of the fishes are mature	Conventionally used as a metric to prevent growth overfishing completely and recruitment overfishing partially. Can be used in situations where the stock is depleted or rebuilding.
SCM	Size at complete maturity or size at which 100% of the fish are mature	Can be used to prevent recruitment overfishing by capping the maximum legal size of capture. Seasonally applicable to fishes which grow to large size and exhibit slow growth rates.

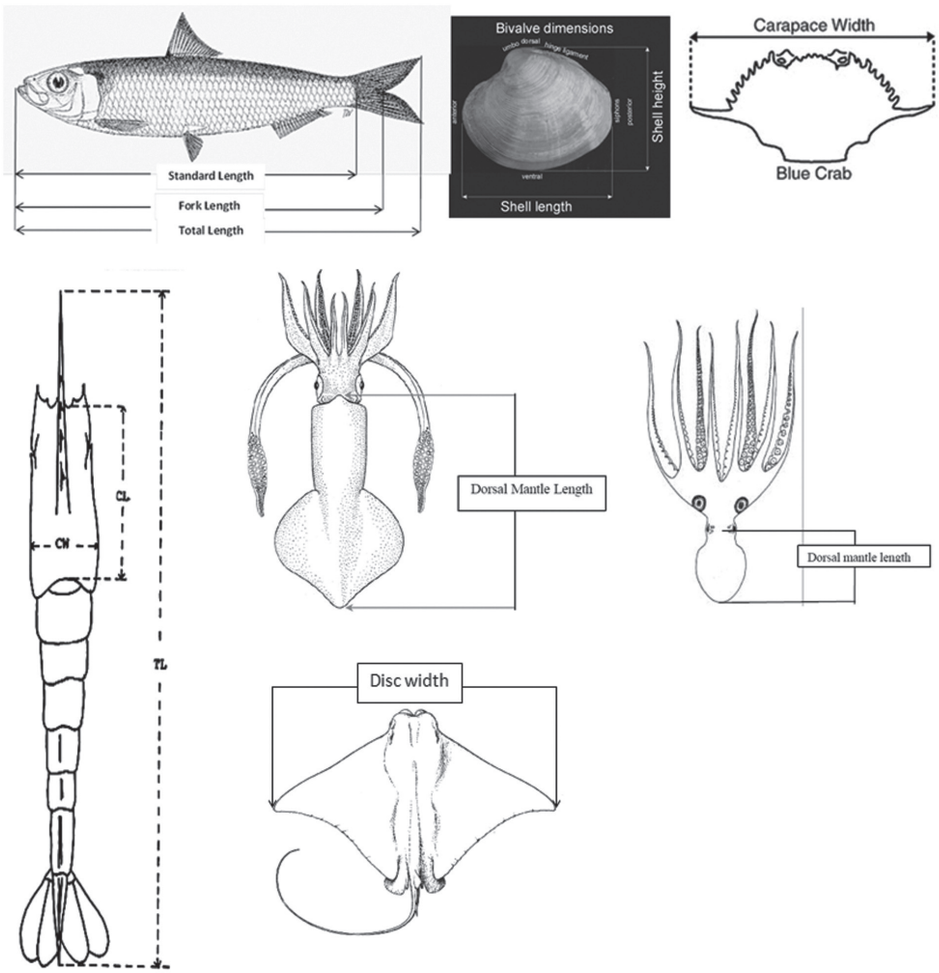
50% of fish are mature) and MSM (minimum size at maturity or size of the smallest mature fish) were determined by logistic curve method. Only female fishes have been considered in this analysis, as males mature at earlier sizes and are reproductively more active.

Net & Mesh Sizes

Exploitation of juveniles of all fishes can be reduced to a very large extent by strictly implementing the optimum net size and mesh size for different gears as prescribed in the recent Trawl Ban Committee Report (2014) already submitted to the DOF-GOK.

Recommendation

1. The CMFRI recommends to the DOF-GOK to implement the suggested MLS (for 58 commercial species) either by promulgating an ordinance or by amending the KMFRA, the former as an immediate measure and the latter as a more permanent measure.
2. The earlier advisory by CMFRI (Pillai *et al.*, 2009) may be considered as revised.
3. For determining violations of the MLS, the DOF is advised to take a random species-wise sub-sample of the catch (about 25-50 numbers), take appropriate measurements, and consider the catch as a violation if more than 50% of the catch sample is composed of fishes at or below the prescribed MLS.
4. Inspections may preferably be carried out at sea or in the landing centre using an unsorted sample.



Recommended MLS for major marine fish stocks of Kerala State to be implemented by the DOF-GOK

No	Species Name	Common Name	Vernacular Name	Recommended MLS (cm) (g*)	Decision Logic	Remarks
Major Pelagic Fish Stocks						
1	*Sardinella longiceps*	Oil sardine	Mathi/ Nei-chala	10 TL	SSD (length of transition from juvenile to adult). MSM is 13 cm	This is a small pelagic having high abundance in the ecosystem. Recruitment is subject to environmental changes and stock is capable of withstanding high fishing pressure. Juvenile fish shoals can be voluntarily avoided by fishers
2	*Rastrelliger kanagurta*	Indian mackerel	Aiyala	14 TL	MSM	This is also a small pelagic, but its abundance is not as high as oil sardine, and therefore needs a more conservative protection measure like MSM.
3	*Euthynnus affinis*	Little tuna	Choora	31FL	MSM	
4	*Auxis thazard*	Frigate tuna	Urulan choora / Kudutha	25 FL	MSM	
5	*Katsuwonus pelamis*	Skipjack tuna	Varayan Choora	35 FL	MSM	
6	*Thunnus albacares*	Yellowfin tuna	Kera	50 FL	MSM	
7	*Auxis rochei*	Bullet tuna	Eli choora	18 FL	MSM	
8	*Sarda orientalis*	Bonito	Neimeen choora	35 FL	MSM	
9	*Thunnus tonggol*	Longtail tuna	Kera choora	44 FL	MSM	
10	*Gymnosarda unicolor*	Dogtooth tuna	Pallan choora	50 FL	MSM	
11	*Scomberomorus commerson*	King seer	Neimeen/ Aiykora	50 FL	MSM	
12	*Scomberomorus guttatus*	Spotted seer	Seela neimeen	37 FL	SFM	The more conservative SFM is applied due to the fact that the stocks are in declining status
13	*Rachycentron canadum*	King fish	Motha	61 FL	SFM	
14	*Coryphaena hippurus*	Dolphin fish	Cycle chain, Pulli motha	38 FL	MSM	
15	*Trichiurus lepturus*	Ribbon fish	Pambada	46 TL	SSD	
16	*Megalaspis cordyla*	Horse mackerel	Vangada	19 TL	SSD	
17	*Selar crumenophthalmus*	Big-eye scad	Aiyilakanni	16 TL	MSM	
18	*Decapturus russelli*	Indian scad	Thiriyan Chamban	11 TL	MSM	
Major Demersal Fish Stocks						
19	*Cynoglossus macrostomus*	Malabar sole	Manthal Nangu	9 TL	MSM	
20	*Nemipterus japonicus*	Threadfin bream (yellow)	Kilimeen Puthiyappla kora	12 TL	MSM	
21	*Nemipterus randalli*	Threadfin bream (red)	Kilimeen Puthiyappla kora	10 TL	MSM	
22	*Lactarius lactarius*	White fish	Parava/ Adavu	10 TL	MSM	
23	*Saurida tumbil*	Greater Lizard fish	Arana meen	17 TL	MSM	
24	*Saurida undosquamis*	Lizard fish	Arana meen	10 TL	MSM	
25	*Pampus argenteus*	Silver pomfret	Vella avoli	13 TL	MSM	

