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Marine Fisheries Information Service

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Marine Fisheries Information Service

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Front Cover : *Holothuria scabra, a high value sea cucumber*

Back Cover : *Diver picking sea cucumbers*

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

In this issue the lead article explores options for the sustainable exploitation of sea cucumbers available in the Indian seas which are highly valued in the international processed sea food market as *Beche-de-mer*. Currently, fishing of sea cucumbers is banned in India and this has impacted several fishermen who were part of a traditional sea cucumber fishery with a history of several hundred years. Also featured is the Marine Fisheries Census 2016 program being conducted by ICAR-CMFRI with support from Department of Animal Husbandry, Dairying & Fisheries (DADF) to create the database on marine fisheries infrastructure, fishermen demography and their socio-economic status that will aid the policy decision processes for the marine fisheries sector of the country. Several notes documenting the fisheries, marine biodiversity of the various maritime states and the mariculture sector are also included.

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

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Status of sea cucumber resources and impact of fishing ban on the livelihood of fishers in Gulf of Mannar and Palk Bay

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Introduction

The sea cucumbers constitute an important part of non-fish income source for thousands of fishers along Gulf of Mannar and Palk Bay of south east coast of India. The fishery which is more than thousand years old was introduced by the Chinese stationed at Ramanathapuram, for preparing a dried sea cucumber product *Beche-de-mer*. The sea cucumber fishery in Gulf of Mannar and Palk Bay was artisanal in nature and consisted of fishermen who were good divers, the processors who acted as middlemen and the exporters. The sea cucumbers were chiefly collected by skin diving to a depth of 1.5 to 6.0 m in the shallow seas using non-mechanised country crafts. They were also caught as by-catch in trawlers locally known as *Thallu madi* (an indigenous modified trawler operating on wind power in shallow waters), besides the *Chanku madi* and *Attai madi* which were operated in deeper coastal waters.

Because of the increase in market demand, low cost of fishing and simple processing techniques for sea cucumbers, the industry developed as a lucrative business. Consequently, the resources were overexploited which was evident from the decline in catch and the size of the specimens fished/ landed, poor catch per unit effort and decreased export volumes of processed sea cucumber from India. Since the sea cucumber fishery was not organized, management measures could not be implemented effectively. This was evidenced from the failure of the first legislation laid by the Ministry of Environment, Forests and Climate change, Government of India in 1982 that imposed the ban on export of *Beche-de-mer* less than 75 mm. The fishery came to a stand still when the Ministry in the year 2003 included all the holothurians as protected animals along with 50 other marine species under the Indian Wild life (Protection) Act, 1972. The fishermen and traders strongly objected to this and representations were given several times to lift the ban, as it severely affected their livelihood. Several clandestine fishery and trade practices were reported for both raw and dried sea cucumbers trade from this region to neighbouring countries especially to Sri Lanka where sea cucumber fishery and trade is not banned. The fishermen who violated the law were also punished.The 14 years of ban might have helped in reviving the population, at the same time it also made a social and economic impact on scores of fishers dependent on the sea cucumber resources for their livelihood. To explore the possibilities of conservation and sustainable use of sea cucumber resource through community participation, ICAR-CMFRI had undertaken a short term project with funding support from BOBLME to study the present status of the sea cucumber stocks and the impact of current conservation measures on the stock and livelihood of fishers. Also, to suggest renewed management measures for the sustainable use of this resources. Some of the salient findings of the study are summarised below.

Status of sea cucumber resources

Of around 39 species of sea cucumbers reported from Gulf of Mannar and Palk Bay, only seven commercially valued species were being used for

Beche-de-mer preparation. Species like *Holothuria scabra* and *H.spinifera* along with *Bohadschia marmorata* and *H.atra* in small quantities were used for *Beche-de-mer* preparation during the initial period. Later, because of the poor prevailing market value, the processing of the latter two species were discontinued. Species like *Actinopyga echinites* and *A. miliaris* were also processed in huge quantities in the subsequent years. The intensive fishing paved the way for a sudden depletion of these two species that resulted in its total disappearance from fishery within a year. Similarly, *Stichopus chloronotus* that was once processed along Gulf of Mannar and Palk Bay also disappeared from the catches of sea cucumber. Occasional landings of *Stichopus hermanni* in large numbers was reported from Thoothukudi. Thus, the fishery of sea cucumbers along Gulf of Mannar and Palk Bay became centred around two species *H. scabra* and *H. spinifera* round the year and occasional landings of species like *Actinopyga echinites*, *A. miliaris*, *Stichopus hermanni* and *S.horrens*.

The status of sea cucumber population in Gulf of Mannar and Palk Bay was assessed by trawl and diving surveys by ICAR-CMFRI in 2015. The Swept Area Method was followed using a trawler (overall length 15m fitted with a 285 hp engine). Prawn trawl nets, modified with added sinkers or bobbins in the foot ropes locally called as '*Attai madi*' was used for the sea cucumber survey. Swept areas of 545,200 m^2 (13 trawl hauls) in Gulf of Mannar and 213,100 m^2 (12 trawl hauls) in Palk Bay were covered for the study. Seagrass was the major trawl catch component and sea cucumbers constituted the fifth major group that formed 3.4 and 3.04% of the catch in Gulf of Mannar and Palk Bay respectively.

Nine sea cucumber species with varying commercial values were collected from Gulf of Mannar. Medium valued *Stichopus horrens* (45%) was the major species followed by *Holothuria leucospilota* (27%), *H. atra* (16%), *Bohadschia marmorata* (8%), *H. scabra* (1.5%) and *H. spinifera* (1.5%). A few numbers of *Colochirus quadrangularis*, *H. edulis* and *Bohadschia* sp. were also observed (Fig. 1). In Palk Bay, six species were recorded. 85% of the catch was of the high value species *H. scabra* followed by *H.atra* (9%), *H. spinifera* (4%), *S. horrens* (1.5%), *B. marmorata* and *H. leucospilota* (Fig. 2). The diversity and density of sea cucumbers were higher in Gulf of Mannar than in Palk Bay which might be due to the greater depth and heterogeneous habitat of the region.

