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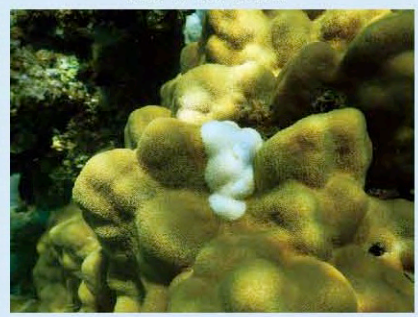

Front Cover : Bleached corals of *Porites* sp.

Back Cover : Ornamental gastropod *Tibia curta* in a processing yard

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.....

Warm greetings to all

The effects of global warming and Climate Change happening around the world is becoming evident each passing day. The warmer sea surface temperatures triggering coral bleaching eventually leading to their death and affecting the marine ecosystem adversely, has been reported from several places globally. A case study on the coral bleaching phenomenon in the Palk Bay is presented in this compilation of MFIS. Innovations in seaweed farming integrated with fish farming in cages, trade in marine ornamental gastropods, emerging fishery resources, records of marine biodiversity and fish seed prospecting to augment supply of fish seeds for aquaculture activities are also reported.

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Abbreviation - *Mar. Fish. Infor. Serv., T & E Ser.*

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Coral bleaching: causes, consequences and mitigation

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The coral reefs are distributed in the tropical regions and cover less than one percent of the earth's surface, but provide habitat for many species in the marine realm. The majority of reef building corals are found in tropical and subtropical waters and typically occur between 30° N and 30° S latitudes (Fig. 1). Coral reefs are greatly valued due for their beauty, biodiversity it encompasses and the products and services they provide to human society. The coral reefs are made of calcium carbonate secreted as skeletal material by the coral polyp. Coral polyps live in association with intracellular algae (zooxanthellae), which provide additional nutrition to the coral in its life processes. The association of coral polyp with zooxanthellae, restrict its distribution in waters up to the depth of 100 meters where sunlight would be available for the photosynthetic zooxanthellae. The worldwide of zooxanthellate corals in the different distribution eco-regions is a unique underwater ecosystem and provides annual net economic benefit around 30 billion dollars (Buddemeier *et al.*, 2004 Pew Center on Global Climate Change, 44p). However, coral reefs are most vulnerable to Climate Change due to the stenothermic nature of coral polyps. Coral reef stressors are multitude (climate to non-climate

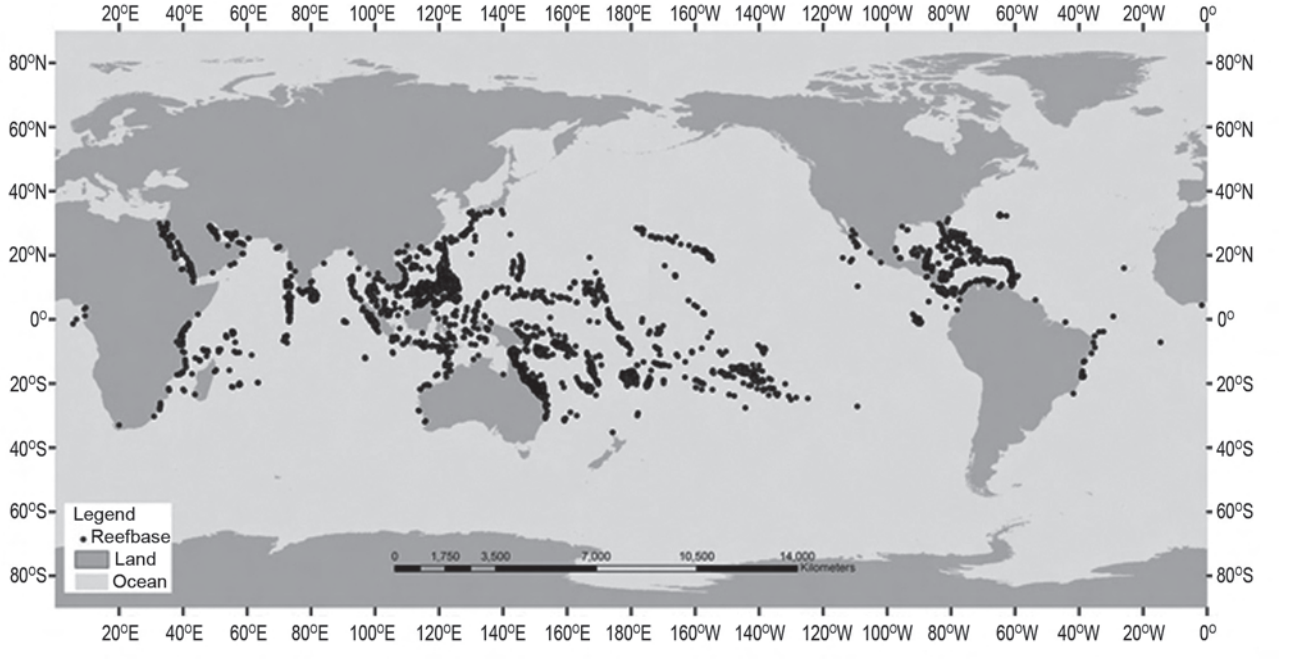


Fig. 1. Distribution of major coral reefs of the world (NOAA Ocean Service Education portal: https://oceanservice.noaa.gov/education/kits/corals/media/supp_coral05a.html)

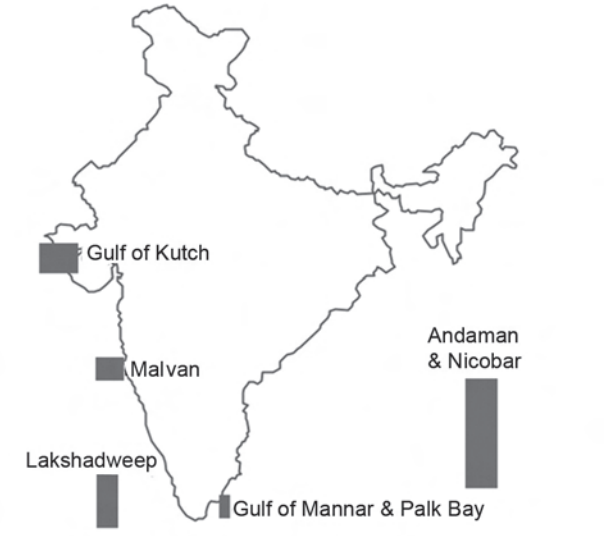


Fig. 2. Major coral reef areas of India

stressors) some are acute in nature like tropical storms and others are chronic like sediment loading (Table 1).

Coral reef areas of India comprise of two reef types viz., fringing reef and atolls. The major reef formations around India are found in Gulf of Mannar, Palk Bay, Gulf of Kutch, Malvan, Lakshadweep and Andaman & Nicobar others. While the Lakshadweep reefs are atolls, the remaining reefs are fringing reefs (Fig. 2). There are also patches of reef in the inter-tidal areas of the central west coast of the country off Ratnagiri and Malvan (Maharashtra) and Gaveshani Bank off Mangaluru, Karnataka. Along the Kerala coast, patch reefs are recorded from Quilon to Enayam. Recent surveys of ICAR-CMFRI reveal the occurrence of reefs between Cuddalore and Puducherry.

Coral bleaching

The turquoise blue colour of the lagoons in coral Islands is primarily contributed by the zooxanthellae associated with the coral polyps. Under extreme environmental conditions like alteration in the sea surface temperature the intracellular zooxanthellae is expelled by the coral polyp as a stress response which makes it appear white. The white, unhealthy corals called bleached corals are weak and susceptible to diseases. Some coral species are hardy and able to recover after bleaching, but in most cases these die and the entire ecosystem is affected. Coral polyps are highly dependent on the nutrition provided by the zooxanthellae, and it is estimated that up to 90 percent of their energy requirement is fulfilled by zooxanthellae (Muscatine, 1990 *Coral Reefs*, 25:75–87), hence any breakup in this association is catastrophic to coral polyps and its ecosystem. Bleached corals are still living and if stressful conditions subside soon enough, the zooxanthellae can repopulate their tissues and the corals survives the bleaching event. However this depends on many factors like light, duration of the high temperature regime, etc. Sea surface temperature (SST) increases of 1 to 2°C above the long term average maximum can trigger mass bleaching (Hoegh-Guldberg, 1999 *Marine and Freshwater Research,* 50 (8):839–866). However, the threshold temperature for coral bleaching varies from place to place and species to species; hence it is highly difficult to have control over this natural process, once it is started. There are two forms of corals, branching and massive forms. The former one suffers more due to bleaching than the massive forms, which is a slow grower and more resilient. However, in many areas of the world this general phenomenon was altered and massive forms became more prone to bleaching than the branching form. This was noticed during the surveys in the Palk Bay coral reefs around the islands of Pamban.

As the ocean temperature is on the rising trend more long lasting coral bleaching effect are expected in the form of disease outbreak in corals viz., black band disease, white band disease, white plague, and white pox, all of which can lead to mass mortality of coral, which endanger the entire ecosystem. Coral bleaching is a relatively recent phenomenon and before 1980 it was hardly noticeable in the wild. The first global corals bleaching event was in 1997-1998, during a strong *El Niño* that was followed by an equally strong *La Niña* phenomenon. Prior to this mass bleaching event coral bleaching was considered to be a localized problem due to local stressers. The second event occurred in 2006. The third global bleaching event