26	*Parastromateus niger*	Black pomfret	Karutha avoli/ Machan	17 TL	MSM	
27	*Priacanthus hamrur*	Bull's eye	Udupu oori/ kalava kuttan	14 TL	MSM	
28	*Otolithes ruber*	Tiger toothed croaker	Kora	17 TL	MSM	
29	*Otolithes cuvieri*	Lesser tiger toothed croaker	Palli kora	16 TL	MSM	
30	*Johnius sina*	Sin croaker	Mutti kora	11 TL	MSM	
31	*Johnius carutta*	Karut croaker	Kuttan kora	15 TL	MSM	
32	*Johnius belangerii*	Belanger's croaker	Kora	14 TL	MSM	
33	*Johnius glaucus*	Pale spotfin croaker	Kuttan kora	15 TL	MSM	
34	*Nibea maculata*	Blotched croaker	Korukka	14 TL	MSM	
35	*Pennahia anea*	Bigeye croaker	Kora	13 TL	MSM	
36	*Epinephelus diacanthus*	Spiny cheek	Kalava grouper	18 TL	MSM	
37	*Himantura imbricata*	Scaly whipray	Mookan thirandi	14 DW	MSM	
38	*Himantura jenkinsii*	Pointed nose sting ray	Thirandi	61 DW	MSM	
39	*Gymnura poecilura*	Long-tailed butterfly ray	Perum thirandi	29 DW	MSM	
40	*Rhizoprionodon oligolinx*	Grey sharp nose shark	Pal sravu	53 TL	MSM	
Major Crustacean Stocks						
41	*Charybdis feriatus*	Crucifix crab	Kurishu njandu	5 CW	MSM	Berried (with egg) female crabs are easily identifiable by fishermen and they should be encouraged to release such crabs back into the sea
42	*Portunus sanguinolentus*	Spotted crab	Kavalan njandu	7 CW	MSM	
43	*Portunus pelagicus*	Blue crab	Kavalan njandu	9 CW	MSM	
44	*Metapenaeus dobsoni*	Flower tail prawn	Poovalan chemmeen	6 TL	MSM	
45	*Parapenaeopsis stylifera*	Kiddi prawn	Karikadi chemmeen	7 TL	MSM	
46	*Metapenaeus monoceros*	Speckled prawn	Choodan chemmeen	11 TL	SFM	This species is depleted and needs additional protection, and therefore, the SFM is used as a conservative measure.
47	*Metapenaeus affinis*	Jinga prawn	Kazhanthan chemmeen	9 TL	MSM	
48	*Plesionika quasigrandis*	Oriental narwhal shrimp	Deep sea pullan	8 TL	SFM	Both these are deep sea shrimps have low regeneration capacities and hence as a conservative measure SFM is used as the metric to decide the MLS.
49	*Aristeus alcocki*	Arabian red shrimp	Red ring	13 TL	SFM	
50	*Panulirus homarus*	Scalloped spiny lobster	Kadal konchu	200 g	WFM	Notified as MLS for export by MPEDA

51	*Panulirus polyphagus*	Mud spiny lobster	Kadal konchu	300 g	WFM
52	*Panulirus ornatus*	Ornate spiny lobster	Kadal konchu	500 g	WFM
53	*Thenus unimaculatus (=T. orientalis)*	Sand lobster	Adippan	150 g	WFM
Major Molluscan Stocks					
54	*Uroteuthis photololigo duvauceli*	Indian squid	Koonthal Olakanava	8 DML	MSM
55	*Sepia pharaonis*	Pharaoh cuttlefish	Kallan kanava	11 DML	MSM
56	*Amphioctopus neglectus*	Ocellate octopus	Neerali Kinavalli	5 DML	MSM
57	*Paphia malabarica*	Short-neck clam	Kalli kakka	2 APM	SFM
58	*Villorita cyprinoides*	Black clam	Karutha kakka	2 APM	SFM

Abbreviations
TL – Total Length
FL – Fork Length
SL – Standard Length
CW – Carapace width of crabs
DW – Disc width of rays
DML – Dorsal Mantle Length in the case of cephalopods
APM – Anterior Posterior Measurement or length of bivalves
SFM – Size at first maturity or the size at which 50% of the fishes are mature
WFM – Weight at first maturity or the weight of the animal where 50% of the fishes are mature
MSM – Minimum size at maturity or the size of the smallest mature fish

Accidental catch of Long-snouted Spinner Dolphin, *Stenella longirostris* (Gray, 1828) at Dummulapeta, Andhra Pradesh

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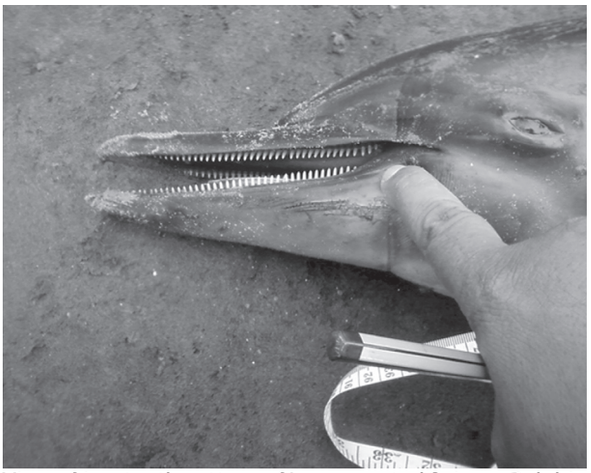
Landing of Long-snouted Spinner Dolphins were reported at Dummulapea landing centre of Andhrapradesh from 11.06.2012 to 12.06.12 and on 21.07.12. A total of five number of spinner dolphin were caught accidentally in gill net locally known as Panduvala and Naravala which was operated at a depth of 18-25m by moorised gillnetter, 20 km away from shore. The total length and weight of the species are ranged from 101 cm to 157 cm and 8 kg respectively. The meat of dolphin is being used

View of colour pattern of Long-snouted Spinner Dolphin

A veiw of Long-snouted Spinner Dolphin accidentally caught by gill net

as bait by fishermen of this region for hook and line fishing of sharks and tuna.

The species is characterized by slender body with an extremely long, thin beak. The head is also slender at the apex of the melon. The dorsal fin slightly falcate and triangular in shape. The tail stock is deepened, with an elongated post-anal keel of connective tissue. The species generally have tripartite color patterns. The dorsal area is dark gray, side is light gray and underside is white. There is a dark band runs from the dark eye to the flipper, bordered above by a thin, light line. The total numbers of teeth on upper and lower jaw are 42-45 respectively.



View of jaw teeth pattern of Long-snouted Spinner Dolphin

The species is listed in Appendix II of CITES (Convention on Interventional Trade in Endangered Speceis of Wild Flora and Fauna) and CMS (Convention on Migratory Species).

Evolution in fishing crafts and gears of the Saurashtra coast

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Veraval Regional Centre of CMFRI, Veraval

Veraval regional centre

Saurashtra coast is situated in the Southwestern part of Gujarat which covers the coastal districts of Porbandar, Junagadh, Rajkot, Dwarka, Bhavanagar, Jamnagar, Amreli, and newly formed Gir somnath. From 1967 to till date there was marked improvement in the fisheries sector of this region. In 1967, trawling was introduced and since then the number of trawlers has increased from 900 to 10,000 (CMFRI, 1978) along the coast.

Crafts used along Saurashtra coast

Trawlers

Trawlers made up of wood are locally known as "halvalii" boat having OAL of 12-16 m with engines of 88-118 hp using nets with a cod mesh size 15-40 mm. Most of the trawlers go for multiday fishing up to 15 days operating along the coast at a depth range of 20-150 m. In 1980s the depth of operation was 20-60 m (Rao and Kasim, 1985). The fishing vessels are operated both northward up to Okha, sometimes in the areas of Kachh and southward off Veraval extending its ground up to Karnataka and Goa. The season of operation starts in September after the 45 days ban from June to August. The cost of a trawler is 25- 30 lakhs.

Gillnetters

OBM (Hodi)

The FRP boats of OAL 8-11 m locally known as "hodi" are operated at a depth of 10-50 m along the coast. They are equipped with outboard motor engines. Each boat carries two engines when they go for long trip fishing as a safety measure. They operate in Veraval, northward off Veraval towards Mangrol and Porbandar and southward towards

Nawabandar and Rajpara. The duration of operation is for 3 days.

Mechanised gillnetter

Mechanized gillnetters made up of fibre locally known as "Bethadi" started operation along the coast in 2008. They exclusively use gillnets (jada jal) targeting tuna and seer fish. At present there are about 150 mechanized gill netters in operation in the region and some trawlers have converted into gillnetters due to less catches in trawls. The depth of operation varies from 150-200 m and duration of voyage is 7 days.

Dolnetters

The dolnetters locally known as "vahan" are of OAL 12-14 m with engine power 85-110 hp. These boats have winch and cold storage facility. The depth of operation varies from 10-60 m. The duration of voyage is 4-8 days. The engine power was used for searching the fishing ground in earlier days but now a days is also used for shooting, piling and hauling.