As a precursor to lift the ban, sea cucumber stock surveys were undertaken by Zoological Survey of India (ZSI) during 2006, 2011 and 2012 which reported the dominance of about 9 medium and low valued species in Gulf of Mannar with no improvement of stock. The survey conducted by CMFRI in 2015 for the BOBLME project also indicated the availability of around 9 number of species from Gulf of Mannar and Palk Bay with the numerical dominance of *S. horrens* from Gulf of Mannar and

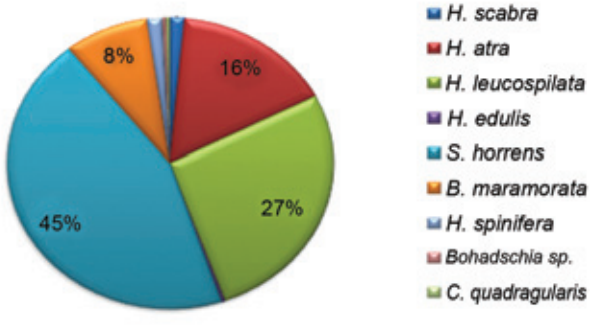

Fig. 1. Species composition of sea cucumbers recorded during surveys in Gulf of Mannar

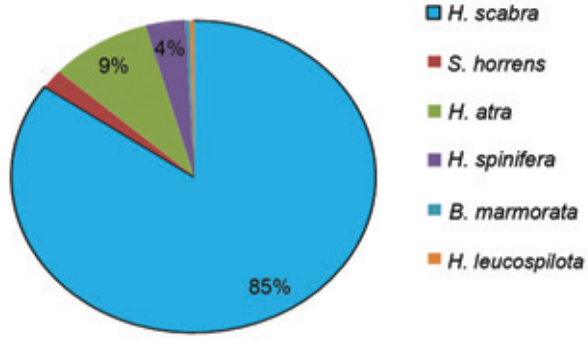

Fig. 2. Species composition of sea cucumbers recorded during surveys in Palk Bay

H.scabra from Palk Bay. All these post ban stock surveys confirmed the availability of high valued *H.scabra* and two medium valued species like *H.spinifera* and *Stichopus* spp. from this region. A few specimens of *Actinopyga miliaris* was reported during surveys in 2006 from Gulf of Mannar but was not reported in 2011 and 2012. Similarly none of the surveys indicated the occurrence of historically processed species *A. echinites and Stichopus chloronotus* from Gulf of Mannar and Palk Bay. This indicates the relatively high vulnerability of these species to fishing and the difficulty of depleted stocks to repopulate to its original level in Gulf of Mannar and Palk Bay because of its low reproduction or recruitment rate. All other species are relatively sturdy and less vulnerable to fishing pressure.

The individuals of *H. scabra* population in Gulf of Mannar was comparatively larger sized but in the Palk Bay most of them were medium sized. The length distribution pattern was unimodal for most of the species in Gulf of Mannar and Palk Bay. In Gulf of Mannar, the major species *Stichopus horrens* was collected from 59.7% of the survey sites and 13.6% each of the survey sites recorded high population abundance of >1000 - >5000 nos.ha^{-1}. Juveniles were abundantly distributed in seven sites. In Palk Bay, the major species *H. scabra* was reported from 96.2% of the survey sites and in 19.2% of the sites their density was >5000 nos.ha^{-1} and 30.8% sites had density with >1000 nos.ha^{-1} while in 34% sites juveniles were present. The studies on length weight relationship indicated allometric growth in sea cucumbers and it appears to be the general case of tropical holothurians. Study indicated that for a given length, the individuals collected from Gulf of Mannar were stouter than those collected from Palk Bay.

Influence of ban on livelihood of fishers

Sea cucumber landings were reported chiefly from 15 major centres in the Gulf of Mannar and from 25 centres in Palk Bay. It served as an important source of income for the livelihood of around 200000 fishermen in this area. The interview survey was carried out in Gulf of Mannar (Ramanathapuram and Thoothukudi districts) and in Palk Bay (Ramanathapuram, Pudukottai and Thanjavur districts) to assess the impact of ban on livelihood of fishers in this area. A total of 21 villages in Gulf of Mannar and 20 villages in Palk Bay were selected for the survey. A total of 400 fishermen who have been specifically engaged in sea cucumber fishery, 80 middlemen and 20 traders were selected using proportionate random sampling technique from the selected villages. Data collection was done through interview method, key-informant interview and focused group discussions. Percentage analysis and Garrett ranking were done to process the data and arrive at meaningful conclusions.

All the respondents were involved in fishing/ trade of sea cucumber, but 31% of the respondents had quit the sector after declaration of ban. They expressed the opinion that genuine fishermen and middlemen/traders have left the sea cucumber fishing as the ban affected their livelihood. They reported a loss in their regular income and they were also unable to take up other fishing activities due to lack of capacity for investment. Consequently, their debts increased and they were unable to give quality education to their children.

Before the ban, most of the fishermen (85%) sold sea cucumbers in the form of *Beche-de-mer* (processed) and remaining (15%) sold the sea cucumbers in fresh form. During ban only 5% of fishermen processed the sea cucumber, while the rest were selling it in fresh form. This was mainly due to the fear of being caught by the authorities during processing of sea cucumbers for violating the fishing ban. Fishers/middlemen/traders received a better price for processed sea cucumbers in comparison to fresh/unprocessed ones. When compared to exporters share, fishermen received ₹ 5,500 and ₹ 9,000 less per kg (20 counts) of processed sea cucumbers before and during ban respectively (Table 1). Thus it is clear that fishermen are receiving only half of the amount exporters receive in the sea cucumber marketing channel.

Bohadschia marmorata

Holothuria spinifera

Colochirus quadrangularis

Stichopus horrens

Holothuria atra

Holothuria edulis

Holothuria leucospilota

Holothuria scabra

Bohadschia sp.

Moreover, the price of sea cucumbers is high during ban enforced period in comparison to pre-ban period. The increase in price is due to the high demand in international markets and low supplies due to ban on sea cucumber fishing.

The results of interview survey based on the perception of fishermen reveals that the stock of sea cucumber population has increased significantly after the implementation of ban on sea cucumber fishing in the Gulf of Mannar and Palk Bay region. However, the clandestine collection of sea cucumbers and accidental catch in trawlers during the ban was also evident from the survey. The fishermen opined that the ban may be lifted at least for a few commercially important species with effective participatory co-management and conservation measures. The effective management measures suggested by them were: seasonal closure, size restriction, strict enforcement regarding banned gears and fishing methods, rotational harvest closures, stock enhancement through sea ranching, conducting periodical awareness programme on conservation of sea cucumbers at village level, standardisation of commercial level seed production techniques of selected species of sea cucumbers and farming trials, demarcation of certain areas designated as No-Take Zone in consultation with the local communities and formation of fishermen co-operatives which can be given license for sea cucumber trade.