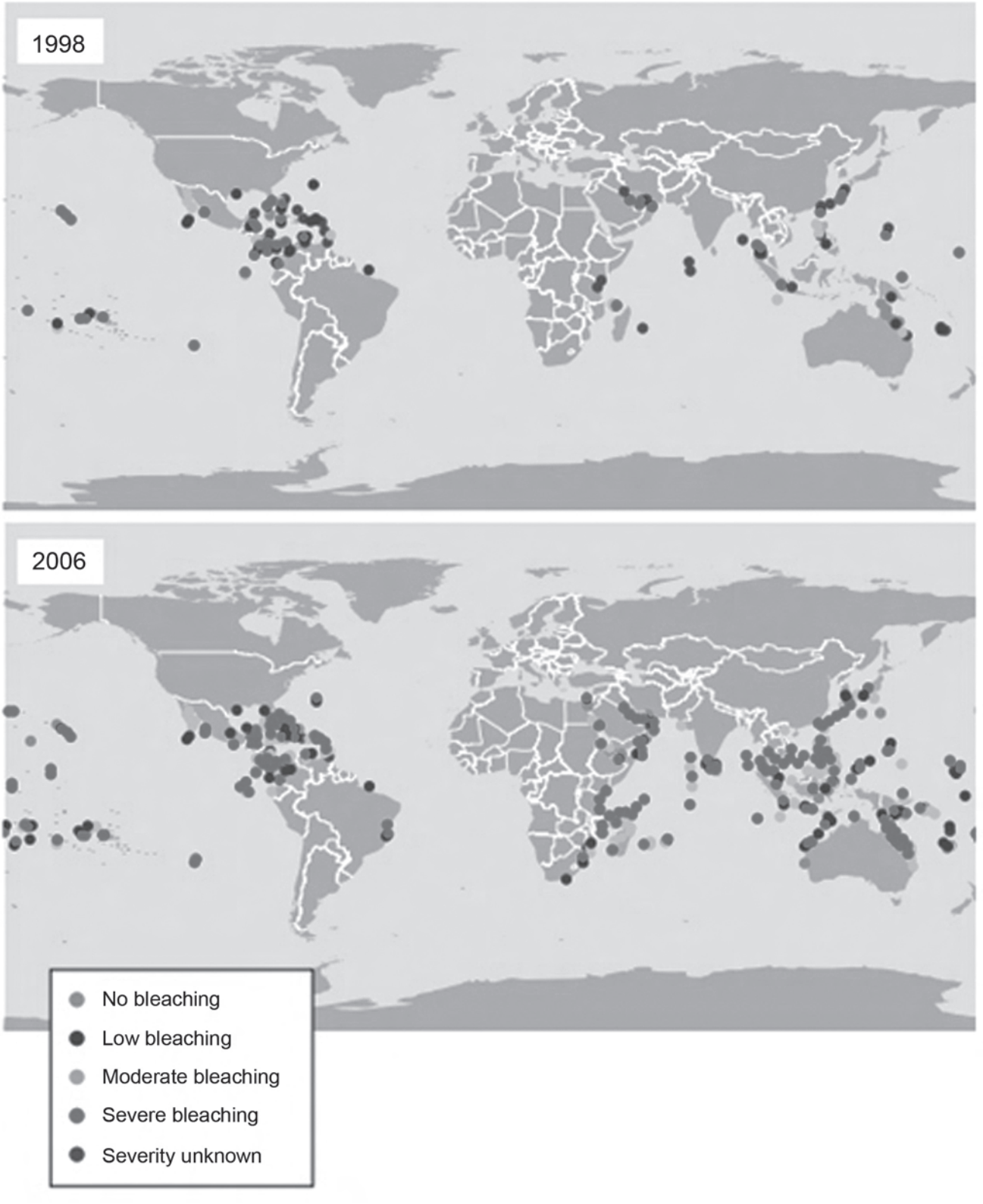


Fig. 3. Comparision of global mass bleaching event of 1998 and 2006 (NOAA CORIS https://www.coris.noaa.gov/activities/reef_managers_guide))

started in 2015 continues unabated. Comparison of the global bleaching events (Marshall and Schuttenberg, 2006, *A Reef Manager's Guide to Coral Bleaching,* 163p) is shown in Fig. 3.

Coral Bleaching Hotspot

Corals are vulnerable to bleaching when the SST exceeds the temperatures they would normally experience in the hottest month. Coral Bleaching Hotspot (HS) product measures the occurrence and magnitude of thermal stress potentially conducive to coral bleaching. HS regions highlights where the Sea Surface Comparative (SST) is currently warmer than the highest Monthly Maximum Mean (MMM) of SST. The HS value less than or equal to zero is categorized as 'No Stress' condition, HS value within the range of 0 to 1.0°C is categorized as 'watch' and values above 1.0°C are the threshold for thermal stress leading to coral bleaching.

Hotspot (°C) = SST – (Monthly Maximum Mean SST)

The HS anomaly is based on the climatological mean SST of the hottest month (Liu *et al*., 2003 *Earth & Space Science News (EOS), Transactions, American Geophysical Union* 84: 137–144).

Coral Bleaching Degree Heating Weeks (DHW)

Corals experience thermal stress, the main cause of coral bleaching, when sea surface temperatures exceed 1°C above the maximum summertime mean. If the heat anomaly persists the stress worsens and mass bleaching of coral occurs due prolonged periods of thermal stress. DHW is a cumulative measurement of the intensity and duration of thermal stress, and is expressed in the unit °C-weeks. The DHW shows any Hotspots greater than 1°C over a 12-weeks period, thus showing how stressful conditions have been for corals during the last three months. DHWs over 4 °C-weeks have been shown to cause significant coral bleaching to more sensitive species. DHW values over 8°C-weeks have caused higher, widespread bleaching and some mortality of corals may also occur.

Coral bleaching survey in Palk Bay

A coral bleaching survey was undertaken during summer months of 2016 along the northeastern part of Pamban Island off Olikuda fishing village in Palk Bay, where the fringing reefs locally known as Lighthouse Reef (located from 9°

Table 1. Scheme for assessing the local, regional and global stress on coral reefs

Chronic stresses	Global	Regional	Local
Carbonate ion decrease and reduced calcification	✓		
Temperature increase	✓		
Overharvesting	✓	✓	✓
Nutrient loading		✓	
Introduced/Invasive species		✓	
Ocean/atmospheric circulation change		✓	
Coastal and watershed alteration		✓	
Sedimentation		✓	
Acute stresses			
Temperature increase	✓	✓	
ENSO	✓	✓	
Diseases, Introduced/Invasive species		✓	✓
Storm frequency and intensity increase		✓	✓
Sedimentation		✓	✓
Urbanization and watershed modification		✓	✓
Commercial and incidental destruction		✓	✓

19' 27.17" E and 79° 19' 46.81" N to 9° 18' 20.7" E and 79° 20' 8.13"N) occur. Fishermen understand the bleaching event and reported that they can recover. During the survey more of massive forms were found to be bleached then the branching form which is contrary to the generalized hierarchy of coral susceptibility to bleaching. The bleaching event in the Lighthouse Reef has been classified as moderate bleaching; where bleached colonies are frequent but constitute less than half of all colonies (Table 2). Some of the most commonly seen bleached colonies belonged to species of *Pocillopora*, *Porites* and *Platygyra*.

Palk Bay, which spans an area of 13,500km^2 with average depth around 9 m, has a narrow connection to the Bay of Bengal through Palk Strait in the north and through Adams Bridge in the south to the Gulf of Mannar. The coral reefs of Palk Bay distributed at a depth of 1 to 4 m runs parallel to the Pamban Island and off Pudumadam lagoon with a width ranging from 200 to 600m. This narrowness makes for poor water exchange and Palk Bay warmer than Gulf of Mannar. The period of warming is also longer in the Palk Bay. These factors invariably make the fringing reefs of the Palk Bay more susceptible to bleaching. Earlier observations on coral bleaching Palk Bay have reported on the slow recovery of corals after bleaching. However recent studies have indicated the reduction in the species richness, which may not be merely due to coral bleaching. The light house reef which was surveyed in the present study has not been widely studied and could become one of the possible eco-reserve. The fishermen of the Olikuda village take care of this reef and operate only minimally invasive fishing gears like bamboo traps in this reef. This area could be developed as a community managed reef. It can also be used for ecotourism activities due to the proximity of Rameswaram temple, in addition to their fishery based livelihood activities.

Mitigation measures

I. Management of local stressors

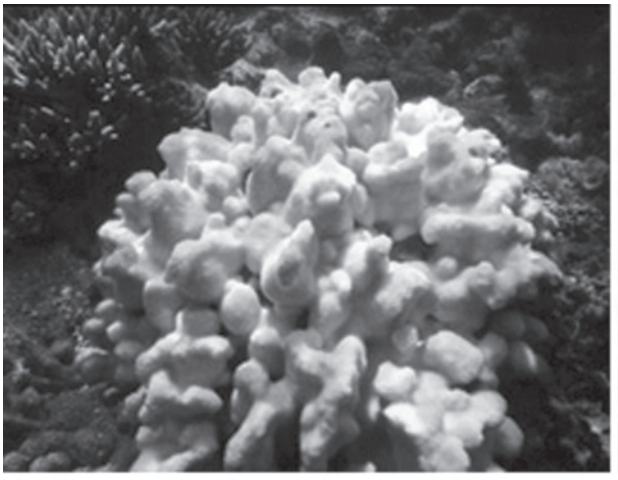
Local stressors includes physical damage due to diving, snorkeling and anchoring, water quality and fishing activity. In the present case, the Lighthouse Reef suffers from physical damage due to anchoring as well as effluent discharge from the adjacent shrimp farms. The local, regional and global stressors for the reef system should be analysed as indicated in Table 1. Monitoring light, temperature and water currents is important as Palk Bay is prone to quick and longer spells of seawater warming.

II. Identifying resilient coral reef areas

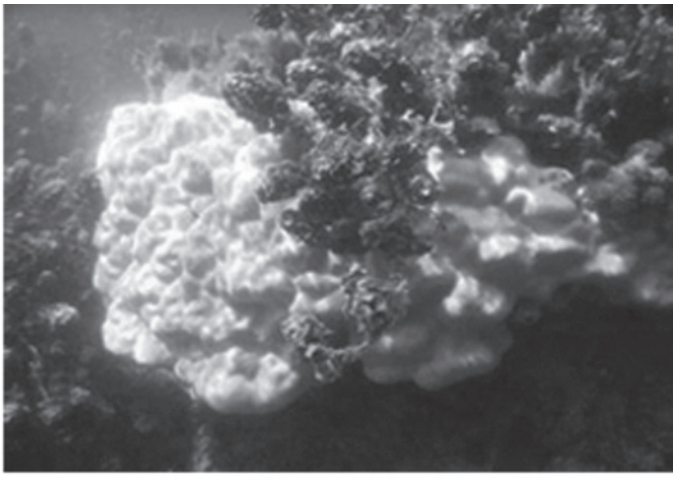
Identifying the healthy reef areas, which tolerate bleaching and protecting them for the reef recovery is required. A resilient coral community might suffer significant coral mortality from a bleaching event, but reorganize so that the community composition shifts toward different coral species that require similar habitat and are more tolerant to coral bleaching. Building long term reef resilience can be achieved by identifying the resilient coral community and incorporating the area into a management plan.

Table 2. Standard methods of recording coral bleaching

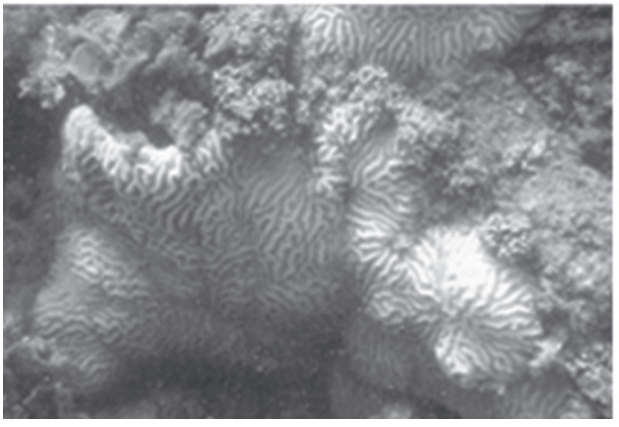
Category	Percent	Description	Visual assessment
0	<1	No bleaching	No bleaching observed, or only very occasional, scattered bleached colonies (one or two per dive).
1	1-10	Low or Mild bleaching	Conspicuous bleached colonies seen occasionally, butvast majority of colonies not bleached.
2	10-50	Moderate bleaching	Bleached colonies frequent but constitute less than half of all colonies.
3	50-90	High bleaching	Bleaching very frequent and conspicuous, most corals bleached.
4	>90	Extreme bleaching	Bleaching dominates the landscape, unbleached colonies not common. The whole reef looks white.



Bleached corals of *Pocillopora* sp.



Porites sp. showing bleaching



Colonies of *Platygyra* sp.

Close up view of bleached *Pocillopora* sp.

Underwater photographs of bleached corals of Light House Reef, Palk Bay

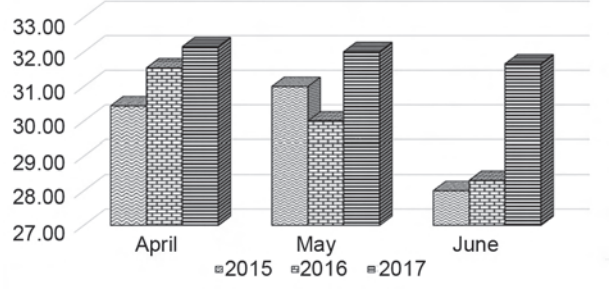


Fig. 4. SST of Palk Bay during summer months of 2015 - 2017 period

III. Fishermen involvement in reporting and monitoring coral bleaching events

Identifying the fishermen for reporting the bleaching events to the state and central government agencies and monitoring the bleached coral reef sites as community management is required.