Time line for the crafts and gears

Trawl net

Trawl nets are locally known as "Oza". Along the Saurashtra coast, trawl fishing first started in 1965 which was for single day operations. Slowly longer trip trawling for three days started in 1975 and 11 days in 2011 due to increase in storage capacity of the boats. The percentage of long trip fishing increased in 1980 onwards and in the present situation 90% of the trawl fishing extends up to 15 days. The target fishing by trawls was started in 2005 mainly for threadfin breams. Recently the trawlers are targeting ribbon fish and squid due to its increased demand in export market. About 10 to 15 trawl nets are carried by the trawlers in each voyage. Along with it they also keep gillnets and hook and line and operate it as and when required depending upon the species availability. The cod-end mesh size for catching ribbon fishes is 40-50 mm with a top of 2000 to 3000 mm while trawl net for other fish catch is having a cod end mesh size of 30-35 mm and top 180- 250 mm. Single day trawlers are having trawl net of cod end size of 15-20 mm and top with 50-80 mm specifically to catch prawns. Target fishing is done for two hauling and they change the gear immediately upon not getting the target fish. As shrimp catch is poorer in these days and as it require more time and laborers for sorting the by catch and debris, shrimp hauling is limited to only single day trawlers.

Fig. 1. A view of the fishing vessels operated along the Saurashtra coast, Gujarat

Gillnets

The use of gillnets started in 1975 which is known as "Kandari jal", made up of cotton and nylon was used extensively along the coast. Slowly jada jal (big mesh gillnets) and chokla jal (small mesh gillnets) were introduced in 1975 onwards and dominated in the fishery due to less catch of seer fish and black pomfret in Kandari net. Nylon monofilament gill nets were introduced in 1976. Mavol jal (thick nylon monofilament) was introduced in 2000 in place of Jada jal. In 2009, chokla jal was modified into Ghaghara jal expanding its width up to 9 to 10 m. Recently, a new gillnet called " Khatri jal" which is a modification of Chokla jal was introduced. The technical details of these nets has been given in table 1.

Prior to 1975 all the gill netters of OAL 8 m were made up of wood. Fiber boat was introduced in 1975 and gillnetters of OAL 11m was introduced in 2001. From 1995 onwards the gillnetters started long trip fishing.

Dolnet

Locally known as "Dor" along the Saurashtra coast these bag nets are about 70-100 m long and each boat carries 3-5 nets. The cod end mesh size

Table 1. Different types of gillnets used along the Saurashtra coast with their operational details

Name of Gill nets	Materials used	Length (mt) (each piece)	Mesh size (mm)	Depth of operation (mt)	Total pieces carried/ boat	Fishes caught	Season of operation
Khandari	Cotton + nylon thin monofilament	4-5	85-90	30-50	40-60	*Hilsa*, *Chirocentrus dorab*,*S. guttatus*, *Thryssa* and other clupeids	Post monsoon
Mavol	Nylon thick monofilamnet	7-8	85-95	80-120	50-80	Tuna, *S. guttatus*, *S. commerson* and *Sphyraena jello*	Post monsoon
Jada	Nylon multifilament	8-10	140-260	50-100	50-250	Sharks, Tuna, *Protonibea diacanthus*, *Otolithoides biauritus*, *Polynemus* etc.	Post monsoon
Chokla	Nylon thin monofilament	4-5	55-60	10-50	25-60	*Trichiurus lepturus*, *Megalaspis cordyla*, Sciaenids and *Rastrelliger kanagurta*	Throughout year
Point (monsoon)	Nylon thin monofilament	7-8	100-110	20-40	30-80	*Pampus chinensis* (small size)	Monsoon
Pankha	Nylon thick monofilamnet	8-10	140-160	10-50	40-80	*Pampus chinensis* and *Parastromateus niger* (bigger size)	Monsoon
Khatri	Nylon thin monofilament	4-5	85-95 and 100-125	10-60	20-45	Hilsa, smaller sized tuna, Mackerel, Catfish	Throughout year

is 25-35 mm and top mesh size 110-240mm. They also go for long trip fishing of 4 to 8 days taking 15-25 hauls. During 1975 the length of dolnet was 40 feet and it became 100 ft in 2001.

The dol net mechanization started in 1966 and 100% mechanization happened in 1995. Winch and pulley system started in 2001 and dolnetters started to carry ice in 2006.

Oysters improve growth of fish in an integrated aquaculture system in a tropical estuary

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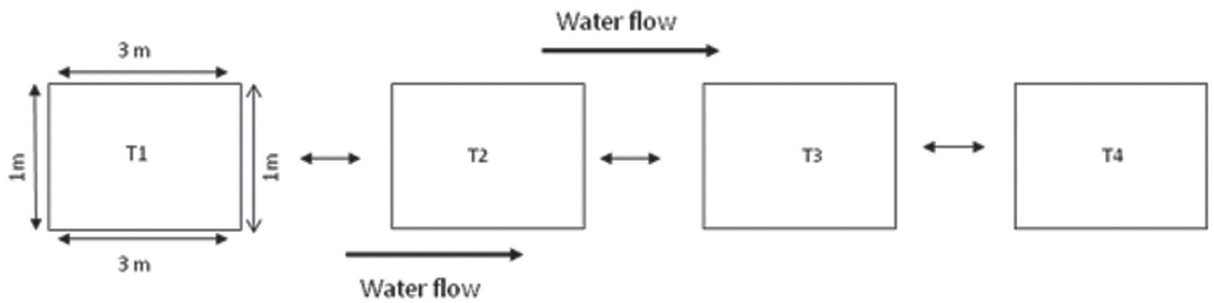
Aquaculture generates large amounts of wastes in the form of uneaten food, faeces, and excretory metabohts. Increased environmental concern about the rapid expansion of aquaculture systems has resulted in integrated techniques where more than one species are cultured simultaneously, as a means

of using the waste. The main concept of integrated systems such as Integrated Multi- trophic Aquaculture (IMTA) is to convert the soluble and solid waste products of the main culture organism (fish or shrimp) into additional valuable products thereby reducing environmental impacts and increasing the sustainability of the farming operation.

If waste material from fish culture is being broken down into finer particles, suspension feeding molluscs may be suitable for absorbing the organic particulate wastes. A bioremediative approach, utilizing lower trophic levels as nutrient recyclers, could reduce waste products and sedimentation, diversify products, and provide economic gains for growers.



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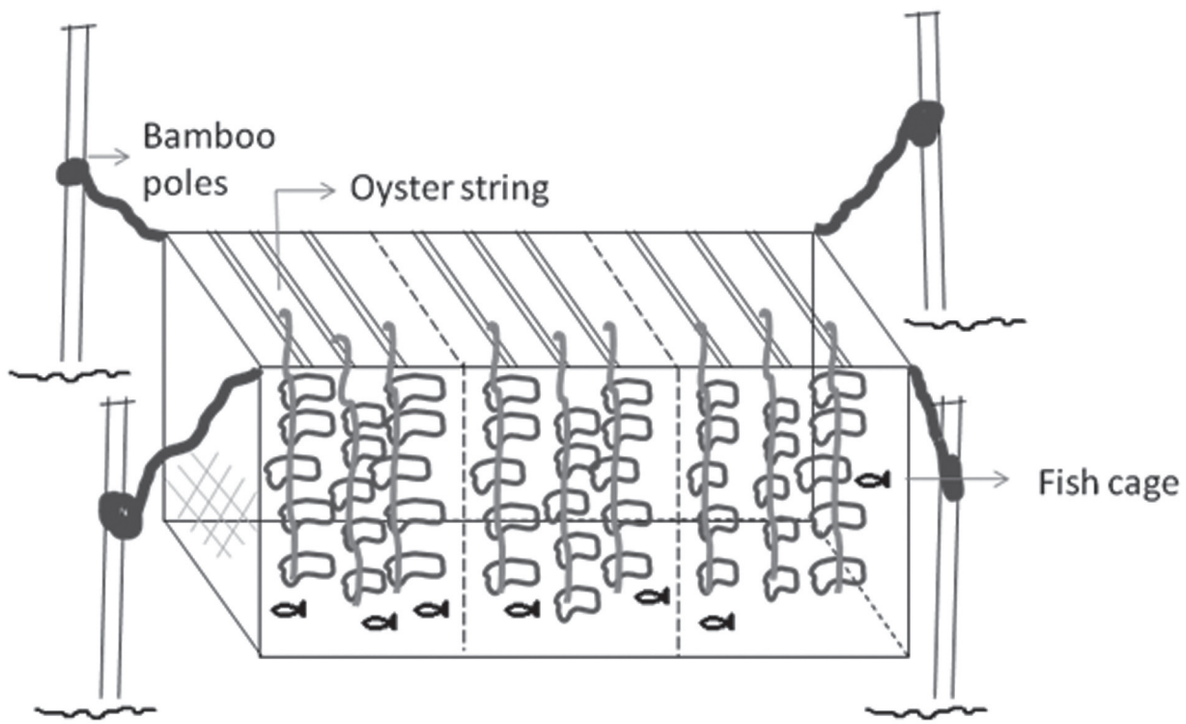