Total sea cucumber fishing ban versus regulated fisheries

The ICAR-Central Marine Fisheries Research Institute has played a significant role in the conservation of sea cucumbers in India. The institute implemented various projects since 1962 to study the systematics, biology, ecology, zoogeography, parasites and animal association, biotoxicity issues as well as captive breeding and farming of sea cucumbers. The institute has conducted several awareness creation programmes on importance of conservation of sea cucumbers for the fishermen of Gulf of Mannar and Palk Bay. The present ban on fishing and trade being implemented for more than 14 years has became ineffective because of the illegal removal of sea cucumbers and clandestine trade. However, if the ban is lifted, the following regulations are suggested to allow the conservation and sustainable utilization of the sea cucumber resources of the region. This can be achieved only through community participation which ensures their access to the resources along with shouldering the responsibility of conserving the resources. It is suggested that the moratorium may be lifted and fishing may be allowed with strict regulations. The

Table 1. Average market price (₹ per kg) for processed sea cucumbers

Supply chain	Before ban imposed		After ban imposed	
	20 counts	45 counts	20 counts	45 counts
Fishermen	5,000	2,000	9,000	3,000
1st level middlemen	5,100	2,100	9,600	3,500
2nd level middlemen	5,300	2,250	10,400	4,100
3rd level middlemen	5,600	2,500	11,800	5,000
Traders	6,200	3,400	15,000	7,000
Exporters	10,500	5,000	18,000	11,400

(1US$ = ₹ 64 approximately)

opinion gathered from interview surveys and consultations with stakeholders suggests that at least 4 or 5 regulatory measures may be needed to manage sea cucumber fisheries which are summarised below.

Seasonal closures

Seasonal closure is suggested to protect the reproductive stock for which peak spawning period of the commercially important species should be considered. Effective spawning of *Holothuria spinifera* and *H. scabra* occur due to changes in salinity, temperature and productivity of the environment, associated with the north east monsoon along south-east coast of India. Hence, seasonal closure of holothurian fishing is recommended from November to January which will ensure that the spawners breed and propagate their progeny.

Size regulation

The minimum individual length or weight of sea cucumber that can be legally fished or traded (Minimum Legal Size, MLS) is considered in this concept. It is based on the Size at First Maturity of sea cucumbers which generally varies with species. The size at first maturity estimated in the case of *H. scabra* is 230 mm. This can be implemented effectively through skin divers, who can visibly estimate the length and can perform selective harvesting, to avoid juvenile fishing. As sea cucumbers remain alive for some time even after capture, the juveniles collected by other modes of fishing like trawl nets can also be returned to sea.

Spatial closure and No Take Zone

The Marine National park located within the Gulf of Mannar Biosphere Reserve ensures the protection of sea cucumbers as fishing and other human activities are prohibited within the reserve. Such protected areas are absent in Palk Bay. The declaration of protected areas in Palk Bay would greatly ensure the protection of sea cucumber and seagrass population. As the sea cucumbers are density dependent breeders, the marine reserves will help in maintaining the breeding population at adequate densities.

Gear regulations

This involves the prohibition or limit on the use of certain types, sizes or number of equipment for collecting sea cucumbers. Accordingly vigilance on the illegal operation of already banned destructive gears like *Thallu madi* and *Roller madi* operated in the inshore areas and seagrass habitats and the strict implementation of ban on operation of trawlers in inshore areas will reduce the damage to sea cucumber habitats and conserve sea cucumber populations in Gulf of Mannar and Palk Bay.

Catch quota

A catch limit or quota should be set for sea cucumber fishery, either for a year or for a fishing season. Quotas, also called "Total Allowable Catch" usually denote the weight in tonnes of live-weight or in terms of numbers also. This can be enforced for the holothurian fishery in Gulf of Mannar and Palk Bay also. This quota system allocated to each licensed fisher will provide a way to equitably distribute potential earnings from the resources. While it will be easier to implement catch quotas among small scale skin divers, it may be difficult for trawlers with high number of fishers participation.

Rotational harvest closure

This involves a periodic, temporal and spatial shifting of fishing effort, in a systematic way among demarcated fishing grounds. Rotational closure allows the size and abundance of sea cucumbers in the closed grounds to recover for a couple of years before being fished again.

Habitat protection

This measure ensures the protection of breeding habitats of sea cucumbers. Normally they occur in a variety of habitats like coral reefs, seagrass beds, salt marshes, mangroves, rocky, sandy and muddy shores etc. and there is a species specific habitat preference. Most of them prefer seagrass habitats

and as a result are profusely destroyed by trawl operations in these grounds. Similar to coral reefs, the protection of seagrass beds and their restoration helps in the conservation of sea cucumbers and other associated fauna. Interestingly, in neighbouring Sri Lanka which shares the Gulf of Mannar ecosystem with India, there is no trawl fishing. Here, the sea cucumber resources in the sea grass beds are reported to be abundant with high diversity.

Trade management

The illegal trade of sea cucumbers in Palk Bay and Gulf of Mannar at present involves a lengthy market chain of fishers, several middlemen, traders and exporters. If regulated fishery of sea cucumbers is permitted, it should be ensured that fishers receive a fair share of the export value by monitoring the income generated by the fishery. Monitoring the whole market chain from fisher to exporter allows government agencies to verify or set appropriate taxes and duties. It is necessary to have a process by which price data from the international market can be collected regularly.

Species requiring stricter management

The best way to manage the trade of sea cucumber fisheries is based on their population status. In Gulf of Mannar and Palk Bay, the fishery and trade of sea cucumbers were mostly restricted to two species namely, the high value *Holothuria scabra* and medium value *H. spinifera*. A few other medium value species namely, *Actinopyga miliaris*, *A. echinites* and *Stichopus hermanni* are fished and traded occasionally. The most widely traded species such as *H. scabra* and *H. spinifera* are more common whereas species like *Actinopyga echinites, A. miliaris* and *S. chloronotus* are rarely observed, indicating that the latter require more management.

Restocking and farming of sea cucumbers

One of the options for recovery of sea cucumber stocks is through restocking of juveniles and adults through hatchery production and aquaculture. In India, the ICAR-CMFRI succeeded in the seed production of *H. scabra* in 1988 and *H. spinifera* in 2001. Further research has helped refining and standardising the mass production of seed of the two species. Programmes to grow hatchery-reared sea cucumbers in sea-pens (sea-farming) or in exclusively managed areas of natural habitat (sea-ranching) are growing in the Indo-Pacific region and Indian Ocean for the purpose of providing income for coastal communities. The community based management system ensures protection of released juveniles until harvest and these can result in small, but dense, breeding populations that improve egg production for rebuilding sea cucumber stocks in neighbouring fishing grounds. Community based sea ranching and farming enterprises can be initiated in Gulf of Mannar and Palk Bay, as we are bestowed with a vast coast line, island territories, bays and lagoons which favour such activities. Upgradation of the existing hatchery technique for cost effective, mass production of sea cucumber juveniles for sea ranching and farming activities can meet the growing market demand and in turn reduce the pressure on the wild stocks. This will aid conservation efforts and create a sustainable fishery that helps export of sea cucumbers from India.