Developing a forecast model for coral bleaching

The US National Oceanic and Atmospheric Administration (NOAA) developed a forecast system on global level for coral bleaching due to thermal stress. Operating on similar lines, the Coral Bleaching Alert System (CBAS) is a service initiated by Earth System Science Organisation – Indian National Centre for Ocean Information Services (ESSO-INCOIS) since February 2011 in India. This employs a model that assesses the thermal stress accumulated in the coral environs with the help of satellite derived SST.

In conclusion, as far as Palk Bay coral reefs are concerned, the damaging effect of anthropogenic stressors are more than the threat of coral bleaching. The growth and recruitment of corals is severely affected by many factors such as overfishing, land based pollution, usage patterns, habitat degradation, introduction of invasive species but can be controlled through appropriate management measures for this unique ecosystem. Coral reefs in Palk Bay are valuable from conservation and biodiversity point of view and could be termed as biodiversity banks where rich species and genetic diversity is stored. It warrants a shared responsibility by all stakeholders including fishermen, public, policy makers and scientists.

Experimental cultivation of seaweed *Kappaphycus alvarezii* using net-tube method

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Kappaphycus alvarezii an economically important red tropical seaweed, is used as significant source for carrageenan that is used in various food, pharmaceutical, industrial and biotechnological applications. The commercial cultivation of *K. alvarezii* was initiated in the Philippines in the year 1960 and later it was introduced in many countries including India for experimental or commercial cultivation. The rapid growth rates, easy dispersal and ways to cultivate *K. alvarezii* makes the species adaptable and flourish in new habitats. It is reported that the species can double its biomass in 15-30 days (Trono, 1992 *Bull. Mar. Sci. Fish. Kochi Univ.*, 12: 51-65) when cultivated in appropriate sites and can spread by means of vegetative fragmentation as well as by sexual reproduction. In India, the successful cultivation and harvesting of *K. alvarezii* was witnessed along Mandapam coast during the last two decades, which could be attributed to the favourable hydrobiological and environmental conditions, prevailing locally. High sea surface temperature (SST), high intensity of light, hypertrophic nutrient conditions and elevated degree of water motions are few environmental conditions which are congenial for the growth and cultivation *K. alvarezii* (Doty, 1990, *Aquaculture*, 84, 245–255).

Similar ideal conditions for the growth and cultivation of *K. alvarezii* prevail along the Saurashtra coast. However till date, only a few attempts have been made to cultivate the species here. The high tidal amplitude occurring on this coast limits the spread of the raft method of

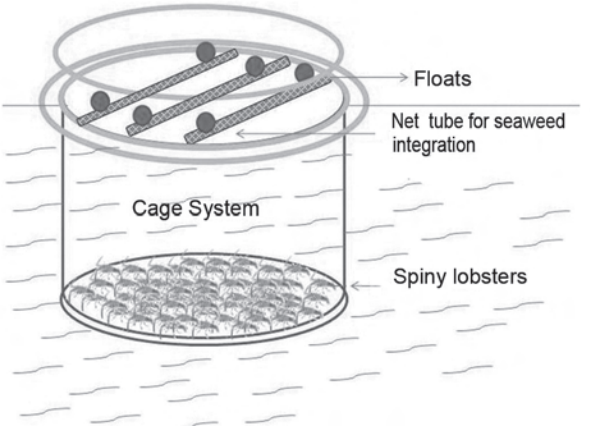

Fig. 1. Diagrammatic representation of net-tube method of seawead cultivation in open sea cages stocked with lobsters

seaweed cultivation. This method is also considered to be laborious that requires time for seeding, maintenance as well as harvesting, leading to higher labour costs. In order to arrive at more efficient techniques, an attempt to try the net-tube method for cultivation of *K. alvarezii* in open sea cages of Gujarat as an avenue for income generation was done (Fig. 1).

The study was carried out in the open sea cages (Station 1: 20° 88' 96.20" N, 70° 38' 77.49" E and Station 2: 20° 88' 94.25" N, 70° 38' 82.87" E), installed by ICAR- CMFRI off Veraval, Gujarat. The seeds of *K. alvarezii* were collected from Gujarat Livelihood promotion Corporation (GLPC) farm at Simar, Gujarat. After acclimitisation of the live material in the wet lab they were transferred to open sea cages, packed in wet jute bags to avoid desiccation. The live materials were tied to the net and kept in floating condition in cages. The Daily Growth Rate (DGR), Specific Growth Rate (SGR) and Biomass Yield (BA) for *K. alvarezii* was studied and the results indicated post monsoon season as the most favourable season with good growth. Keeping this in mind, the experiments were conducted from January to February 2016 by placing six net tubes in two cages (three in each cage) with a known quantity of *K. alvarezii,* in each net-tube (Fig. 1).

Net-tube 4 m length used for cultivation of *K. alvarezii*

Seeding and tying of seeded net- tubes at sea cage sites

Harvests were made at an interval of 50 days. The open sea cages were also stocked with the lobster *Panulirus polyphagus* at different stocking densities.

Net-Tube fabrication was done using fishing nets of square mesh (10 mm) used as a bag net of 3-4 m length and 40 cm diameter. The nets were stitched so as to divide the net into six compartments of 30×70 cm each. An average 1000 gm of good quality seed material was placed in each net-tube. In order to prevent the escape of seed materials, both ends of the tube were tied with 20 mm nylon rope. This seeded net-tube was tied to the inner frame of the circular GI cage stocked with the lobsters. The growth of *K. alvarezii* was evaluated by measuring daily growth rate (DGR), Specific Growth Rate (SGR) and biomass yield (BA) as indicated below.

DGR (% day^{-1}) = ln (Wf / W_0) / t × 100,

where Wf is the final fresh weight after the t days of culture, and W_0 is the initial fresh weight (g).

Specific Growth Rate = (Nt/N_0))/t x 100

where, N_0 is initial wet weight and Nt is wet weight at day t.

Biomass (BA) of seaweed was determined by weighing the fresh harvested plant material. The quantity of fresh biomass obtained per net-tube was determined and presented as a crop yield (kg FW tube^{-1}).

The water temperature and atmospheric temperature were recorded. Salinity, pH and dissolved oxygen of the water samples were analyzed using a multiparameter kit. Nitrate and phosphate levels were estimated using standard procedures. The atmospheric temperature and sea surface temperature varied between 25.37 - 30.69°C and 26.37 - 30.46°C respectively. The salinity varied between 33 to 35 ppt. The dissolved oxygen content was 4.83 -6.14 mg/l and pH ranged from 8.14 to 8.25. Nitrate and phosphate levels ranged between 0.67 to 1.31 µ mol L^{-1} and 0.17 to 0.42 µ mol L^{-1} respectively. The water parameters were optimum during the culture period and hence supported the growth of seaweed in cages.

Growth studies during the cultivation period of January to February 2016, until crop was harvested after 50 days of culture was completed. The seaweed was harvested at 7 day intervals in order to determine the DGR, SGR and BA of seaweeds from each tube from both the cages. DGR varied from 5.79 - 7.76 % day^{-1} between the tubes with highest biomass (1500 – 1772 g FW $line^{-1}$) observed during the first seven days of culture period. Net-tube samples harvested after 14 days showed the highest growth rate and commendable DGRs (6.65 – 7.99% day^{-1}), with corresponding specific growth rate (6.87 – 8.31% day^{-1}) and biomass yield (2485 – 2897 g FW $line^{-1}$). The minimum DGRs, SGR and BA were observed during 35th and 42nd days of sampling.

A consistent growth was observed during the study period, with the most favourable condition during the month of February, as the DGR and biomass showed the highest value during that time. A DGR above 3.5% day^{-1} is considered a good value for commercial cultivation (*FAO Fisheries Technical Paper,* 1987, 281 : 123-161). The present study showed DGR value above 3.5% day^{-1}, thus signifying high potential of *K. alvarezii* cultivation along the Saurashtra coast of Gujarat. High tidal amplitude and rough sea conditions do not support raft cultivation method of seaweed farming. Hence the net-tube farming method can be a promising alternate method for seaweed cultivation where above mentioned sea conditions prevail 2011. The present study clearly indicates the suitability of net-tube method for year around seaweed cultivation because of cost effectiveness, minimal loss of seedlings and maximum harvesting of *K. alvarezii*. The horizontally placed net-tube give support to the plants when fully grown and it also helps in minimizing the breakage and dislodging of fronds by wave action and water currents.

In conclusion more attention needs to be give to net-tube method of seaweed cultivation in Saurashtra coast and it should be popularized as an effective means for income generation as cultivation is easy and doesn't employ laborious techniques. Net-tube cultivation method serves as a promising alternative for seaweed farming method over raft culture, along the Gujarat coast. Cultivation of *K. alvarezii* in net-tube can also be used as part of Integrated Multi-trophic Aquaculture (IMTA) which is designed to mitigate the environmental problems caused by aquaculture.

Ornamental gastropod shell trade in India : A macroeconomic assessment

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The capture fisheries results in landing of sizeable amount of by-catch which includes molluscs, crustaceans (certain varieties of crabs, and Squilla spp.), finfishes (non-edible varieties), sea snakes and echinoderms. The (shellfish and fin fish) by-catch is utilized to an extent but a major

share is dumped back to the sea as it has no commercial value. The molluscan by-catch mainly consists of gastropods and bivalves, which are used in production of handicrafts and curios. It forms a niche industry restricted mainly to the coastal regions and supports a huge number of the coastal population. The ornaments and handicrafts made out of molluscan shells are becoming highly priced objects in Indian and foreign markets. Gastropods are exploited on a regular basis and sustain the ornamental/shell craft industry and a study to assess the magnitude and economic value of the industry was carried out. The study probes species wise and destination wise export- import of gastropods and socio-economics status of the people involved in the industry based on collection of data by schedules, personal interview and focused discussion with traders, labourers, boat owners, Shell pickers across selected centres of the south east coast namely Thirunelveli, Keelakarai and Ramanathapuram. The results are discussed under the following heads

(i) Species traded

The shell craft industries collect 40-45 major species of gastropods from the landing centres such as *Architectonica laevigata*, *Chicoreus virgeneus, C.ramosus, Murex tribulus, Lambis lambis, Tibia curta, Melo melo, Septa rubecula, Cymbium* sp., *Conus amadis, Conus litteratus, Telescopium telescopium, Vexillum* sp., *Harpa major, Natica* sp., *Umbonium vestiarium, Babylonia spirata, B. zeylanica, Bursa spinosa, B. margariticula, Turritella duplicata, Cypraea tigris, Haustellium* sp., *Monoplex pilearis, Ficus gracilis, Fusinus colus, Phalium glaucum, Neverita didyma, Tonna dolium, Turbinella pyrum, Xenophora corrugata, Terebellum terebellum, Purpura bufo, Volegalea cochlidium, Melo melo, Rapana rapiformis, Olive shells* etc. for their shell craft works.