Fig. 1. Experimental setup. A) Schematic lay-out of the system B) Schematic layout of a single cage

Cycling of nutrients in estuaries may be controlled in large part by filter feeding bivalves. Bivalves feed selectively, so that certain particles are ingested and digested while others are rejected as pseudofaeces. Such selective feeding could affect the nutrient (nitrogen and phosphorous) removal, enhance water clarity and thereby increase the growth of the fishes cultured in the system. Here we report, in brief, the results of a study which focuses on the role of oysters in improving the growth of fishes in an integrated aquaculture system in a tropical estuary of Kerala.

The field work was carried out in Azhikode estuary at Moothakunnam ($10^0 11´$ N and $76^0 11´$ E), Ernakulam District. The experimental setup consisted of four cages (T1, T2, T3 and T4) which were laid in the direction of the current and the distance between cages being 50 m (Fig.1). Each treatment was made in triplicate. The area of the cage was 1 m^2 and the depth was 1 m. The organisms chosen for culture were the pearl spot, *Etroplus suratensis* and the Indian backwater oyster, *Crassostrea madrasensis*. The four cages differed in the stocking density of the organisms cultured. Keeping the quantity of the fish steady (100 per cage of 3-5 g fish), the oyster stocking biomass was 1:0.3 (T1), 1:0.5 (T2) and 1:0.7 (T3). The control (1:0; T4) did not have any oyster. Fish were fed daily with pelleted feed at the rate of 80-100% of the body weight initially and 5-8% during the last phase of culture. The culture period lasted for 270 days.

Samples were taken on a monthly basis from February to November 2012. During the study period temperature, pH, salinity and DO were measured. The nutrient parameters measured in the samples included ammonia, nitrite, nitrate (dissolved inorganic nitrogen, DIN) and orthophosphate (dissolved inorganic phosphorus, DIP). Samples of fish and oysters were collected monthly to obtain the length-weight data.

Water Quality

Temperature, pH and salinity did not show any variation between the four treatments. The temperature at the culture site during the study period ranged from 27.7^0C in August to 32^0C in November The pH ranged from 7.5-7.8 during the study period and the salinity ranged from 0.15 ppt in August to 30 ppt in May.

The DO measured during the culture period varied between the four treatments. Among the four treatments, higher value for DO was observed in T2 (9.36 ± 0.41ppm) and lower value in T4 (5.39 ± 0.7 ppm). Higher value in T2 could be attributed to the optimum stocking density of oysters whose filtration capacity reduces the turbidity thereby increasing the light penetration and thus the levels of DO. The absence of oysters in T4 causes excess heat adsorption due to the presence of concentrated sediments and thus reduce oxygen levels.

Nutrients

Nutrients are important parameters in the estuaries influencing growth, reproduction and metabolic activities of biotic components. Phytoplankton are filtered from the water column by the oysters and after ingestion and digestion these nutrients are available to support the oyster's metabolism and growth. Nutrients like nitrogen, and to a lesser amount phosphorus, in the form of dissolved inorganic nitrogen and phosphorus (DIN and DIP) are required to synthesize proteins used to build tissue as the oyster grows. The nutrients, ammonia [NH_3], nitrite [NO_2^-] and nitrate [NO_3^-] constitute the dissolved inorganic nitrogen (DIN) while dissolved inorganic phosphorus is constituted by orthophosphate [PO_4^{3-}].

The four treatments showed variation in the ammonia content (Fig. 2). Among the four treatments, T2 was characterized by lower values of ammonia (0.04± 0.01 ppm) and higher values (0.13 ± 0.03 ppm) by T4. The presence of filter-feeding oysters in T2 stimulates the bacterial process of nitrification and denitrification, helping the escape of nitrogen gas, thus lowering the ammonia content in water. The nitrite and nitrate values did not show any variation between the treatments. Nitrite and nitrate values ranged from 0.002 to 0.009 ppm and 0.003 to 0.10 ppm

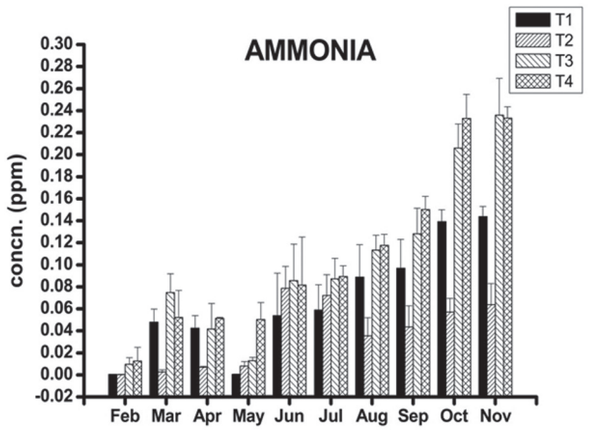


Fig. 2. Monthly variation in ammonia during 2012 for the treatments 1,2,3,4

respectively. Treatments 1, 2 and 3 were found to be similar in orthophosphate content (Fig. 3) with T2 exhibiting higher levels (0.05 ± 0.01ppm) and T4 showing lower levels (0.03 ± 0.01ppm). The removal of phytoplankton by oyster filtration in treatments 1, 2 and 3 prevents the assimilation of orthophosphate by the phytoplankton and thus increased level of the nutrient.

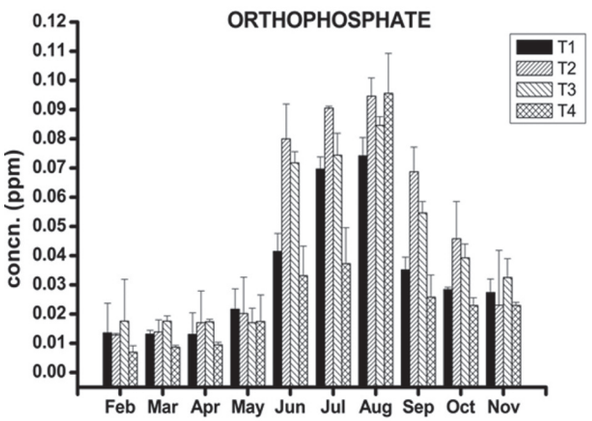


Fig. 3. Monthly variation in orthophosphate during 2012 for the treatments 1,2,3,4

Growth of fish and oysters

The organisms were harvested at the end of the culture period (Fig. 4, 5, 6). Highest mean length (12.95 ± 0.36 cm) and mean weight (69.62 ± 6.70 gm) of fish were obtained from T2. The specific growth rate in terms of fish weight in T2 was 1.38% which was higher than the other treatments. Data collected on shell length and width of oysters showed that T2 recorded the highest value of 92.11 ± 2.94 mm and 51.39 ± 1.61mm respectively (Table 1).

Fig. 4. Harvest of fish and oysters at the end of the culture period

Fig. 5. Harvested fish

Fig. 6. Harvest of oysters at the end of the culture period

Summary and conclusions

The results shows that the treatments 1, 2 and 3 outperformed T4 regarding the various water quality parameters and growth of fish and oysters. The

Table 1. Biological parameters of fish and oysters at the end of the culture period

Treatments	Fish			Oyster		
	Length (cm)	Weight (gm)	SGR_w (%)	Length (mm)	Width(mm)	SGR_l(%)
T1	12.19 ± 0.34	59.14 ± 4.57	1.32	72.73 ± 2.72	49.68 ± 1.72	0.25
T2	12.95 ± 0.36	69.62 ± 6.70	1.38	92.11 ± 2.94	51.39 ± 1.61	0.29
T3	11.75 ± 0.32	54.14 ±5.21	1.24	68.14 ± 1.50	48.91 ± 1.37	0.24
T4	11.74 ± 0.30	50.77 ± 6.21	1.20	_	_	_

*SGR_w- specific growth rate of fish in terms of weight

*SGR_l - specific growth rate of oysters in terms of shell length

better results in T2 could be attributed to the reason that fish and oysters in the ratio of 1:0.5 by weight is the optimum stocking rate in an integrated aquaculture using fish and oysters in a tropical estuarine system.