Ecosystem approach to fisheries management

Effective management of sea cucumber fishery can be achieved by following an ecosystem approach, in which multiple regulatory measures are applied in a participatory manner in full consideration of the sea cucumber stocks, the ecosystems in which they live and the socio-economic systems. Considering the importance of multitude of critical habitats like coral reefs, seagrass beds, seaweeds, mangrove forests and rocky coast in this region, which also serves as the home for several endangered and vulnerable species habitats and species, it is worthwhile considering the management of entire area through an ecosystem approach jointly by India and Sri Lanka.

Approach and implementation strategies for Marine Fisheries Census 2016

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Introduction

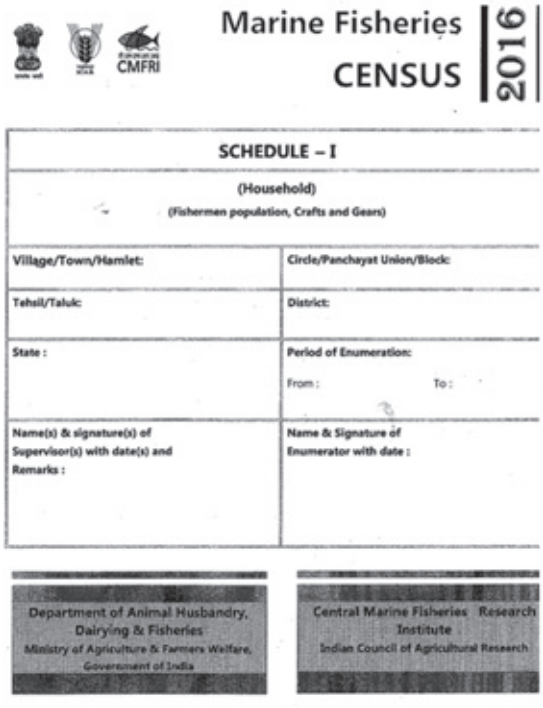
Fisheries sector plays a significant role in the socio-economic development of a developing country like India by generating employment and income, besides being source of protein for a large section of the population. It generates a substantial amount of foreign exchange through exports. Over a period, marine fisheries sector in India has witnessed a significant improvement in fishing gear technologies, infrastructure, communication and transportation facilities which resulted in an increase in the annual marine fish production from 0.5 million tonnes in 1950 to 3.59 million tonnes in 2014. Marine fisheries are considered as renewable resources, but its management and development supported by focussed research activities are necessary to ensure sustainable fish production from the seas. For this, it is very much essential to have reliable and updated knowledge about marine fishery resources as well as the information about socio-economic status of fisher-folk and infrastructure facilities existing in marine fishing villages.With this aim, the first planned survey was carried out by ICAR-Central Marine Fisheries Research Institute (CMFRI) during 1948-49 period and the information regarding fishing seasons, village-wise fishermen population, number of active fishermen, various types of fishing units and variety of fish caught were collected. A systematic and well organized Marine Fisheries Census was carried out by the institute in 1980 covering all maritime states except Maharashtra, within a period of less than a month. Micro level information on different aspects of marine fisheries was collected by covering 2132 marine fishing villages, 1442 landing centres and 333038 households. Realising the importance about demographic features, socio-economic status and infrastructure of marine fishing villages for developmental plans, Government of India, restarted 'Marine Fisheries Census' scheme in 2005 during the 10th Five Year Plan after a gap of 25 years. Covering 3202 marine fishing villages, 1332 marine fish landing centres and 756212 households the 2005 Marine Fisheries Census generated a wealth of information on various aspects of marine fisheries in India. Subsequently in 2010, the Marine Fisheries Census was completed within a period of 30 days in all the maritime states and Union Territories as a component of the 11th Five Year Plan of India. It now continues at a regular five year interval through ICAR-CMFRI with funding support from the Department of Animal Husbandry, Dairying and Fisheries (DADF) under Ministry of Agriculture and Farmers' Welfare.

'Marine Fisheries Census-2016' will be carried out by ICAR- CMFRI in the maritime states of West Bengal, Odisha, Andhra Pradesh,Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat as well as Union Territories of Puducherry and Daman & Diu. The islands of Andaman & Nicobar and Lakshadweep will be covered by the Fishery Survey of India. Planned to be executed in the beginning of year 2016 within a period of 30 days as 'Marine Fisheries Census 2016' it has several important objectives. The objectives are to determine fishermen population size and structure at micro level, to assess the educational and socio-economic status of fisher-folk,to obtain occupational status of fishermen, to determine active fishermen engaged in fishing, to determine gender-wise occupation in fishing allied activities, to determine the number of craft and gear owned by fisher-folk and the number of crafts and gears in the fishery,to obtain information on existence of infrastructure facilities and social aspects.

Schedule preparation

Three types of schedules (Schedule-I, Schedule-II with subset of 'Form a-e' and Schedule-III) were designed on preliminary basis by the Fishery Resources Assessment Division (FRAD) following brain storming sessions in the institute, in which Heads of different Divisions, Scientist-in-Charges of Regional / Research Centres and other Scientists made their contributions. The first Pre-Census workshop was organized at CMFRI, Kochi on 28th May 2013 in collaboration with DADF, Ministry of Agriculture, New Delhi. The workshop was attended by Deputy Director General (Statistics), DADF, Director-General, Fishery Survey of India, senior officials from ICAR-CMFRI, DADF, FSI and State Fisheries Departments. Detailed discussions were done on different data collection schedules used in Marine Fisheries Census 2010 and modifications were suggested. The developed data collection schedules were approved by the Technical Monitoring Committee set up by DADF.