(ii) Export and Import - destinations/ species

The major destinations of export are United States of America, Australia, Japan, Philippines, Vietnam, Africa, Malaysia, Belgium, Croatia, England, Haiti Island, Sri Lanka, France,Netherlands, Germany and South Africa. The major species exported are *Conus* sp., *Umbonium* sp., *Chicoreus ramosus, Lambis lambis,Babylonia spirata, B. zeylanica, Telescopium* sp., *Terebralia* sp., *Tonna* spp. and *Cerithium* sp.

The major importing countries includes USA, Mexico, New Zealand, South Africa, Australia, Phillipines, Spain and other African countries. Around 20-25 species are imported and the major species imported included *Busycon* sp., *Haliotis* sp., *Cypraea tigris, Mitrella* sp.

(iii) Resource collection and operation of the shell craft industry

These shells are mostly landed as live shells. Larger to medium sized gastropods such as Sacred Chank *Turbinella pyrum*, *Chicoreus* sp., *Hemifusus* sp., Beggar's bowl (*Cymbium melo*), *Strombus sp, etc.* are given to local merchants by fishermen themselves at the landing centres. These merchants transport all the collected shell resources to nearby shell craft industry on a daily basis. For smaller sized gastropods, fisherwomen are engaged for segregating them from the trash fish in the fish drying yards. Such segregated shells are heaped in a place adjacent to the yard till it reaches a sizable quantity, when these are packed in plastic/gunny bags and transporting by trucks to the shell craft industries.

The shell craft industries are dependent on the seashells of different shapes and size and no varieties of shells are discarded. The shell craft industry operates in four stages viz., raw material production unit, processing unit, finished whole shells and shell products unit and marketing unit .The operational cost of the selected industry indicated that Around 79% of the cost is spent for labour, 15% for raw materials, 2% for acids and chemicals, 4% for other expenses (rent/lease/ electricity/depreciation/maintenance). It is found out that for processing one ton of the finished output, 5 man days are required. Hence, for the current operation in the industry, exporting 10,000 tonnes(t), will demand 50000 employment opportunities, with an average monthly wage of ₹

9,000. The benefit-cost ratio worked out to be 3:1, which indicates that for every one rupee spent by the manufacturer he realises a return of ₹ 3.

(iv) Assessing the shell craft Industry

The magnitude of the shell craft industry in term of procurement of shells, shell collection, processing and trade was assessed through operating cost and revenue. The total estimated quantum of trade of gastropods is 11,000 tonnes (10% is contributed by imports) and the revenue around ₹ 100 crores. According to the Federation of Sea Shell Handicrafts Merchants Association (FOSSHMA), there are around 90 active sea shell handicrafts traders in India, of which 20 are very active, 30 with minimal functioning and 40 dormant units. Around 350 containers each having a capacity of 20 t are exported annually. The traders stock around 20-25,000 t annually which are sourced either locally (30%), from other parts of India (60%) and through import (10%). Among the different gastropod species procured as raw materials 75% of them are small sized. The average cost per tonne of procurement ranged from ₹ 6,000 -10000 (locally) , 10,000-15,000(within India) and ₹18,000- 35,000 (import). The economic analysis of the trade indicated the total operating cost estimated for the shell craft industry is ₹ 25 crores. The cost of the raw material ranged from ₹ 6 - 36 weighed in kilogramme or per piece and the price of the product ranged from ₹ 30-150 weighed in kilogramme or per piece. Among the total products traded to the tune of 11000 t, more than 75% of the finished products is exported, 24% is sold within the country and less than 1% of the finished products is sold in the local markets.

(v) Legal issues in gastropod trade

The Wildlife (Protection) Act, 1972 was enacted with the objective of effectively controlling poaching and illegal trade in wildlife and its derivatives. The 2002 Amendment Act which came into force in January, 2003 has made punishment and penalty for offences under the Act more stringent and also brought 24 species of molluscs in its purview. This has brought restrictions in the collection of ornamental gastropods for the trade.

The interaction with the traders revealed that the shell products were being seized by law enforcing authority even though they were abiding by the law. This problem could be linked to misidentification of gastropods by concerned authority due to lack of information. The other major threats to the resources are from tourism related activities on the beach, dumping of untreated industrial and domestic wastes into the sea, dredging operations depositing large quantities of silt which increases the turbidity of the water that result in damage to the nursing and feeding grounds of larvae and juveniles of gastropods.

Marine cage farming of Asian seabass under participatory mode - A success story

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Karwar Research Centre of ICAR-CMFRI in association with the Directorate of fisheries, Govt. of Goa identified Polem village (14° 54' 21.12" N ; 74° 04' 32.20" E) in south Goa for the cage culture demonstration under the proejct 'National Innovations on Climate Resilient Agriculture (NICRA)'. Awareness programmes were conducted for the fishermen communities in the village regarding the present status of marine fisheries resources of India and future prospects. Self Help

Site selected for cage farming of Asian seabass at Polem, Goa

Stocking of Asian seabass in 6 m diameter steel cage

Monitoring of growth parameters of Asian seabass

Fish harvest conducted in the presence of Director of Fisheries, Goa

Groups (SHGs) were formed among the fishermen of Polem village and hands on training on various aspects of cage farming was given to the identified group at the Karwar Research Centre of ICAR-CMFRI.

Site selection for the cage farm at Polem was done following a standard protocol (Philipose *et al*., 2012. *Indian J. Fish.*, 59 (1) : 83-88). The seeds of Asian seabass, *Lates calcarifer* (average size 5.0 ± 0.3 cm) were procured from Rajiv Gandhi Centre for Aquaculture (RGCA) and nursery rearing was done in the marine hatchery complex of Karwar Research Centre for 30 days. A total of 8 cages of 6 metre(m) diameter were installed. Nursery reared fishes (average size 15 ± 0.2 cm) were stocked @ 14 numbers / m^3 in the cages in two batches. The first batch of fish was stocked in November 2015 and second batch in December 2015. The culture period lasted for six months. All the technical services such as net exchange, feeding, growth and health monitoring of fishes were given by the scientists and technical staff of the centre from the day of stocking till the harvest.

During the culture period, fishes were fed with trash fish @ 6% biomass. Nets were exchanged at monthly intervals to avoid settling of barnacles and other fouling organisms and also to maintain free flow of water into the cages. Growth parameters were monitored at monthly intervals and average growth rate was recorded. Fish health was examined every month for the presence of any external parasites. Average temperature, salinity, pH and dissolved oxygen of the water from cage site ranged between 27° C to 30.5° C, 30 to 35 ppt, 7.3 to 8.2 and 6 to 6.5 mg/l respectively. Nutrients were found

to be within the permissible limits. Total bacterial count and *Vibrio* count of sediment ranged from 2×10^4cfu/g to 5×10^4cfu/g and 2.5×10^3cfu/g to 8.2×10^3cfu/g respectively. After 6 months of culture, first batch recorded a maximum weight of 1.2 kg with 60 % survival rate, while the second batch recorded a maximum weight of 0.8 kg with 58% survival rate. The SHGs got a final production of 11kgs/m^3 and 9kgs/m^3 of Asian seabass from two batches and benefited with a profit of ₹ 5, 00,000.

Successful cage farming of Asian seabass by Self Help Groups (SHGs) at Polem, Goa indicated that marine cage farming can play an important role in improving the livelihood and socio-economic status of the coastal communities. High density stocking was not possible for want of enough numbers of seabass seeds during the farming period. Provided the sea bass seeds are available, production at the rate of 50 kg/m^3 can achieved easily.

Large scale farming of green mussel in Ashtamudi Lake, Kerala

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Green mussel, *Perna viridis*, farming is spreading fast in the lower stretches of Ashtamudi Lake in Kollam district of Southern Kerala. Huge demand for green mussel in the northern part of Kerala has resulted in significant increase in its price. The price has increased to ₹ 10,000 per gunny bag of 70 kg for medium sized mussel (50-100 mm) whereas larger ones (120 -150 mm) fetch prices as high as ₹ 400 per kg (8 pieces). This has prompted local fishermen to try mussel farming using on bottom method of mussel culture which some farmers practiced earlier with locally available seed.

Gunny bags of seeds of green mussel

Seed for the farming is collected and supplied to farmers in Ashtamudi Lake from Kozhikode, Kannur and Thalaserry in North Kerala. Seeds and packed in wet jute bags are transported to Kollam by rail which takes about 12 hours and from there it is transported to Kavanad Ferryboat Jetty by van. Consequent to the large scale mussel spat settlement during this year (2016), more than 1800-2000 gunny bags of seeds of green mussel has been bought from northern Kerala, for farming. Each jute bag weighs 70 kg (contains 2.0 lakh seeds) making the total seed used from farming during this season around 140 tonnes (t). Average length of green mussel seed was 21 mm. The seed bags were conditioned in the back waters for 2-3 hours. Then bags were cut open and seeds were washed and sold to farmers according to their need. One gunny bag of seed (about 70 kg) was sold at a price of ₹ 3700. The washed seeds are transferred to the boats and covered with wet gunny bags to prevent heating and dehydration during the transport to the farming site.

Sowing of mussel seed

Clump formation of green mussel seed

After conditioning, seeds are taken to the place of sowing by boats. During the morning hours seeds are broadcast on the backwater beds which has muddy soil and unpolluted, productive green water. This year seed sowing started early in the month of October and continued till January.

Technical details such as salinity requirements and farming methods were suggested by ICAR-CMFRI scientists to interested farmers. Farmers also showed keen interest in using hatchery produced seed and provided brood stock free of cost for conducting the hatchery trials. Sites selected were mostly sandy-clay areas with least disturbances by navigation and fishing actived. Usually they prefer areas adjacent to their homes or where they can entrust someone who can take care of the stock. In some places they use net pens to demarcate the area for additional protection against poaching.

During the month of October, the water temperature was 29-30 ºC, Salinity 32 ppt and pH 8.2. Within a week after the seed are spread out, mussels form clumps of 20 to 30 numbers which helps to prevent their sinking into the mud. The mussels grow fast on the bottom and are usually harvested by May.

Profile of fishermen/farmers involved in mussel farming in the Ashtamudi Lake was studied. In some areas farmers residing close to the lake are doing mussel farming with the help of local fishermen who helps in procuring the seed, sowing and harvest. In other areas, fishermen invest the money and local families guard the stock and share the harvested mussels. Farming may extend more than one year but peak harvesting is during the Ramzan period during which the demand from the northern Kerala is high and good price can be got. Harvested mussels are transported live to places like Kozhikode, Thalassery and Kasargod in north Kerala for making "Arikadukka" a local delicacy prepared using mussel.

Large scale mussel farming is done in areas such as Thekumbhagam, Dalavapuram, Kallada,Vellimon, Koyivala, Aravila, Pampa, Kureepuzha, Prakulam, Pallapu, Kadavoor, Sampranikudi, St. Thomas island, St. George Island and Fatima Island. The production of mussel from Ashtamudi Lake is expected to increase to an estimated 2800 t. Demand for mussel seed is also expected to increase manifold in the coming years. Erratic mussel spat fall can adversely affect the farming of activity. ICAR-CMFRI is making efforts to produce mussel seed and supply it to the farmers. Field trials using hatchery produced spat are being conducted at Ashtamudi Lake with the help of local farmers. If this is successful, mussel farming will reach new heights in the near future.