In summary, the present study has shown that oyster culture has a significant impact in connecting water column processes where nutrients are central to the production of single cell plankton upon which oysters feed. The filter-feeding oysters process the DIN and DIP pool, to help attain water quality improvements and thereby improve the growth of fish.

A comparative study of marine fisher-folk census 2005 and 2010 of Puducherry

D. Pugazhendi
Madras Research Centre of CMFRI, Chennai

The Central Marine Fisheries Research Institute regularly undertakes **Marine Fisheries Census** for all the maritime states of the country. Based on the census report of Puducherry a comparative study focusing mainly on population, fishing villages, landing centres, sex ratio, religion, BPL, education and occupation was carried out for two census period viz. years 2005 and 2010.

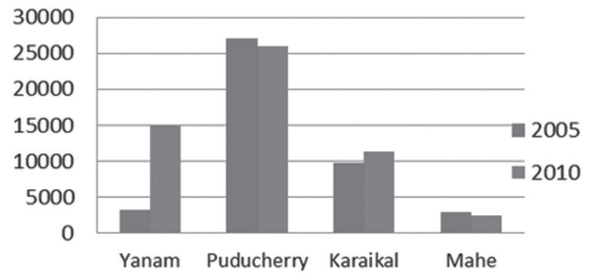
The Union Territory of Puducherry comprises of four coastal districts namely, Yanam, Puducherry, Karaikal and Mahe with coastline extending over 45 km.

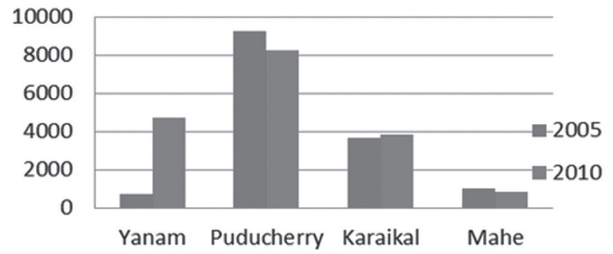
Population

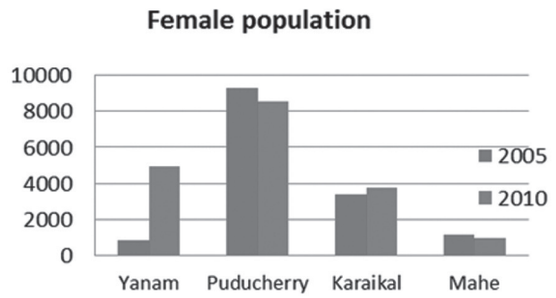
The fisher-folk population has been recorded during 2005 and 2010 as 43028 and 54627 respectively. The average family size slightly increased after five year period and average person per village has considerably decreased in Karaikal district where as in the other three districts it increased significantly. The adult population of male and female have increased by 0.3 and 3.3 % respectively and both male and female children population evenly increased to 29 and 25% respectively (Fig. 1.).

Landing Centres and Fishing Villages

A total of 28 and 40 fishing villages were recorded during 2005 and 2010 respectively. Though the number of fishing village has increased over the period the number of landing centre decreased by 1, making a total of 25 during 2010. In Yanam district fishing villages increased 6 times over the period followed by puducherry district increased by 2 time. Though 10 fishing villages have popped up in the Yanam district there is no single landing center recorded. Puducherry and Karaikal district landing centre sizes increased and decreased by one each respectively, and Yanam district has no landing centre by losing one centre over the 5 years.







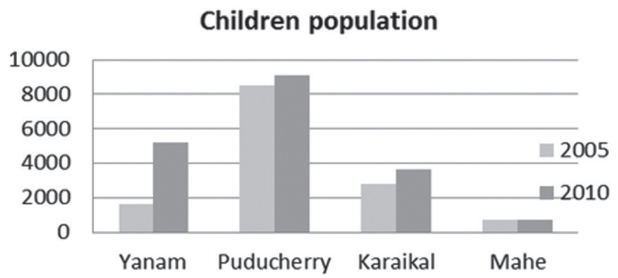


Table 1. Fishing Villages, Landing Centres, family size, total population

	Landing Centres		Fishing Villages		Fishermen families		Fisher-folk population		Average Family Size	
District	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Yanam	1	0	2	12	775	3754	3218	14893	4.15	3.97
Puducherry	15	16	15	17	7513	7088	27047	25892	3.60	3.65
Karaikal	9	8	10	10	2858	3077	9858	11294	3.45	3.67
Mahe	1	1	1	1	395	352	2905	2548	7.35	7.24
Total	26	25	28	40	11541	14271	43028	54627		

Sex Ratio

In the year 2005, average female to male ratio was 980. The Mahe district has the highest value of 1114 and the Karaikal district remained last with a value of 936. The average sex ratio in 2010 was 982, and the highest and lowest value remained same after 5 years. There is closer to perfect ratio in the Yanam district with a rated of 1007 in 2010.

Religion

The people belonging to Hindu religion families constituted 99.2 and 99.7% in 2005 and 2010 respectively. The Christian and Muslim families had been moved down marginally. The SC/ST population have decreased by 27% over the period. The Yanam and Puducherry districts got more SC/ST population and 97% families migrated to Yanam and Puducherry districts.

Membership

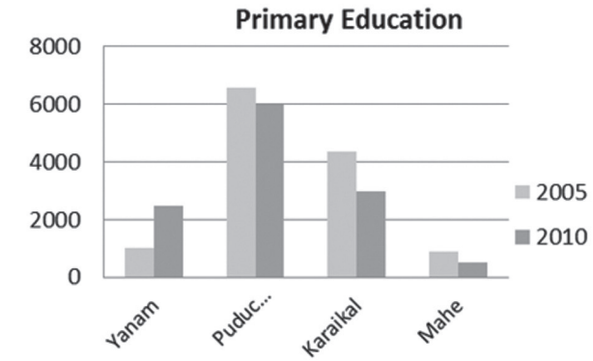
In 2005, about 63% adult fisherfolk have membership in fisheries and other co-operative societies where as in 2010 the adult fisherfolk having membership in co-operative societies increased by 8%.

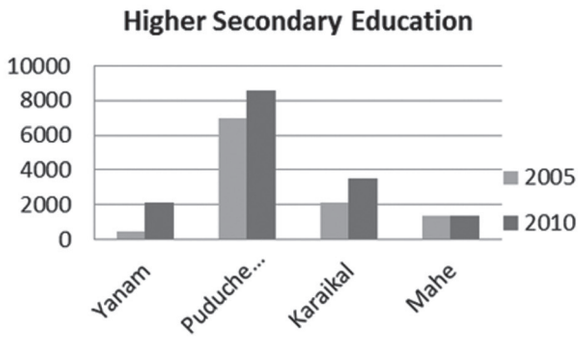
Below Poverty Line

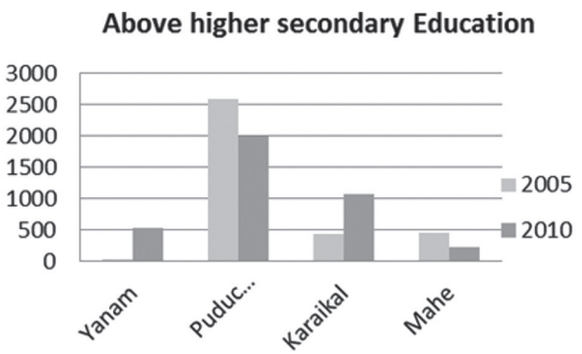
The latest survey reveals that 77% of families fall below poverty line. The Yanam district acquired disfavor status of first place with 96% followed by Puducherry 73% and Karaikal 67%. In 2011-12, a general survey reveals that 9.7% of population are Below Poverty Line (BPL) in Pondicherry despite Govt. of India estimates for in 2011-12 was 21.9% by Planning Commission adopting Tendulkar Methodology.