In the second phase, a series of workshops were conducted at Vishakhapatanam, Mumbai, Chennai and Mangalore to finalize the data collection schedules and to finalize the list of marine fishing villages in consultation with the state fisheries department officials and the field staff of ICAR-CMFRI.The draft schedules were presented and approved in a meeting organized by DADF under the chairmanship of Joint Secretary (Fisheries), with DDG (Fisheries), ICAR, Fisheries Development Commissioner DADF, Director General, Fishery Survey of India and Scientists of FRAD at Krishi Bhavan, New Delhi on 6th March 2014. Schedule-I was prepared for collecting the information about marine fishermen families, fishing crafts and gears owned by fishermen, their social, educational and occupational profile. Demographic features of marine fishing villages will be collected using Schedule-II while 'Form a-e' of sub-set of schedule-II will be used for collecting the information of Boat Building cum Repairing Yards (Form-a); Ice Factories and Cold Storages (Form-b); Freezing plants and Processing Plants (Form-c); Fish Curing Yards and Peeling Sheds (Form-d) and Oil Extraction Plants and Fish Meal Plants (Form-e) existing in the maritime district. The information related to Schedule-I will be collected by trained enumerators, while the detail in Schedule- II and Form a-e will be



Marine Fisheries CENSUS 2016

CMFRI

SCHEDULE – I

(Household)

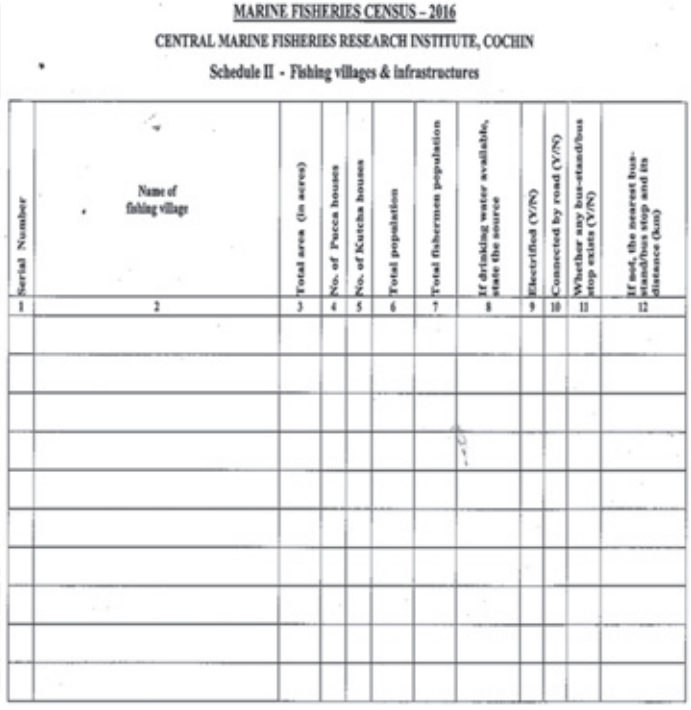
(Fishermen population, Crafts and Gears)

Village/Town/Hamlet:	Circle/Panchayat Union/Block:
Tehsil/Taluk:	District:
State :	Period of Enumeration: From : To :
Name(s) & signature(s) of Supervisor(s) with date(s) and Remarks :	Name & Signature of Enumerator with date :

Department of Animal Husbandry, Dairying & Fisheries
Ministry of Agriculture & Farmers Welfare, Government of India

Central Marine Fisheries Research Institute
Indian Council of Agricultural Research

Fig. 1. Schedule-I



MARINE FISHERIES CENSUS – 2016

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN

Schedule II - Fishing villages & infrastructures

Serial Number	Name of fishing village	Total area (in acres)	No. of Pucca houses	No. of Kutcha houses	Total population	Total fishermen population	If drinking water available, state the source	Electrified (Y/N)	Connected by road (Y/N)	Whether any bus-stand/bus stop exists (Y/N)	If not, the nearest bus-stand/bus stop and its distance (km)
1	2	3	4	5	6	7	8	9	10	11	12

Fig. 2. Schedule-II

Fig. 3. Workshop at Vishakhapatnam

collected by the field level supervisors during the census period. Schedule-III will be used for the collecting the information about the fishing crafts in the marine fish landing centres, which will be carried out by the field staff of the institute during the Fishing Ban period in the various maritime states. Both Schedule- II with subset of 'Form a-e' and Schedule-III were prepared in English, while Schedule-I was made in bilingual in respective regional languages for all maritime states and UTs.

Pre-Census Survey and Preparation of Frame

Marine fishing village is the basic geographic unit for the collection of data during Pilot Census.The lists of marine fishing villages for each maritime states and UTs were obtained from the respective State Fisheries Department to plan enumeration areas. All these marine fishing villages were verified, validated and updated through field visits by the deputed staff of ICAR-CMFRI in the Pre-Census phase during 12th to17th October, 2015. A local person with minimum educational qualification of 10th class was the basic criteria for identification of local enumerators. They were selected either from the same or nearby fishing village, who were able to speak the regional language and collect detail information from the fisherfolk.

The information collected during pre-census survey from all maritime states and UTs by the field staff through State Level Supervisors (Scientist-in-charge of Regional/Research Centre of ICAR- CMFRI) were compiled before the actual census operation. This also gave the provisional information about the number of households to be covered per enumerator in a particular region.

Supervision of data collection

Fig. 4. Workshop at Chennai

The involvement of correct supervision is very essential to finish the entire census within the decided time frame. The various levels of supervisors were identified from both scientific and technical staff of the institute including Field Level Supervisors (Technical staff), District Level Supervisors (Scientists), State Co-ordinators (Scientist-in-charge of Regional/Research Centres), Regional Co-ordinators (Scientists of Fishery Resources Assessment Division), Project Leader (Head, Fishery Resources Assessment Division) and National Co-ordinator (Director, ICAR-CMFRI).

Total six workshops of two days duration were conducted to train all involved field, district and state level supervisors in the procedures for "Marine Fisheries Census-2016". The first workshop was conducted on 12th to 13th November, 2015 for all district level supervisors and field level supervisors of Kerala at Kochi. The successive workshops were conducted on 18th to 19th November, 2015 at Veraval Regional Centre ICAR-CMFRI for Gujarat, on 18th to 19th November, 2015 in Chennai Research centre ICAR-CMFRI for Tamil Nadu and Puducherry, on 19th to 20th November, 2015 at Vishakhapatnam Regional Centre ICAR-CMFRI for Andhra Pradesh, Odisha and West Bengal;on 20th to 21st November, 2015 in Mumbai Research Centre of ICAR-CMFRI for Maharashtra and Daman & Diu and on 1st-2nd December, 2015 at Mangalore Research centre of ICAR-CMFRI for Karnataka and Goa by the staff of FRAD. In total, 220 officials of ICAR- CMFRI were trained through the workshops to monitor and supervise "Marine Fisheries Census-2016" in the entire marine fishing villages of India.

Report on occurrence of Yellow Sea Snake *Hydrophis spiralis* off Kerala coast

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Sea snakes play an important role in the marine food web and studies on their diversity and distribution are very limited in India. Globally, 70 species of sea snakes have been reported under the family Elapidae which is divided into two subfamilies (i) Laticaudinae and (ii) Hydrophiinae. Sea snakes belonging to the subfamily Hydrophiinae are considered as 'true sea snakes' with 62 species which are viviparous (give birth to live young at sea). Laticaudinae sea snakes called the 'sea kraits' have 8 species and are oviparous. They come to the land for mating and to lay eggs.