Standardization of culture aspects of *Apocyclops cmfri* sp. nov. a native cyclopoid copepod

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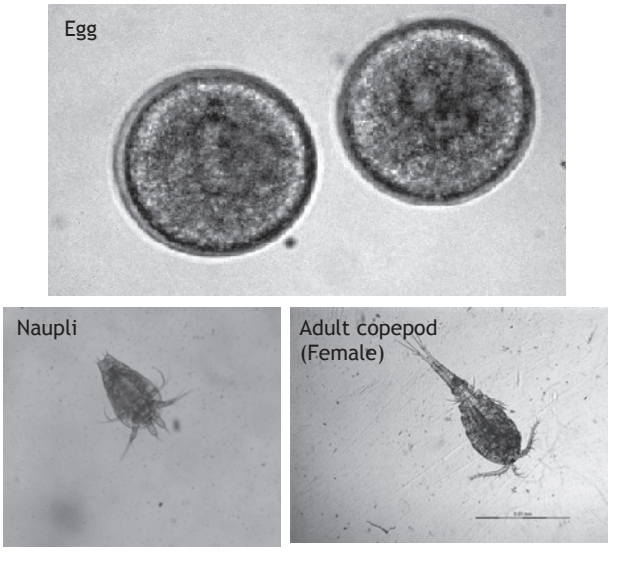
Copepods are considered as ideal larval feed, due to their smaller size (<100µm), high protein and favourable fatty acid profiles. There are three types of copepods viz., harpacticoid, calanoid and cyclopoid, which can be cultured on a large scale under controlled conditions as live feed for the initial stages of fish and shellfish larvae. Karwar Research Centre of ICAR- CMFRI made a significant contribution in standardizing the protocols for the culture of a new cyclopoid copepod, *Apocyclops cmfri* sp. nov. a species native to Karwar (Loka *et al.*, 2017, *Indian J. Fish.*, 64(2): 1-9).

Copepods were collected off Karwar (14^{0} 49' 914" N; 74% 06' 002" E) near the cage culture site, using plankton net (100 µm mesh size) and transported to the laboratory for further isolation and culture. The cyclopoid copepod, *Apocyclops cmfri* sp. nov. was isolated using standard methods and was cultured in laboratory by feeding with *Chaetoceros calcitrans* and successive generations were maintained. Length and width of the newly hatched nauplii and adults were measured (µm unit) under microscope. By following the standard methods, life cycle, hatching and survival rates were assessed. To study the variations in size and density of copepods fed with different microalgal diets (1.2x10^{7} cells /ml) and salinities (0, 10, 20, 30 and 40 ppt), density trials were carried out for a period of one month. Experimental trials were carried out on suitability of cyclopoid copepod as live feed in hatcheries. 1500 numbers of *Penaeus vannamei* larvae (Average weight:20 mg ± 0.5 mg) and *Chanos chanos* (10 mg ± 0.1 mg) were fed with nauplii and copepodites (@ 10 numbers/fish respectively) for twenty days. Water exchange was carried out with filtered seawater daily. The survival and growth rates of the fish were calculated at the end of the experiment.

Life cycle of hatchery reared *Apocyclops cmfri* sp. nov. was studied in the live feed laboratory of Karwar Research Centre. The shortest life cycle recorded was 8 days, when fed with *Chaetoceros*, whereas it was 15 days when given *Chlorella vulgaris*. Fecundity was 175 eggs in its life span. Hatching rate of eggs was 90% while survival rates nauplii and adult copepod sages were 90 and 95% respectively. Hatching rate and survival of naupliar stages and copepodites varied significantly (P<0.05) with salinity and microalgal diets provided during rearing.



Different life stages of the copepod

Pure isolates of cyclopoid copepods were cultured in batch and mass culture tanks by feeding with different microalgal diets viz., *Chaetoceros calcitrans, Isochrysis galbana, Nannochloropsis oculata, Chlorella vulgaris* and also by varying the salinities. Salinity experiments revealed that it tolerates the salinity range between 0 to 40 ppt with an optimum of 30 ppt. A significant variation in the size and density of nauplii and copepodites fed with different microalgal diets at different salinities was recorded (Table 1, Fig. 1). The size of the nauplii was minimum when fed with *Chlorella vulgaris* and maximum when fed with *Chaetoceros calcitrans*. Size of the copepod nauplii ranged between 70 – 110 µm whereas the copepodite size varied between 220 – 650 µm and for the adults it varied between 850 µm – 1.2 mm. It was observed that the size of nauplii was minimum when fed with *C. vulgaris*. The minimum size of nauplii fed with *C. calcitrans* was 80 µm. Thus the naupliar and copepodite stages are suitable as live feed in fish and shrimp hatcheries.

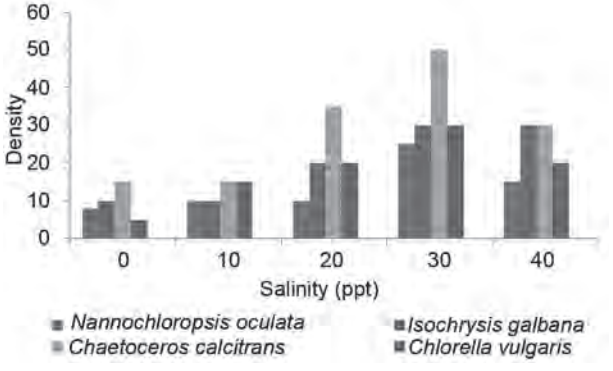


Fig. 1. Variations in the copepod density fed with different microalgae at different salinities

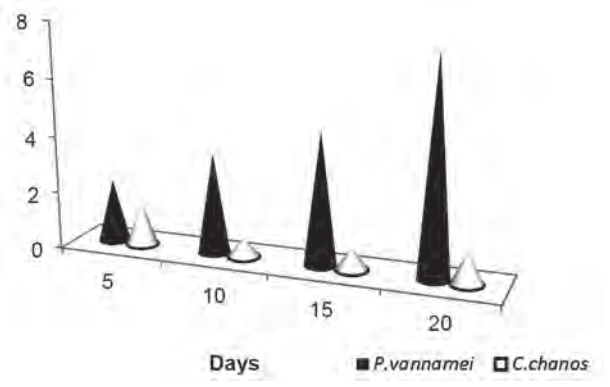


Fig. 2. Weight gain (mg/day) of fish and shrimp larvae fed with *Apocyclops cmfri* sp. nov.

The density trials with different microalgae, *N.oculata*, *C. calcitrans*, *C. vulgaris* and *I. galbana* resulted in a significant variation ($P<0.05$) between the diets, with a maximum density of 50 numbers per ml when fed with *C. calcitrans*. The density of this species was more when fed with *C. calcitrans* in all the salinities with a maximum at 30 ppt.

Experimental trials examined revealed it is suitable as live feed for both fish and shrimp. The survival rate was 90% for shrimp *(P. vannamei)* and milkfish larvae. The study also revealed that shrimp larvae showed a significant increase in growth rate of 30.2 ± 0.5 mg per day, whereas, in milk fish weight gain was recorded as 14.5 ± 1.5 mg/day after 20 days of the experiment. It was observed that there is a significant variation ($P<0.05$) in the weight gain of both the fish and shrimp, with a maximum weight gain on 14th and 20th day of experiment respectively.

In conclusion, the study indicated that cyclopoid copepod, *Apocyclops cmfri* sp. nov. isolated from

Table 1. Size variations of nauplii, copepodites and adult copepods fed with different microalgal diets

Microalgae	Size (µm)		
	Nauplii	Copepodites	Adult copepods
Nannochloropsis oculata	85-105	320-520	850-1200
Chaetoceros calcitrans	80-110	380-650	950-1200
Chlorella vulgaris	70-85	220-450	825-950
Isochrysis galbana	75-90	250-560	900-1125

Karwar waters, can tolerate a wide range of salinities with an optimum of 30 ppt and minimum naupliar size and maximum density occurs when the salinity was 30 ppt. Culture protocols for this species were standardized in Hatchery complex of ICAR-CMFRI at Karwar with 1.2. million naupliar production at every three days interval. The lifecycle was 8 days with high fecundity and survival rate of 90%. It is suggested that *C. calcitrans* is the most suitable diet for rearing *Apocyclops cmfri* sp. nov. a potential candidate species for rearing of shrimp larvae and can contribute to the aquaculture feed industry.

A note on the button shells fishery in Kakinada Bay

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Umbonium species commonly called as 'button shells' are the smallest gastropod shells under the family Trochidae and subfamily Umboninae. They are also known as 'button top shells' or 'button snails'. They come in vast array of colours, in shades of grey, brown, olive green, pink, red, yellow or even white, almost uniform or with different axial and/ or spiral patterns. Even in single species various colour and patterns can be seen. They are distributed in the Indo-West Pacific regions where they lie burrowed in the shallow, soft and sandy bottoms. They occur in high densities and the individuals are usually very active. They feed on detritus and algae, sometimes depending on filter feeding unlike other snails. When confronted by predators they bury into the sandy bottom using their long foot or float into the water column to escape. They are non-edible ornamental gastropods that have high demand in the ornamental shellcraft industry.

The fishery for *Umbonium* sp. landed at Chollangi, Yetimoga, Dumulapeta, Pedavalasa villages and also at Kakinada Fisheries Harbour is described below. *Umbonium vestiarium* (Vesta's button top shell) is the commonly landed species. Ladies are mainly involved in the harvesting of these shells by handpicking and using small scoop nets. Local crafts such as the shoe *dhoni*, Kakinada *Nava* and fibre boats (*teppa*) are used to reach the fishing ground. Usually the fishermen families of about 2-6 members go for fishing. They use gillnet, dragnets, stake nets, hook and line for fishing while hand picking of shells is done mostly by the women and children. The fishing method adopted is based on tide as during low tides collection of shells by hand are carried out while gillnetting, stake netting and drag netting are done during the high tide. During full moon and new-moon periods when the low tides are very low, catch is more. The fishing ground is about 4-8 km from the shore around the Hope Island which has about 4 km^2 area. Fishing is done for about 26-28 days per month if favourable conditions exist. The estimated total landings of the species during the study period 2013-2016 was 319.35 tonnes (t)