Education

Literacy shows decreasing unschooled strengths in 2005 and 2010 as 37% and 32% respectively. Primary education decreased by 8% whereas higher secondary level increased by 3%. On the whole literacy level decreased by 6% (Fig 2.).







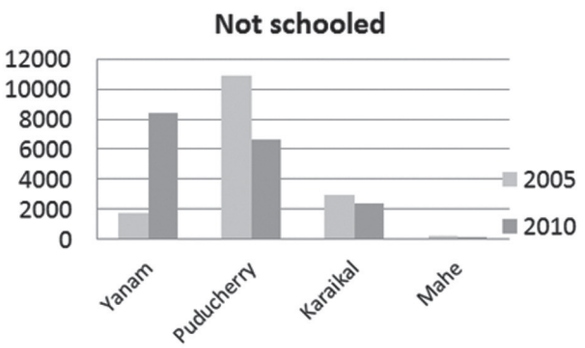
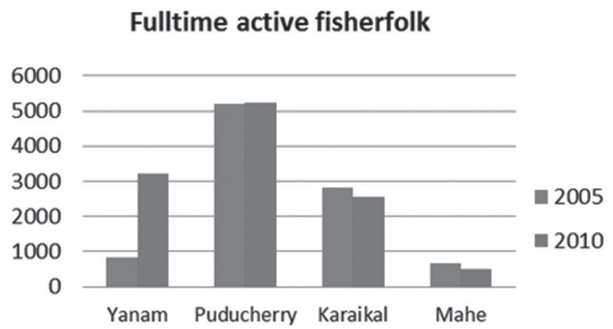


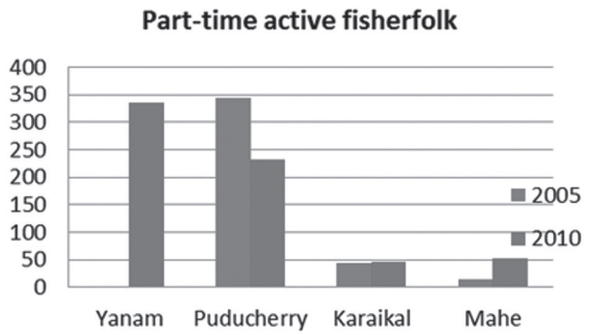
Table 2. Male, Female and Children population distribution

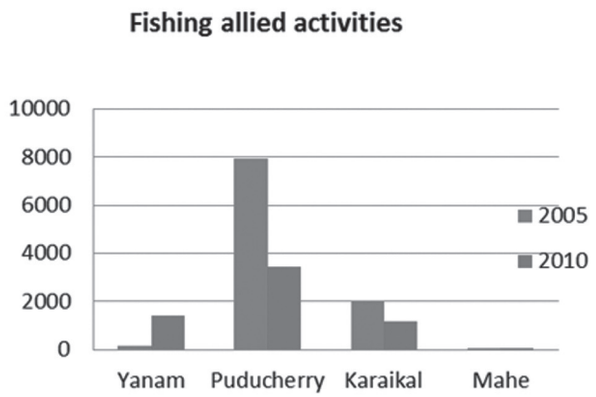
	Male Adult		Female Adult		Male Children		Female Children		TOTAL	
District	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Yanam	751	4714	845	4975	823	2707	799	2497	3218	14893
Puducherry	9247	8253	9312	8559	4447	4909	4041	4171	27047	25892
Karaikal	3678	3870	3401	3764	1413	1903	1366	1757	9858	11294
Mahe	1021	858	1180	992	353	341	351	357	2905	2548
Total	14697	17695	14738	18290	7036	9860	6557	8782	43028	54627

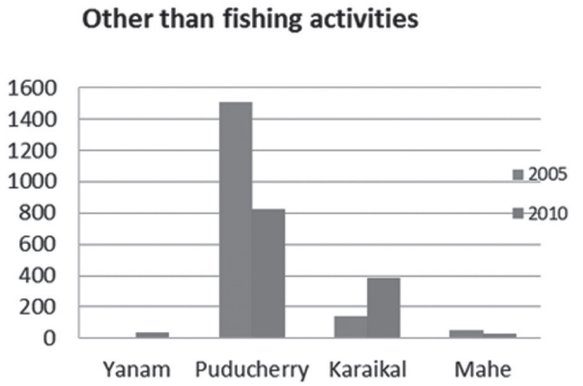
Table 3. Occupation details of fishermen in various districts

	Full Time Fishing		Part Time Fishing		Fishing Allied Activities		Other than Fishing	
District	2005	2010	2005	2010	2005	2010	2005	2010
Yanam	818	3217	0	336	145	1390	0	33
Puducherry	5208	5247	343	233	7956	3417	1505	821
Karaikal	2804	2547	44	47	1980	1192	143	387
Mahe	673	499	14	52	14	11	49	30
Total	9503	11510	401	668	10095	6010	1697	1271









Occupation

The full time fishermen density over the periods increased from 92 to 94% and the same trend continue even in part time by 2%. Of the total fishermen population, the active full time and part time fishermen increased by 21 and 66% respectively. The fisher-folk to engaged in allied activities such as marketing, repairing/making nets, curing/ processing, peeling, labours and other related activities drastically decreased by 40%. The deviation from fishing activities shows favorably that 421 fishermen returned to their traditional line of work by 25%. The Puducherry and Karaikal fishermen have more trustiness on their own industry by engaging 85%. The ratio of other than fishing was decreased by 8% over the periods.

Arothron stellatus (Anonymous, 1798) recorded from Gujarat, northwest coast of India

Sreenath, K. R., Koya, M., Gyanaranjan, Dash, Swatipriyanka, S., Vinayakumar, V., Pradeep S., Shiju P., Kumari, S. and Makwana, N. P.
Veraval Regional Centre of CMFRI, Veraval

On 25th March 2014, a juvenile specimen of *Arthronstellatus* was landed by multiday trawler at Bhidiya Harbour, Veraval. Secondary information collected from the fishermen roughly indicates that the fish was caught from a depth of 60 - 70 m. This fish which is poisonous to eat is commonly called

as Starry Puffer because of its typical body coloration. It is distributed in shallow waters in the tropical and subtropical areas of Indo-Pacific region.Though there are earlier reports of this species from Southern coasts of India, this is for the first time it is being reported from Gujarat waters.

***Arothron stellatus* (Anonymous, 1798)**

SYSTEMATICS

Class ACTINOPTERYGII

Order TETRAODONTIFORMES

Family TETRAODONTIDAE

Genus *Arothron* Muller, 1841

Arothron stellatus(Anonymous, 1798)

Fig. 1. *Arothron stellatus* juvenile

Diagnosis

A single lateral line on the side of torso; nasal organ is not covered by a small sac with two nostrils like other tetraodontids and have two bifid tentacles; nasal organ is visible to eye without any magnification in adults but not so easily detectable in juveniles

Description

Arothron stellatus has an oval body which is spherical and elongated. The skin is not covered with scales but with small spinules. Pelvic fin is absent. The dorsal fin and the anal fin are small, symmetric and located at the rear end of the body. The head is large with a short snout which has two pairs of nostrils with bifid tentacles.The mouth is terminal with four strong teeth.

Coloration

The juveniles are characterized with deep yellowish body with black zebra stripes. Young adults may retain the stripes and yellow colour in the ventral region but primarly white coloured with star like spots. Light yellowish fins. Median fins with dark spots.

Distribution

Commonly found in the deep reef associated areas with sandy bottom. In India occurrence of this species were reported earlier in the southern region viz., Vizhinjam, Kashimedu, off Ratnagiri *etc.*

Table 1. Morphological and Meristics measurements of *Arothron stellatus* juvenile

Sl No	Characters	Measurements in mm
1	Total length	85
2	Standard length	71
3	Body depth	70
4	Eye diameter	4
5	Dorsal fin length	7
6	Dorsal fin base	2.5
7	Anal fin length	6
8	Anal fin base	3
9	Pectoral fin Length	11
10	Pectoral fin base	8
11	Caudal fin length	18
12	Caudal Peduncle depth	7
13	Total weight	34
14	Dorsal soft rays No.	10
15	Anal soft rays No.	11
16	Pectoral fin No.	18
17	Caudal fin No.	9
18	Weight (in grams)	36

Occurrence of *Porphyra* sp. from Dhalawapuram, Ashtamudi Lake

Kaladharan, P., Khambadkar, L. R., Alloycious, P. S. and Saji, K. K.
Central Marine Fisheries Research Institute, Kochi

Porphyra, the most important red algal genus is widely cultivated for edible purposes. It is commonly known as purple laver and its value added product marketed as *nori* is very popular in Japan. *Porphyra* grows normally in temperate waters which is the most widely consumed marine alga in the world. There are more than 150 species of *Porphyra* reported to occur worldwide and four species are known from Indian waters.