Sea snakes have several adaptations such as vertically flattened, paddle-like tail for locomotion, valved nostrils for excluding water while diving and a sublingual gland for excreting excess salt. Many sea snakes have the potential to dive beyond 100 m and remain underwater for more than 2 hours. So far, 25 species of sea snakes have been reported from India. All the sea snakes are protected under schedule IV of Wild life (Protection) Act, 1972. However, sea snakes are not listed under CITES and hence they are harvested heavily in Southeast Asia for human consumption and use in traditional medicine.

Incidental catch of sea snakes in the gill nets, trawlers and purse seines are observed in India. Five species of sea snakes caught as by-catch in trawls

Fig. 1. *Hydrophis spiralis* (dorsal side)

have been reported from Kerala, namely, Beaked sea snake *Enhydrina schistosa*, Short sea snake *Lapemis curtus*, Annulated sea snake *Hydrophis cyanocinctus*, Spotted sea snake *Hydrophis ornatus* and Yellow-bellied sea snake *Pelamis platura*. During an experimental trawl fishing operation by FRV *Silver Pompano* off Kochi, mainly *E. schistosa* and *L. curtus* were caught. On 20.10.2015, a Yellow sea snake *Hydrophis spiralis* (Fig.1) was caught as by-catch in the fish trawl operated at 33.3 metre depth off Kochi (10°01'24"N; E 76°00'02"E). Along with the sea snake, other fishes like *Nemipterus japonicus, Epinephelus diacanthus*, *Scomberomorus commerson, Rastrelliger kanagurta, Mene maculata, Decapterus russelli, Stolephorus commersonii*, *Saurida* sp., gastropods like *Tibia* sp., *Bursa* sp., and crabs such as *Charybdis feriatus* and *Portunus sanguinolentus* were also obtained.

The longest yellow sea snake specimen recorded in the world from Penang, Malaysia was 2.75 m. The species was first described as *Hydrus spiralis* in the year 1802 by George Shaw based on the holotype specimen collected from Indian Ocean deposited in British Museum of Natural History and the length of the specimen was only 2 feet. Occurrence of this species from India was first reported as *Hydrophis robusta* by H.M. Phipson in the year 1886 based on the specimen collected from Alibaug, Maharashtra and deposited with the Bombay Natural History Society. Later, Prater (1924) described the species as *Leioselasma spiralis* based on the materials collected from Indian coasts and named the sea snake as 'Narrow-ringed Sea Snake'. Occurrence of yellow sea snake off Tamil Nadu coast is very common with most of the specimens being less than 2 m length. However this species is reported from Kerala for the first time. In India, the longest specimen of *H. spiralis* was measured as 2.50 m from Madras as reported by Wall in 1911. Smith (1943) reported that the species obtained from India had 41-48 annuli (dark black bands) while specimens from Persian Gulf had 46-54 annuli. The total length of the present specimen caught off Kochi was 2.30 m and it had 65 bands. It was very aggressive and showed a ready to bite nature.

The taxonomical account of yellow sea snake is given below.

Yellow Sea Snake *Hydrophis spiralis* (Shaw, 1802)

Hydrus spiralis Shaw, 1802.*Gen. Zool.*, **3**, p. 564.

Hydrophis robusta Phipson, 1886. *J. Bombay nat. Hist. Soc.*, **1**, p. 85.

Distira spiralis Wall, 1911, *J. Bombay nat. Hist. Soc.*, **20**, p. 858-863.

Leioselasma spiralis Prater, 1924. *J. Bombay nat. Hist. Soc.*, **30**, p. 174.

Hydrophis spiralis Smith, 1943. *Fauna. Brit. Ind.*, **3**, 453.

Hydrophis spiralis Karthikeyan & Balasubramanian, 2007. *Int. J. Zool. res.*, **3**, 115-117.

Hydrophis spiralis Rasmussen *et. al.*, 2011. *Zootaxa.*, **2894**, 1–20.

Diagnostic Characters

Total length 230 cm; elongated body, moderate head; 7 maxillary teeth behind poisonous fang, Rostral tips pointed protrudes downwards; body scales smooth, overlap; 65 narrow black bands encircle body, black spots on the ventral band ridge; 1 preocular and 2 postocular scales; eye diameter less than eye-mouth distance; 26 scale rows around neck, 33 on the middle, 331 on the ventrals; dorsal scales edged with black colour; body yellowish green above, pale yellow below; interspaces broader than bands posteriorly, black head with yellow horseshoe marking; tail with 6 dorsal bands, tip of the tail with black patch.

Distribution:

Indian Ocean, Persian Gulf and Arabian Peninsula, New Caledonia/Loyalty Islands, Southeast Asia. In India, it is distributed along both the coasts, but not common on the west coast.

Rough triggerfish, *Canthidermis maculata* from Gujarat coast

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A specimen of the Rough triggerfish, *Canthidermis maculata* (Bloch, 1786) was landed by a multiday trawler on 25th November 2015 at Mangrol Fisheries Harbour, Gujarat. The specimen was brownish grey in colour with characteristic white spots all over the body including the head. It measured 309 mm and 256 mm in Total length and Standard length respectively with a weight of 580 g (Fig. 1). The fish is usually found in areas having sandy, muddy or rocky bottoms at a depth range of 50-100 m and is reported from the Western Indian Ocean.

Fig. 1. *Canthidermis maculata*

The information collected from the fishermen indicated that the fish was caught from a depth >50 m. The species is considered as inedible and is usually discarded at sea by the fishermen. However, there is a recent trend of using balistids for human consumption and export. There is also demand for these fishes in live condition for keeping in marine aquariums.

A first instance of whale shark caught in *Dol* net and rescued in live condition at Gorai- Malvani, Maharashtra

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The history of various records of whale shark from coastal waters of India has been compiled by Prater (*J. Bombay Nat. Hist. Soc.*, 42:255-279, 1941), Silas (*Mar. Fish. Infor. Serv. T&E Ser.*, No.66,1986), Pravin (*Curr. Sci.*, 9(3), 2000)), Hanfee (TRAFFIC, 2001) and Venkatesan *et. al.* (*Mar. Fish. Infor. Serv. T & E Ser.*, No.198, 2008). In Maharashtra *Dol* (bag) net operations are widespread but there are no reports on the landing of whale shark by this gear. However, the capture of whale shark has been reported in bag net at Kaveripattinam in Tamil Nadu (*Mar. Fish. Infor. Serv. T & E Ser.* No.145, 1996).In the present communication the author who is a fisherman himself, has recorded his experiences in the light of age old practice to rescue whale sharks as and when they are caught in fishing gears by fishermen from Maharashtra who respect this fish like a God and worshipfully call it as "Deo Mushi".