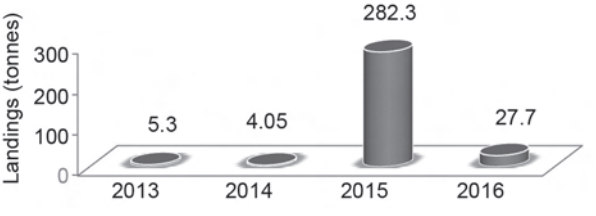

Fig. 1. Annual landings of *Umbonium* sp. in Kakinada Bay during 2013-2016

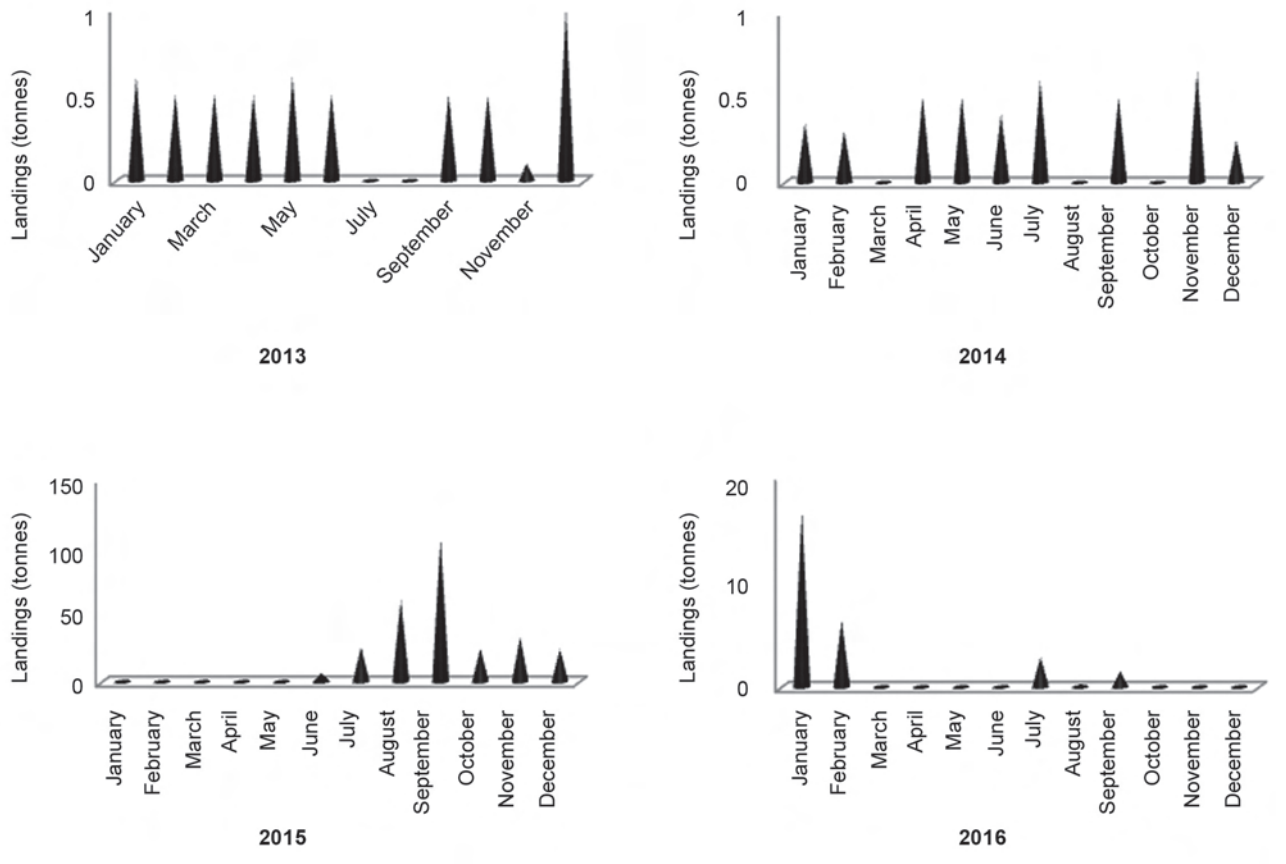

Fig. 2. Monthly landings of the button shells in the Kakinada Bay during 2013-2016

which is about 11.8% of the total gastropod landings. The landing peaked during 2015 (34.72% of the total gastropod production) due to increase in the demand for ornamental purposes and lime powder industries. But during 2016 it suddenly decreased due to lack of demand and most of the women labourforce shifted from shell collection to processing sectors such as peeling, packing etc. Not much seasonal variation in landings was observed during the period.

The marketing of these shells is done in neighbouring states like Tamil Nadu, Odisha, Maharashtra and Telengana. The small scale exporters from Kakinada, Yanam, Guntur and other regions of Andhra Pradesh participate actively. The agents collect shells from the fishers and sell to the different buyers, based on demand. The marketing is mainly done at Chollangi Landing Centre from where the dead shells are transported

Crafts made of *Umbonium* spp.

by lorries. The shells are sold in baskets with small plastic baskets weighing about 40-50 kg each costing ₹ 800-1200 depending on the size of the shell (grade). The fishers are getting only about ₹ 7-8 per kg. The small scale industries are selling both the cleaned shells as well as lime powder to the

dealers. From these shells various attractive craft items are prepared like windows or door curtains, mirror or photo frames, clock, lamp shades, flower vases, trays, candle stands, wall hangings, jewelleries and other crafted pieces are prepared. These shells are also used for making lime by small scale kilns located near Kakinada, which is widely used in aquaculture ponds in Andhra Pradesh.

Distribution of *Plesionika semilaevis* along the southwest coast of India

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The commercial deep-sea caridean shrimp *Plesionika martia* (A. Milne-Edwards, 1883) has long been recorded from India and constitutes an important part of catches of the deep-sea shrimp fisheries. A recent survey in some deep-sea fishing harbours along the south-west coast of India, however, revealed that all material previously reported as '*P. martia*' is actually a misidentification of its closely related species *Plesionika semilaevis* Spence Bate, 1888. The fishery was observed fortnightly during 2014-2016 from two fishing harbours (Kalamukku and Sakthikulangara) where deep sea fish landings occur to understand the *Plesionika martia* species complex using morphometric and meristic methods. The results of the present study showed the dominance of *P. semilaevis* (100%) in comparison to *P. martia*. Voucher specimen (ED.2.4.5.1) was deposited in Designated National Repository (DNR) of ICAR-CMFRI, Kochi. The present study reports the new record of deep sea pandalid shrimp *Plesionika semilaevis* with morphological description.

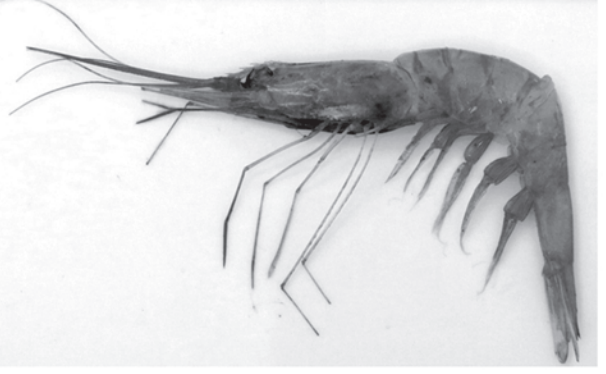

Fig. 1. *Plesionika semilaevis* (male)

Description: Rostrum extending beyond the antennal scale, dorsally armed with 7-8 teeth, including 3 on carapace posterior to level of orbital margin, armed ventrally with 35-44 teeth; abdomen without posteromesial tooth or median dorsal carina on 3rd somite, none of abdominal pleura with distinct marginal tooth or denticle, 6th somite about twice as long as maximum height; telson about as long as 6th somite, with 4 pairs of dorsolateral spinules, including lateral pair of posterior spines; antennal scale is more wider; 3rd maxilliped with epipod; pereopods with epipods on 4 anterior pairs, 2nd pair sub-equal, with 20 carpal articles, 3rd pair extending beyond the antennal scale by a length of dactylus, none of pereopods are extremely slender or thread like. Total length (102 mm), carapace length (17 mm) and rostral length (37 mm) for the voucher specimen was recorded.

This species is closely related to *P. martia*. In *P. semilaevis*, anterior part of the post-rostral carina is elevated and seperated from carapace, the orbital margin distinctly curved backwards. In *P. martia* anterior part of post-rostral carina is not elevated and not distinctly away from carapace, orbital margin is nearly vertical.

Emerging fishery for Japanese ruby fish in Vizhinjam

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Unique catch of Japanese ruby fish, *Erythrocles schlegelii* (Richardson, 1846) locally known as *Imbooraan* accurred at Vizhinjam Landing Centre for the last few months. A demersal fish (family Emmelichthyidae) they are commonly known as ruby fishes, rovers, bonnet mouths and redbaits. Marine plywood boats fitted with two 9.9 HP engines are operating hooks and line to exploit these fishes. Daily trips with fishermen departing early at 3.00 am from the shore, travelling about 20-25 km to operate at more than 100 m depths and reaching back by 3.00 pm in the afternoon is common. *Erythrocles schlegelii* occurring as a regular fishery along Indian coast has not been reported earlier. The rare landing of the Japanese ruby fish at Veravel was reported (Swatipriyanka, 2014 *Mar. Fish. Infor. Serv. T&E Ser.*, 222:12). In Vizhinjam, this fishery started from 2015 onwards and contributed steadily to the fish landings of the centre. The peak landings were during December to April period and the catch per unit varied from 5 – 10 kg. The fishery was supported by juveniles and adults whose total length (TL) ranged from 90 to 560 mm and the total weight ranged from 40 g to 1.45 kg. The normal average market price per kg of the ruby fish varied from ₹ 80 to 100 per kilogram. The catch is auctioned directly at the landing centre by fish merchants and women vendors for domestic sale. Being an emerging fishery resource, initially the consumer demand was very poor but consumer acceptance is picking up.

Erythrocles schlegelii sold at Vizhinjam Landing Centre

The seasonal hand line fishery for yellowfin tuna at Colachel

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In Tamil Nadu, the oceanic tunas like skipjack and yellowfin tuna are exploited mainly by multiday drift gill netters. However, in Colachel, Kanyakumari, there is a seasonal fishery targeting yellowfin tuna of medium size weighing around 30 kg, with hand lines that are operated from multiday trawlers. This is an additional income for both the fishermen and the trawl boat owners.

The main season is from February to April. Hand line with hooks (Hook Size Numbers 7-8) are

operated akin to pole and line and trolling, usually in the early morning. The non-edible fish by-catch from the previous day's trawling is used as bait for the operations. Once the tunas are located , the fish by-catch is broadcast into the sea and along with it the hand line is also dropped into the water while the boat keeps moving slowly. The line is pulled in once the tuna is hooked. The fishing ground is within the shelf area only and the tunas are found near the surface.Tunas of an average size of 114 cm Fork Length (FL) either in fully mature stage or in partially spent condition are caught. This clearly indicates presence of spawning shoals and that February-April probably is a major spawning season. Many tunas had stomachs replete with juvenile ribbon fish which was actually the by- catch broadcast into the sea which shows that these tunas were in search of food. The mode of fishing without baits hung on the hooks and hand lines operated from the trawlers without any additional modification is unusual. The flesh of these tunas were not of *Sashimi* grade. They were subsequently and degutted, their gills removed, cleaned thoroughly with water, packed in ice and sent to the processing plant for further preservation in -40^0 C, for exporting.

Emerging clam fishery in Muthalapozhi Estuary

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Muthalapozhi Estuary is located in northern part of Thiruvananthapuram District, Kerala. Perunguzhi and Azhoor are commercial bivalve landing centers located along the Muthalapozhi Estuary, where large-scale clam exploitation has emerged during the recent past (Fig. 1). This new development is due to the increased domestic demand for clams in Karnataka, Goa and Maharashtra consequent to the decreased availability of clams in their traditional local clam fishing grounds.

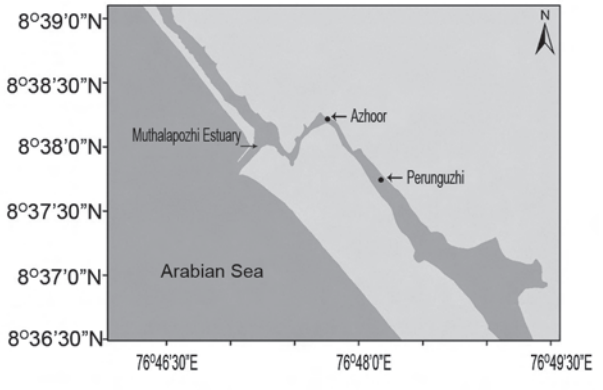

Fig. 1. Muthalapozhy Estuary showing the bivalve landing centres

Fishery commenced from 2016 after some fish merchants from Kollam and Kozhikode visited the area and found out from the local fishermen that good clam beds are available in the estuary. Today, more than 350 fishermen including women are actively involved in the clam fishery that exploit the rich clam beds by hand picking and hand dredging. Agents from Kollam and Kozhikode Districts are procuring the harvested clams from Thiruvananthapuram and Kollam Districts and transporting them to Karnataka where the clams are conditioned and repacked for marketing in Goa and Maharashtra.