Huge mass of large, foliose and purple- red thallii of red seaweed *Porphyra* sp were found floating in Dhalawapuram estuary of Vembanad lake system near Neendakara during the second week of February 2014 which lasted till the end of the month. The floating thalii of *Porphyra* sp (Fig. 1) were deep purple coloured, flat, thin but mucilaginous and foliose. Some of the floating bits of *Porphyra* sp. could be seen with discoid holdfast connected through short stipe. The thallus length ranged from 20-32 cm and the breadth ranged from 9- 14 cm and the margin was entire. Along with *Porphyra* sp. *Ulva reticulata*, (Fig. 2) *U. fasciata* and hydromedusae were found floating. The water salinity was 30 ppt.

Fig. 1 Thallus of *Porphyra* sp. floating in the estuary

Fig. 2. Entire thallus of *Porphyra* sp collected from Dhalawapuram

Besides the floating mass, no plants of *Porphyra* sp. growing attached to rocks or shells could be observed from the Dhalawapuram estuary. To collect any fresh and living specimens of this red alga, attempts were made from the intertidal rocky coast of Thirumallavaram during the low tide on 1st March 2014 and we could see neither any living nor floating purple coloured algae. However, some bits of partly dried thallus of *Porphyra* sp with short stipe and discoid holdfast were found cast ashore along with

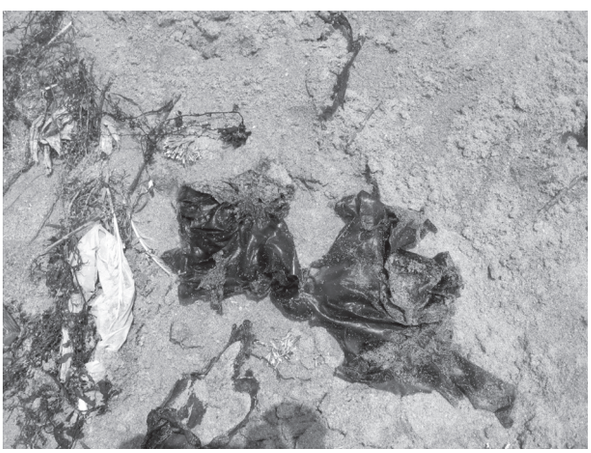


Fig. 3. Partly dried seaweeds from the Valavilthopu beach

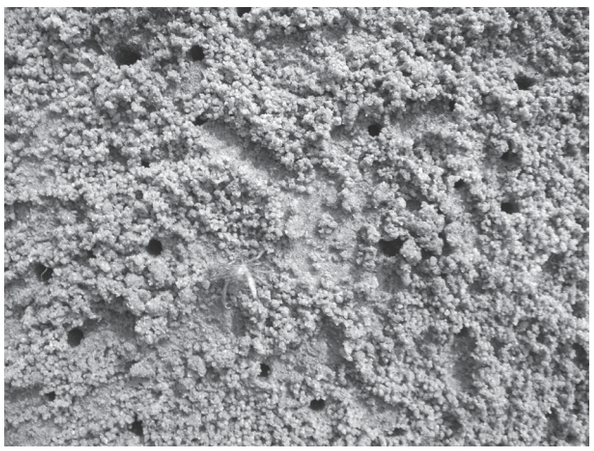
Sargassum wightii, *Ulva reticulata* and *Stoechospermum marginatum* from Valavilthoppu beach (Fig. 3) which is situated 1.5 km north of Thirumallavaram and just before the Neendakara barmouth.

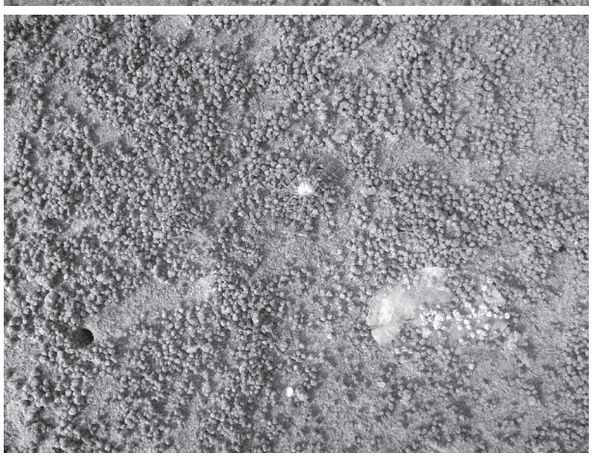
As we could collect only the floating mass of *Porphyra* sp. though in huge quantities and even from the eastern region of the estuary (St Sebastian Island) which is far away from the barmouth, it is believed that these plants of *Porphyra* sp. grow in the rocky intertidal waters of Thangaserry - Thirumallavaram and after getting detached drifted along with the northerly current and might have entered the Dhalawapuram estuary during the high tide hours.

Predation of droves of soldier crabs (*Dotilla myctiroides*) by red fire ants *Solenopsis invicta*

Kaladharan, P., Asokan, P. K. and Anasukoya, A.
Calicut R.C. of CMFRI, Kozhikode

Soldier crab *Dotilla myctiroides* is a known burrower and form dense aggregations called droves around tropical muddy or sandy beaches including mangrove swamps. Due to their burrowing and feeding activities, one can see deposition of pseudofaecal and excavated pellets of moist sand around their burrows. Hence they are also known as sand bubbler crab. During the low tide they remain buried inside the burrows. In one of the routine observations on the seagrass flats near the mangrove stands of Kadalundi, near Kozhikode during low tide, we could observe the red fire ants inhabiting on the reeds and shrubs growing along the beach were dragging live soldier crabs from their burrow (Figs 1-3) and taking them to their nest for





consumption. This could be seen during the subsequent observation trips during the low tide at the seagrass flats. This invasion of red ants of

terrestrial ecosystem to the burrows of *Dotilla* crab of intertidal zone adjoining seagrass ecosystem and the possible threat to *Dotilla* due to regular and mass predation is reported for the first time. *Dotilla* plays an important role as a sediment mover in this very specialized habitat.

Giant devil manta rays landed by purse seiner at Cochin fisheries harbour

Kishor. T. G., Shiyas. C. A., Sivakumar. G., Rekha J. Nair, Dinesh Kumar. S., Seetha. P. K., Sobhana. K. S., Najmudeen. T. M., Sajna. V. H. and Zacharia. P. U.
Central Marine Fisheries Research Institute, Kochi

Two specimens of giant devil ray, *Manta birostris* locally known as '*Aanathirandi'* measuring 307 and 194.5 cm in TL, 534 and 416 cm in disc width and weighing about 780 and 570 kg respectively were landed at Cochin fisheries harbour on 19.05.14 and 20.05.14 (Fig. 1). *Manta birostris* are caught generally by gill net and on this occasion these rays were caught from the inshore waters off Cochin at $9^0$52'N., $9^0$56' E at a depth of 30-40 m by purse seiner boats. Along the Indian coast, landings of devil

Fig. 1. Giant Devil Manta ray *Manta birostris* landed at Cochin Fisheries Harbour

Table 1. Morphometric measurements of *Manta birostris* landed at Cochin fisheries harbour

Sl. No.	Measurements	Specimen 1 (Female) (cm)	Specimen 2 (Male) (cm)	Pup (female) (cm)
1	Total length	307	194.5	148
2	Standard length	292	182	87
3	Disc width	534	416	176
4	Mouth width	80	64	23
5	Inter gill length	65	48	17
6	Inter cephalic horn distance	95	71	30
7	Cephalic horn length	65	39	20
8	Cephalic horn width	26	19	10
9	Eye length	6.5	6	3.5
10	Eye width	6	5.5	3
11	Inter orbital length	140	108	76.5
12	Vent length	41	16	9
13	Pelvic fin length	25	-	13
14	Pelvic fin width	74	-	8
15	First gill slit width	72	41	17
16	Second gill slit width	67	43	18
17	Third gill slit width	63	41.5	16
18	Fourth gill slit width	55	37.5	15
19	Fifth gill slit width	50	29.5	12
20	Total weight (kg)	780	570	22
21	Clasper inner length	-	26.5	-
22	Clasper outer width	-	10	-
23	Clasper width	-	6	-

rays have been reported during 25 occasions.However, is the first report with detailed measurements (Table 1) from Cochin Fisheries Harbour.