The first observation of *Rhincodon typus* that was rescued live from *Dol* net on October 21 st, 2015 is given here. A male whale shark, about 6.5 m in length incidentally entered the *Dol* net at 30 m depth off Gorai-Malvani region, Mumbai. The net was hauled after about four hours with the help of a winch. At that time fishermen noticed a huge live

fish trapped in the cod end of the net. Fishermen endeavoured vigorously to pull the cod end parallel to the boat to release it from the net. Due to the lashing movement of its tail, strong tidal current and wave action, it took more than an hour to set the whale shark free by cutting the cod end of 2 mm twine with a knife (Fig. 1). Fishermen were not aware of the time at which the fish entered the net.

Fig. 1. The cod end being cut open to release the whale shark

On 29th October 2015, one more whale shark, with an approximate length of 4 m and weight of 2 tonnes (t) was caught in *Dol* net at the depth of 35 m off Madh Island, Mumbai. The net was hauled along with the fish on the deck by winch. The fish was removed from the net and kept at the side on deck. To ensure that it should not entangled or caught again in any nets, all the nets in the vicinity were hauled within an hour. The fish was released into the sea in live condition (Fig. 2). Gupta *et al* (*Mar. Fish. Infor. Serv. T & E Ser.* No.110, 1991) had observed lashing movements of whale shark for about two hours after being landed on the beach which indicate that this whale shark released live would also have strong chances of survival subsequently. The fishermen along Maharashtra appeared to be conscious of the need to protect whale sharks and their role in maintaining the ecological balance of the seas.

An incidental catch of whale shark in a multiday trawler operating at 45 m depth off Dabhol-Harney region, Maharashtra was also observed. The female

Fig. 2. Whale shark released from the deck of *dol* net boat back to the sea using winch

whale shark of 4.7 m in total length and weighing 1.7 t was brought to the Versova Landing Centre on 11.5.2015. However, there were no bidders for the fish and the carcass was once again loaded on the trawler and disposed into the sea.The trawl owner thus incurred a loss of about ₹ 12000/- towards damage of mast, net and labour charges for to and fro transport.

A number of fishermen were interviewed to understand the occurrence of whale sharks in the fishing areas. They opined that the species is now rarely seen in fishing grounds. Nowadays when a whale shark enters the net, they are generally released back in live condition by fishermen. When whale sharks get accidentally caught in the trawl net, fishermen immediately sense the sudden reduction in speed of boat. On entering the net, the whale sharks remain immoblized with pectoral fins bent towards the belly, and upper caudal lobe bending either side. The fishermen then haul up the net with the help of winch, cut the cod end of net manually by knife and release the fish as this species is protected by schedule 1 of Indian Wildlife (Protection) Act 1972, whereby its catch and marketing is prohibited. Only fishermen who are unaware of this bring the fish to the shore and subsequently have to take the carcass back to the sea incurring financial loss. Hence such fishermen also need to be made aware on the protected status of whale sharks with the help of posters and leaflets in local languages.

Seahorses along Thoothukudi coast

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During routine visit to the Mottaigopuram fish landing centre at Thoothukudi on 27.7.2015 and on 20.10.2015, five numbers of seahorses were collected from the fish catch kept for auctioning. These were caught in indigenous trawl operated along the near shore sea grass beds at Thoothukudi. This gear mainly targets juveniles of prawn (especially *Penaeus semisulcatus)*, crabs, cephalopods and fishes. Occasionally stray numbers of seahorses are also caught. The species obtained in the present collections were *Hippocampus fuscus, H. trimaculatus* and *H. spinosissimus*.

1. Hippocampus fuscus

Height: 104.2 mm; Trunk rings: 11; Tail rings: 35; Head length: 22.9 mm; Snout length: 8 mm;

Head length/Snout length: 2.86; Dorsal fin rays: 16; Pectoral fin rays 15; Coronet: Low, arch of neck is a smooth curve or is slightly raised and rough; Spines: low, slightly developed; head large compared to body; deep head; slightly dark

Fig. 1. *Hippocampus fuscus*

2. Hippocampus trimaculatus

Height: 94.1 mm; Trunk rings: 11; Tail rings: 40; Head length: 21.3 mm; Snout length: 9.9 mm;

Head Length/Snout length: 2.15; Dorsal fin rays: 20; Pectoral fin rays: 17; Coronet: Low, in line with arch of neck, visible as five tiny points; Spines: low and small; Sharp, hook-like cheek and eye spines (appear flat); narrow head; no nose spine; Colour pattern: Golden orange, sandy coloured; large dark spots on the dorso-lateral surface of the first, fourth and seventh trunk rings

Fig. 2. *Hippocampus trimaculatus*

3. Hippocampus spinosissimus

Height : 98 mm; Trunk rings: 11;Tail rings : 37;Head length : 21.1 mm; Snout length: 9.9 mm; Head Length/Snout length: 2.2;Dorsal fin rays : 20;Pectoral fin rays :16;Coronet: five sharp spines; Spines: well developed, sharp, longer on first, fourth, seventh and eleventh trunk rings; Single cheek spine; small nose spine; spine in front of coronet rather undeveloped. Males have strongly

developed blunt-tipped spines bordering the pouch; Colour pattern: Variable, pale with darker saddles across dorso-lateral surface and with darker cross-bands on tail.

Fig. 3. *Hippocampus spinosissimus*

The entire genus of *Hippocampus* is listed in Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) effective from May 2004. *H.trimaculatus* is listed as vulnerable and *H.fuscus* as data deficient by the International Union for Conservation of Nature (IUCN). In India, all species of *Hippocampus* have been placed under Schedule –I of the Wild Life Protection Act (1972) in 2001 which bans any collection or trade of seahorses. According to the fishermen, earlier there were agents who would purchase live seahorses for ₹ 25 per piece. However, due to the intervention of the Forest Department and for fear of punishment,this trade has now stopped. Any seahorse noticed while sorting the catch is therefore released back to the sea. This feedback from the fishermen might be true as the traders did not show any objection when these seahorses present in the catch to be auctioned were collected for the present study.