Active fishing is being carried out in the backwater area from Azhoor to Perunguzhi, a stretch of about 1.5 km. Physico-chemical parameters of the estuarine water indicated temperature of 30^0 C, salinity 23 -31 (psu) and pH 8.1. Maximum

depth in the area of exploitation is about 6-8 m and the bottom is sandy clay.

Fishery started during the month of November 2016. Fishing is done by hand picking in shallow areas up to a depth of 1.2 m. 40 fishermen in Azhoor and 350 fishermen in Perunguzhi are engaged in hand picking. Skilled hand pickers can collect up to 50-70 kg of clams per day. Men start fishing from 6 am and continue till 4 pm whereas women are engaged in hand picking from 8 am to 3 pm. The clam catch by women is generally less and ranging from 18 to 25 kg per day. Harvested clams are collected in aluminum vessels. Once the vessel is filled, they are transferred to gunny bags, which are kept in wet condition. Occasionally, the entire fisherman family is involved in the fishery.

From deeper waters, clams are harvested using hand dredges operated from wooden canoes 18-20 feet OAL. Three fishermen go in a canoe, rowed by one while the other two are engaged in dredging. Average catch from a canoe is about 150 to 200 kg per day operated from 6 am to 4 pm. In this area there are only 5 canoe units. Clam harvest is higher during the low tide period. Fishing is done for six days in a week excluding Sunday and 25 fishing days in a month is common.

Species which contributes to the fishery are short neck clam *Paphia malabarica* (97%), baby clam, *Marcia opima* (2%), backwater clam *Meretrix casta* (1%) and rudder ark *Anadara indica* in stray numbers.On an average 45-50 gunny bags of clams are harvested per day from the 2 landing centres. Landing centre price for one gunny bag of large size clams (34-43mm) of 70 kg weight is ₹ 3000. Price of the small and medium size clam (22-35mm) is ₹ 1500 per sack. In some cases merchants segregate clams according to colour/species and price varies from ₹ 500 to ₹ 3000.

Clams packed in gunny bags ready for transportation

Collected clams are washed, packed in gunny bags and transported under moist conditions by road. Mulki Estuary near Mangaluru and Kundapur Estuary in Udupi (about 655 to 750 km away) are the two destinations in Karnataka, where the clams are conditioned before transporting to Goa and Maharashtra. After 15-18 hours of transportation, the bags are loaded into canoes for conditioning in the saline, estuarine waters. The bags containing clams are conditions in the deeper areas of the

Table 2. Details of clams landed and marketed

Month	Species	Length range (mm)	Mean length (mm)	Weight range (g)	Mean weight (g)	Price per gunny bag(50-70 kg)
December, 2016	*P.malabarica*	28-50	39.91	4.4-21.4	10.35	3000
	M. opima	37-46	41.6	8.9-20.1	14.06	500
	M. casta	23-34	29.3	2.5-5.3	3.9	1500
January, 2017	*P. malabarica*	24-49	34.58	1.2-23.2	6.96	3000
	M. opima	30-40	35.25	8.6-19.3	12.7	500
	M. casta	23-34	28.5	2.7-5.6	4.15	1500
	A. indica	22-27	24.5	3.0-3.29	3.14	-
February,2017	*P. malabarica*	25-45	27.2	1.2-23.2	6.35	1500
	M. opima	30-40	34.25	8.3-17.9	11.25	500
	M. casta	21-30	25.1	2.5-5.0	3.75	1500

estuary for 2 -3 days and then repacked in 5 or10 kg plastic bags. This fetches ₹ 900-1000/ per 10 kg bag, on retail. Loss during transportation is about 10-20%.

On an average **around** 50 sacks of clams (50-70 kg clams/sack) were exploited daily and the estimated catch per day from Azhoor to Perunguzhi stretch was 3000-3500 kg. The estimated total catch of clam exploited from November 2016 to January 2017 was 225 t. Total revenue from the fishery was an estimated ₹ 150000 per day and ₹ 3750000 per month.

The price changed within two months of fishing due to the decrease in the average size of the short neck clams landed. During the month of February, clams of size 25-29 mm dominated the fishery and this led to decline in price and the fishery stopped. At present the size of the clam of *Paphia malabarica* collected is more than recommended Minimum Legal Size (20 mm). Since large scale exploitation started for the first time in these two places, to sustain the fishery, closed season (December to February) as practiced in Ashtamudi Lake and awareness about Minimum Legal Size (MLS) of various clam species has to be created among the fisherfolk. Fishing of clams of 25-29 mm size is not economically feasible and may affect the fishery adversely in the coming years unless certain management measures are implemented by creating awareness among the fisherfolks.

Report of Potato grouper and Cloudy grouper in fishery landings at Mumbai

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Grouper fishery of Maharashtra is dominated by *Epinephelus diacanthus* with occasional landing of *E. bleekeri, E. malabaricus*, *E.coioides, E. areolatus*, *E. polylepis, E. morrhua, E. latifasciatus, E. epistictus*, *E. radiatus* and *Cephalopholis sonnerati*. During the routine fishery survey at Sassoon Dock on 9th October 2016 a single specimen of Potato grouper *Epinephelus tukula* measuring 35 cm TL (1.7 kg) was observed in the landings of a trawler operated at a depth of 40 off Ratnagiri. Reports of *E. tukula* is rare from Indian coast and other reports are from Lakshadweep, Vizhinjam (Kerala), Grand Island (Goa), Muttom, Enayam (Tamil Nadu) coasts (Sluka and Lazarus, 2010 *Marine Biodiversity Records* 3:1-3). Potato grouper, is a widely distributed Indo-Pacific species, but sparsely known in their distribution range from Red Sea to Kenya and Australia. The name refers to the potato-shaped dark blotches on the body. A reef-associated species, it can grow to maximum size of 200 cm and weigh around 110 kg. Though reported as a rare and uncommon species, it is listed as "Least Concern" in the IUCN red list category. The distinctive colour pattern and blotches makes *E. tukula* easy to identify from other species of groupers.

Potato grouper *Epinephelus tukula*

Cloudy grouper, *Epinephelus erythrurus*

On 28.12.2016, a single specimen of Cloudy grouper, *Epinephelus erythrurus* was collected from the by-catch of a trawler operated off Maharashtra coast. Olive brown coloured with irregular pale blotches, the specimen measured 268 mm TL and 303 g weight. A rare Indo-West Pacific grouper species, it is listed as "Data Deficient" in the IUCN red list category. It occurs in muddy/sandy bottoms with a geographical distribution range from Pakistan to Borneo (Heemstra and Randall,1993 *FAO Species Catalogue* Vol. 16. *Groupers of the world*).

A brief note on portunid crab, *Charybdis (Goniohellenus) omanensis septentrionalis* from southwest coast of India

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Crustacean Fisheries Division of ICAR-CMFRI, has recently taken up a two year programme on experimental trawling using fishing vessel *F.V. Silver Pompano*. Samples were collected from different bathymetric stations off Kochi and Alappuzha during fortnightly intervals. Samples in the last fortnight of August 2016, collected at a depth of 65m off Alappuzha, included a good number of *Charybdis* (*Goniohellenus*) *smithii* along with fishes and other crustaceans. While segregating the samples of swarming crab *C.* (*G.*) *smithii*, approximately 5 kg of small sized *Charybdis* sp. was also collected. This species was not included in the earlier samplings of the programme as well as in the commercial fishery landings. Hence detailed studies were carried out and found the species is *C.*(*G.*) *omanensis septentrionalis,* a new record in the Indian seas. The detailed morphometric and diagnostic characters examined were similar to the descriptions given by Türkay & Spiridonov (2006) *Fauna of Arabia* 22: 199-223; who first recorded the species from the Red Sea. Specimens of the species have deposited in the Designated National Repository (DNR) of ICAR- CMFRI, Kochi (ED: 5.5.10). The species size ranged between 17 to 37mm carapace width and total weight between 0.62 and 5.53 g. The carapace is light brownish in colour and anterolateral border with six teeth, and among them second is the smallest and sixth is the longest (Fig. 1). Chelipeds are almost similar in size and bear

Fig. 1. *Charybdis (Goniohellenus) omanensis septentrionalis*

granular reddish brown patches. Second to fourth ambulatory legs are slender and shorter than chelipeds; swimming legs with propodus and dactylus flattened and bear numerous fine setae along the borders. The identity of the species is confirmed based on the morphological characters viz., shape of the median frontal teeth which are not pointed; not twisted or weakly twisted downward distal tip of gonopod 1 and the ratio between carapace width and carapace length. When compared to the other species of portunid crabs of the region, *C.*(*G.*) *omanensis septentrionalis* is very small in size and has little importance in the commercial fisheries at present.

Record sized *Alepes vari* and *Nematalosa nasus*

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The herring scad, *Alepes vari* is a common pelagic fish species in the family carangidae. The species is the largest fish of the scad genus *Alepes* and maximum length so far recorded all over the world oceans is 560 mm TL (Froese & Pauly, FishBase 2016, *http://www.fishbase.org*.). During a regular field visit, an unusually large specimen of *A. vari* was recorded from Kalamukku Landing Centre, Kerala on 25th May, 2016. This was a male individual measuring 600 mm in total length (TL) and weighing 1.6 kg (Fig. 1)and was caught by hook and line. Young ones occasionally occur in pelagic trawls and larger ones rarely occur in gill net and hook and line catches.

Nematalosa nasus (Bloch's gizzard shad), is a small pelagic mostly captured with ringseines and occasionally found in the catches of pelagic trawls and gill nets. During a regular field visit, on 25th October 2016, an unusually large specimen of *N. nasus* (241 mm total length (TL) and 171.5 g total weight (TW) was collected from a chinese dip net, operated at Fort Kochi (Fig. 2). The specimen was deposited in the collections of Marine Biodiversity Museum of CMFRI, (accession number, GB 13.2.37.6). The largest record of *N. nasus* (252 mm TL and 190 g TW) was reported from Chilka Lagoon, Odisha (Panda *et al.*, 2016 *J. Appl. Ichthyol.*, 32(6): 1286-1289). The detailed morphometric measurements and meristic counts of both the species are given in the Table 1.

Table 1. Morphometric measurements and meristic counts of *A. vari* and *N. nasus*

Morphometric characters	*Alepes vari*		*Nematalosa nasus*	
	Measurements (mm)	% of TL	Measurements (mm)	% of TL
Total length (TL)	600		241	
Fork length (FL)	490	81.7	206	85.5
Standard length (SL)	452	75.3	186	77.2
Pre 1st dorsal fin length	144	24.0	84	34.9
Pre 2nd dorsal fin length	224	37.3	-	-
Pre pectoral fin length	100	16.7	47	19.5
Pre pelvic fin length	108	18.0	88	36.5
Pre anal fin length	227	37.8	134	55.6
Head length	105	17.5	48	19.9
Pectoral fin length	123	20.5	43	17.8
Pelvic fin length	53	8.8	23	9.5
Maximum body depth	156	26.0	78	32.4
Head length (HL)	105	**% HL**	48	**% HL**
Pre-orbital length	31	29.5	13	27.1
Snout length	39	37.1	18	37.5
Eye diameter	17	16.2	12	25.0
Inter orbital width	41	39.0	20	41.7

Meristic counts		
1st dorsal fin	VIII	17
2nd dorsal fin	I+26	-
Anal fin	I+22	22
Detached anal fin spines	II	-
Pectoral fin	I+19	16
Pelvic fin	I+5	8
Gill rakers on first gill arch	24+10=34	-
Lateral line scutes	69	-
Belly scutes	-	18+13=31

Fig. 1. *Alepes vari* (600 mm TL)

Fig. 2. *Nematalosa nasus* (241 mm TL)

A note on a large sized Indian squid landed

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Indian squid, *Uroteuthis (Photololigo) duvauceli* (Orbigny, 1835) locally called as *Narsingha*, forms an important cephalopod resource in Gujarat. The present specimen was collected on 20th January 2017 from the Veraval Fishing Harbour caught by a singleday trawler operating at a depth zone of 40 to 60 m off Gujarat coast. The particular trawler also landed about 20 kg of considerably bigger size squids. *U. (P.) duvauceli* show differential allometric growth and the asymptotic length for male is higher than females, whereas the female grows faster compared to males. Male lives up to 3.2 years where as female are up to 2.6 years (Mohamed, 1996, *Bulletin of Marine Science,* 58(2): 393-403). The detailed morphometric measurement of the specimen and the earlier reported specimens from different locations is given below.