The ray could be identified as *Manta birostris* with the unique characteristics such as long gill plate, uniform dark brown/black coloration, terminal mouth, knob-like bulge at base of tail with a small dorsal fin. Inner side of mouth and cephalic fins coloured black, cephalic fins large and unfurl to meet together at the centre of the mouth. The giant oceanic manta ray *M. birostris* belong to the family Mobulidae, and is considered as the largest ray in the world. They are circum global in distribution and are typically found in tropical and subtropical waters, but can also be found in temperate waters. Manta rays feed on plankton which they scoop up with their large mouths. They take a long time to reach sexual maturity, have long gestation periods, and often give birth to a single pup. *M. birostris* is considered as 'Vulnerable' by the IUCN Red List of Threatened Species.

The specimen landed on 19.05.14 was a mature female and the other one was a mature male with calcified and long claspers. When the fish was cut open a young female pup measuring 148 cm in TL, 170 cm disc width and weighing about 22 kg was obtained from inside the womb, stomachs were empty (Table 1). The manta rays are generally utilised for their gill plates, meat, cartilage and skin. There is increasing demand for the brachial filter plates of manta rays in southeast Asian countries for medicinal purpose and for preparation of soups.

Fig. 2. *Remora albescens*, found inside the gill chamber of Manta ray

Four numbers of white manta sucker fishes identified as *Remora albescens* and the Indo-Pacific oval flounder *Bothus myriaster* were collected from the gill chamber (Fig. 2). The sucker fishes were in living condition when collected.

Further landings of manta rays at Cochin Fisheries Harbour were reported by local news papers on 18th and 22nd May 2014 also. The details are given in the Table 2. Landing of Manta rays in purse seiner was earlier reported from Karwar Fisheries Harbor (Kakati and Dinesh, 1995).

Table 2. Details of manta rays landed at Cochin Fisheries Harbour

Sl. No.	Date	Number of rays landed by purse seiner	Total weight (kg)
1.	18/05/14	2	2400
2.	19/05/14	1	780
3.	20/05/14	1	570
4.	22/05/14	1	650

Market structure analysis of fish markets in Ernakulam district

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Central Marine Fisheries Research Institute, Kochi

Fisheries sector, being one of the major productive sectors of Kerala, contributes to about 3 per cent to the economy of the state (DoF, Kerala, 2011). Kerala has a coastline of over 590 km, covering nine coastal districts with 222 fishing villages and 187 landing centres (Marine Fisheries

Census, 2010). Ernakulam district is one of the leading coastal districts in marine fish production (26 % during 2013) with 46 km of coastline. The marine fisheries profile of Ernakulam district is given in Table 1.

Table 1 Marine Fisheries Profile of Ernakulam District

1	Total coastline (km)	46
2.	No. of landing centres	20
3.	No. of fishing villages	21
4.	No. of fishermen families	9318
5.	Total fisher folk population (lakhs)	0.42
6.	No. of fish markets	198
	Wholesale markets	24
	Retail markets	134
7.	Number of export units	66
8.	Crafts in the industry	1443
	No. of mechanized	82
	No. of motorized boats	326
	No. of non-motorized boats	1035
9.	Fisheries production (2013) lakh tonnes	1.61

Source: Marine Fisheries Census (2010) CMFRI
PANFISH Book, Ernakulam District, Department of Fisheries, Kerala

Fig. 1. Chambakkara fish market

Fish market structure analyses

The market structure analysis was based on the major dimensions namely; location, lat- long ,type of market, access, timing, conduct, arrival and disposal sources, infrastructural adequacy, union and regulation and news and intelligence. The market structure of three major markets viz., Chambakkara, Thevara, and Thoppumpady was analyzed and the details are given in Table 2.

The market accessibility was found to be good for the above markets facilitating easy transportation of fish from one place to another.

Fig. 2. Thevara fish market

The nearest major landing centre for the three markets is Thoppumpady. The nearest railway station to all the three markets is Ernakulum Junction/ South situated at an average distance of 5.5 km, whereas the nearest bus station is at an average distance of 3.5 km from the markets. The Cochin International Airport is the nearest airport to the three markets which is at distance of 30.8km. Among the three, Chambakkara and Thoppumpady markets are controlled by local bodies with an entry fee of ₹ 5-20/box paid for transaction in the market premises.

Fig. 3. Thoppumpady fish market

Market arrivals and disposal

The study of market arrivals and disposals indicate that in Chambakkara fish market, the fish arrivals are mainly from Chambakkara, Munambam, Alleppey, Vypin, Chellanam, Cochin harbor, Calicut, Karnataka *etc*. The Chambakkara market often disposes fishes to different landing centres and markets of the state including Alwaye, Moovatuppuzha, Thodupuzha, Ettumanoor, Calicut, Malappuram, Kasargod, Trivandrum, Kunnamkulam and to the neighboring states like Karnataka, Andra Pradesh and Goa.

Table 2. Market structure analysis of fish markets

Market Dimension	Chambakkara	Thevara	Thoppumpady
A.Location			
Year of establishment	1950	1973	2004
Type of Market	Wholesale & Retail	Wholesale & Retail	Retail
Lat/Long Position	9°57'N/76^{0}19'E	9^{0}56 'N/76^{0}17'E	9^{0}55'N/76^{0}16'E
B. Market control	Cochin corporation	Cochin corporation	Cochin corporation
C. Market access			
Nearest landing centre (km)	Thoppumpady (7.4)	Thoppumpady (12.5)	Thoppumpady (1.6)
Nearest railway station/ Distance (km)	Tripunithura (3.6)	Ernakulam JN. (6.3)	Ernakulam JN (6.5)
Nearest bus station (km)	Vyttila mobility hub (3.1)	Ernakulam JN.(6.3)	Kannamali bus stand (1.1)
Nearest airport (km)	Cochin International Airport (30.9)	Cochin International Airport (30.7)	Cochin International Airport (30.7)
Nearest seaport (km)	Kochi port (12.6)	Kochi port (13.5)	Kochi port (4.6)
D. Market Timing	05.30-09.0011.00-13.00	06.00-09.00	16.00-20.00
E. Market conduct			
Registered marketers	25	20	28
Entry fee for operation in market	10/ box	5/ box	30 / day

In the case of Thevara market, the major fish arrivals are from Kayamkulam, Alapuzha, Cochin Fisheries harbor, Chellanam, Chambakkara, Munambam and Vypin. Mostly the fish arrivals of Thoppumpady market are from Vypin, Chambakkara, Chellanam, and Cochin Harbour. The major fish disposals are done to differentmarkets of the stateincluding Trivandrum, Aluva, Kunnamkulam, Malappuramand Kozhikode.

Nearly 25 to 30 marine fish species are marketed in Thoppumpady market, whereas 20-25 marine fish species are marketed in Chambakkara as well as Thevara markets.The most common fishes traded include Silver Pomfrets, Silver Moony, Mackerel, Sardine, Catfish, Mullet, Seer Fish, Threadfin bream, Mystus, Pearl Spot, Thryssa, Ambassis, Anchovies, False Trevally, Milk fish, Cyprinus, Barracuda, Shark, Cow nose Ray, Tilapia, Blue fin trevally, Sword fish, Congers, Prawns, Red snapper.

The trade union in the markets functions by loading, unloading, transporting and related activities. While analyzing the quantum of fish trade in the markets, the total quantity of fish traded in Chambakkara wholesale market is estimated at around 100 tons. Whereas, in Thevara and Thoppumpady it is estimated at around 2 tons and 12 tons respectively.

Constraint analysis of markets

The constraint analysis of markets was done on the basis of the opinion of different market functionaries. Accordingly, the major constraint faced by the marketers was the high marketing cost and price discrimination. Lack of adequate infrastructure facilities like parking area, waste management, drinking water, freezers etc. were also cited as constraints the major constraints faced by the marketers are presented in Table 3.

Table 3. Problems/ Constraints faced

Particulars	Rank
High marketing cost	I
Lack of infrastructure and amenities	II
Price Discrimination	III
High transportation cost	IV
Lack of access facilities	V
Cut-throat competition among traders	VI

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