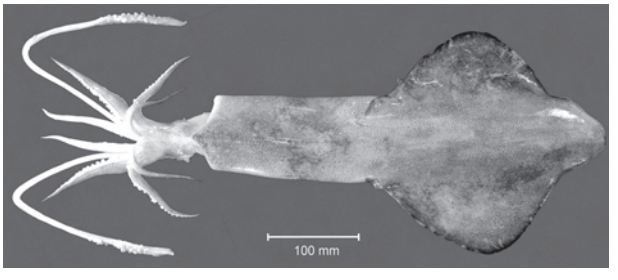

Fig. 1. Largest reported Indian squid, (Sex: male; Size: 445 mm DML) caught off Gujarat

Table 1. Morphometric measurements of *Uroteuthis duvauceli*

Morphometric Characters	Measurement (mm)	% of DML
Total Length (TL)	829	
Dorsal Mantle Length (DML)	445	
Pen Length (PL)	433	97.30
Body Girth (BG)	215	48.31
Fin Length (FL)	257	57.75
Fin Width (FW)	235	52.80
Arm Length (AL)	133	29.88
Tentacle Length (TnL)	362	81.34
Head Length (HL)	46	10.33
Eye Diameter (ED)	21	04.71

Table 2. A comparison of the present specimen with earlier reports of large sized Indian squid

Earlier reported size (DML in mm)	Sex	Reported Area	Reference
415	Male	Mangalore, India	Mohammed, 1996 *Bull. Mar. Sci*. 58(2):393-403.
385	Unsexed	Mumbai, India	Karnik *et al.*, 2003, *Indian J. Mar. Sci*., 32(1): 67-70
380	Unsexed	Mumbai, India	Chakraborty *et al.*, 2013 *Indian J. Mar. Sci.*, 32(1): 67-70
262	Unsexed	Arabian Sea, Pakistan	Soomro *et al.*, 2014 *Indian J. Mar. Sci.*, 44(10): 1598-1603.
445	Male	Veraval, India	Present Study

Neoplasia in oil sardine from Palk Bay

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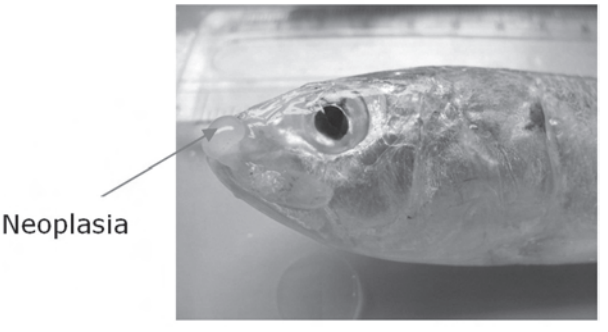
During a routine fishery survey programme at Irumeni fishing village, Palk Bay on 03rd December 2016, a single specimen of oil sardine *Sardinella longiceps* with neoplasia, measuring 163 mm in total length (TL) and weighing 119 gram was collected from the gillnet landings. The specimen was a female with empty stomach.

The methodology of Sanil and Sobhana, 2014 *'Monitoring Neoplasia/Tumours in Marine Fish'* was followed for reporting on the specimen. Grossly, the neoplasia was a whitish solid hard structure on the upper maxillary part, that measured 5.9 mm in



diameter. Microscopically, the growth at the mouth part showed an area of fibroblast proliferation along

with the bony tissue. The osteoclast cells had become atrophic and were varied in shapes having lost its structure. Pleomorphisms of the cells were also present. There was considerable anaplasia of cells with marked variation in size and shape and scattered giant cells were readily evident. The histological studies further revealed that the tumour was 'Fibroma' and its etiology and metastatic nature requires further scrutiny.

Finfish seed collection in Krishna and West Godavari Districts, Andhra Pradesh

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Marine finfish culture using locally available wild seed is gaining importance in Andhra Pradesh. Fishes such as Asian seabass, milk fish and different species of mullets are the major species available in sufficient quantities in the wild. Understanding the availability of the wild seeds in the backwaters of Krishna and West Godavari districts, aquaculture of those fishes has been established in most of the coastal districts of Andhra Pradesh. Part- time seed collection operations are being practiced by fishermen in several fishing villages from these districts. Traditional methods of fish seed collection employed are based on tidal patterns. There are two major methods of seed collection depending on the location. The fish seeds are collected using scoop nets during low tide time from the water pools in the mangroves. The fish seeds are also collected with drag net or seine net in the backwaters and sea shore areas. During high tide, nets are installed with poles, near periphery of the estuary. The fish seeds get collected in the net during low tide and when water recedes further they are collected by the fishermen. The seed collection is mainly practiced during March to May for Asian seabass, March to July for milk fish and throughout the year for mullet. Large scale seed collection is being followed for Asian sea bass and milk fish.

The collected seeds are stocked in small ponds near the seed collection sites. Normally these seeds are less than 2 cm in size and they are separately stocked in *Hapas* or released directly to the pond of 1-2 acre in size. The ponds for seed rearing are prepared with two different depths, the deeper portion in the periphery and shallow depth in the middle. Rice bran is used as feed for milk fish while Tilapia juveniles are fed to sea bass. Interestingly, small branches of a plant, commonly known as 'babul' (*Acacia nilotica* , '*Nalla thumma*' in telugu), is placed at different places of the pond. This is used as aggregation device for the fish seeds. In addition, the epiphytic algae and zooplankters that accumulate in it are feed for both milk fish and seabass. The stocked fishes are allowed to grow for 1-2 months and then sold to fish farmers for culture. Generally milk fishes are sold at the size of 3-5 cm, but seabass are grown to a comparatively bigger size. While catching the fish from the pond, the branches are removed slowly and the cast net operated in the same site so that more numbers of fish gets entrapped in the net.

The selling price for milk fish seed (1 inch size) is around ₹ 60,000 -70,000 for 1 lakh seeds. The 1-2 inch sized sea bass is sold at around ₹ 25 /seed while a bigger sized sea bass seed (100 g) costs around ₹ 80-100 per piece. The price of mullet seed is comparatively less and it costs ₹ 10 for 100 g of seed. The seed prices varies depending on the size and demand of the seeds. Mostly, the collected seeds are transported within Andhra Pradesh and to some places in Tamil Nadu, Karnataka and Maharashtra. In addition to finfish seed, the collection of mud crab and prawn seeds is also progressing well in these districts and most of the families in the villages are actively involved in collection of fish seed as a part time occupation.

Three baleen whales washed ashore along Uttara Kannada coast of Karnataka

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Three instances of stranding baleen whales were observed along the coast of Uttara Kannada district of Karnataka during July and August 2016. All strandings were recorded from the southern part of the district.The first whale was washed ashore on 20th July 2016 at Ramangindi, Dhareshwar, 12 km south of Kumta (14^0 21' 710"N and 74^0 24' 36^0E). The whale was in a decomposed condition when washed ashore. The post mortem was carried out by a veterinary doctor. It was identified as Bryde's whale *Balaenoptera edeni*. The total length of the male whale was 44 feet weighing approximately 10 tonnes (Fig. 1). The second whale washed ashore on 27.7.2016 at Hollangadde 7 km from Kumta (14^0 27' 432" N and 74^0 22' 615" E was also in decayed condition. It was identified as baleen whale and measured 46 feet (Fig. 2).The

Fig. 1. Bryde's whale stranded at Dhareshwar

third, identified as a baleen whale (*Balaenoptera* sp.) washed ashore on 13.8.2016 at Pavinkurva-taribagilu 7 km from Honnavar (14^0 19' 348"N and 74^0 24' 811"E) was in a decayed condition and its total length was 40 feet (Fig. 3). All the three whales, after post mortem by local veterinary

Fig. 2. The baleen whale stranded near Kumta

doctors at the place of stranding were buried by forest officials and Gram Panchayat authorities. Literaure review on whale strandings indicated reports of two baleen whales stranded on this coast, one at Nadibag, near Ankola on 16th April 1987 and another at Hollangadde 7 km south of Kumta on 29th April 1987 (Telang, 1987, *Mar. Fish. Infor.Serv. T&E Ser.*, 78:17). Another stranding of baleen whale was recorded on 29th September 1996 at Harikantrawada, Keni of Ankola Taluk (Kakati, 1997, *Mar. Fish. Infor.Serv. T&E Ser.* 147:15). The strandings of three baleen whales within a period of one month is a rare phenomena on the Uttara Kannada coast.

Fig. 3. The baleen whale stranded near Honnavar

Sharptail mola landed at Thoothukudi

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A large Sharptail mola *(Masturus lanceolatus)* measuring 180 cm in Total length (TL) landed on 28.07.2016 at Tharuvaikulam Landing Centre, Gulf of Mannar. Interaction with the local fishermen indicated that it was caught at a depth of 150 m in a drift gill net conducting multiday fishing for 4-5 days about 40 km from shore. Morphometric measurements were recorded as standard length (SL) 135 cm, body depth 90 cm, head length 41 cm, eye diameter 7 cm, snout length 20 cm, dorsal fin length 62 cm, pectoral fin length 19 cm, anal fin length 56 cm and caudal fin length at pointed tip 47 cm. The specimen weighed 70 kg. The first report of *Masturus lanceolatus* from Gulf of Mannar was made during 1976 at Pudumandapam (Devaraj *et al.*, 1976, *J. Mar. Biol. Ass. India*, 18(3) : 663-666) and subsequently only few specimens have been reported (Arumugam *et al.*, 1994, *Mar. Fish. Infor. Serv. T&E Ser.*, 128: 16-17; Badrudeen, 1995, *Mar. Fish. Infor. Serv. T&E Ser.*, 137:20; Chellappa *et al.*, 2002, *Mar. Fish. Infor. Serv. T&E Ser.*, 174:10).

Baleen whale washed ashore at Neendakara

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On 9th October 2016, a baleen whale, *Balaenoptera* sp measuring 15.5m in total length was washed ashore at Neendakara Landing Centre, Kollam (Fig. 1). The animal was in highly decayed condition and identification to species level was difficult. The local fisherman reported that the animal was found drifting in the offshore for a couple of days before it got washed ashore. The Local Body authorities later buried the animal on the beach itself

Balaenoptera sp washed ashore at Neendakara Landing Centre, Kollam

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Friedman and Bell. 1996, ***J. shellfish Res.***, 15: 535-541. (Reference with two authors)

Pauly, 1980, ***FAO Fish. Tech. Pap.***, (234).

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