Unprecedented heavy landings of juvenile Kiddy shrimp, *Parapenaeopsis stylifera* along Karnataka coast

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Parapenaeopsis stylifera is one of the most abundant and highly valued shrimp species in India. It forms about 20% of the penaeid shrimp catch of Karnataka with the period from January to June contributing the majority of the catch. In general, the post-monsoon months of August to December is considered as a lean period for *P. stylifera*. During this period single day fishing trawlers land catch of a mixture of fish, prawns, stomatopods and other crustaceans. The contribution of prawns in the catch is around 10 to 20%. Traditionally, the single day operating trawlers of Bhatkal and Gangoli fisheries harbours go for bottom trawling immediately after the lifting of mechanised fishing ban in early August, whereas the trawlers based at Mangalore and Malpe

Fig. 1. Catch of juveniles of kiddy shrimp at Gangolli Fisheries Harbour

start bottom trawling by late August or by September only. In August 2015, it was found that the trawlers that operated from Gangoli and Bhatkal Fishery Harbours landed unprecedented high catches of *P. stylifera,* which were entirely juveniles. This trend extended till November. Once bottom trawling commenced from Malpe and Mangalore Fisheries Harbours, similar trend of heavy landings of *P. stylifera* juveniles were recorded at these harbours also. The *P. stylifera* landed ranged from 48 to 78 mm in length, with an average weight of 1.5 g. Due to small size they were sold at prices as low as ₹ 10 to 12 per kilogram, and most of them were used for drying.

It is estimated that at Gangoli Fisheries Harbour, 24 t of *P. stylifera* juveniles were landed in August, 2015 with a catch rate of 60 kg/unit (Fig.1). The size range was 50 to 75 mm with a mean size of 63 mm. In Mangalore and Malpe, the estimated catch of this species during September to November period were 228 t and 415 t respectively with a catch rate of 124 kg and 155 kg per boat. The size range of the juveniles caught from these landing centres was also 45 to 78 mm with a mean size of 62 mm. Compared to the same period in 2014, the catch of *P. stylifera* at Malpe and Mangalore were only 31 and 20 t respectively. This indicated a seven fold increase in catch at Malpe and 20 times increase at Mangalore in 2015. By end of November, the catch of juvenile *P. stylifera* reduced considerably and fishery showed a trend as observed in earlier years with an average catch rate of 25 to 30 kg/boat, with lesser percentage of juveniles.

The juvenile fishery of *P. stylifera* by trawlers in such high magnitude is a rare phenomenon in Karnataka. Due to its very small size almost entire catch of *P. stylifera* was sold for drying. An estimated 700 million juveniles were landed at Gangoli, Malpe and Mangalore Fisheries Harbours during August to November, 2015 period. The reason for such heavy landing of juveniles is not well understood. However the change in wind and current pattern might have influenced the juvenile distribution. Seasonal migration of this species with the alteration of oceanographic characteristics has been reported by many workers during their studies on prawn fisheries off south west coast of India. More studies on the distribution of this species in relation to oceanographic parameters especially the current pattern are needed to explain this phenomenon and evaluate its impact on the sustainability of the prawn fishery.

Unusual landings of Blood clam *Anadara granosa* at Kasimedu Fishing Harbour

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Anadara granosa (Linnaeus, 1758) belongs to family Arcidae and is popularly known as 'Blood cockle' or 'Blood clam'.

On 29th October, 2015 an unusual landing of approximately 200 kg of Blood clam was observed in Kasimedu Fishing Harbour, Chennai. The clams were caught by trawl net and sold at a market price of ₹ 50 per kilogram. Although, *A. granosa* is often landed as by-catch along with other gastropods and bivalves in trawl landings it does not form a fishery

A. granosa landed at Kasimedu Fishing Harbour

and notable quantity of blood clam landings have not been reported earlier from this harbour.

The species is widely distributed in the Indo-Pacific region.Though the true cockles of the genus *Cardium* are not abundant in Indian waters, the cockle-like ark clam *A. granosa* forms extensive beds in some areas. The blood clams constitute an important fishery in Kakinada Bay and contributes about 50% of the total molluscan landings there. It is one of the commercially important molluscan resources of India. Though its meat is consumed locally to a limited extent, its demand in the ornamental shell trade is growing. The clam shells are also used in producing lime by burning the whole shells.

A note on the ribbonfish *Trichiurus auriga*

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The ribbonfishes belonging to the family Trichiuridae is a major fishery resource of India. Three species under the genus *Trichiurus* namely *T. lepturus*, *T. auriga* and *T. gangeticus* are reported from India. Of these, the largehead hairtail *T. lepturus* commonly grows to 100 cm in size and has high market demand. *T. auriga* (Pearly hairtail) is a small sized species (maximum size < 40 cm) and reported to occur in huge shoals in the upper slope regions. With little market demand for consumption due to its small size, whenever caught they are most likely to be diverted to fish meal plants. There is wide spread concern on the large scale capture of juvenile fishes which adversely affects the resources. Recently several restrictions on the capture of under-sized/ immature fishes of commercially important species and provisions for imposing fines on violations have been implemented

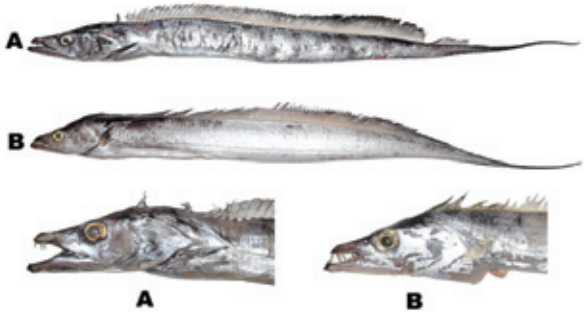

Fig. 1. *Trichiurus auriga* (A) and *T. lepturus* (B)

Fig. 2. Fang like anterior teeth without barbs in *T. auriga*

by the Fisheries Department of Kerala. Many fishermen themselves are concerned about the capture of juveniles and have enquired about the species identity of the small sized ribbonfishes landed by deep-sea trawlers operating off southern Kerala Coast, especially during October to December period which is the peak season for ribbonfish fishery along Kerala coast.

Silas and Rajagopalan (1974) first confirmed the occurrence of the small sized deep water ribbonfish *T. auriga* in Indian seas, based on the specimens collected from trawl surveys in the upper slope regions off south west coast. During the FORV *Sagar Sampada* cruise 332 on 6th December, 2014 a huge catch of small sized ribbonfish was made off

Fig. 3. Fang like anterior teeth with barbs in *T. lepturus*

Thriuvananthapuram (8^{0} 26'N 76^{0} 25' E) at 200 m depths which was confirmed to be *T.auriga*. The most characteristic feature of *T. auriga* is the presence of fang like teeth without barbs, the very slender body and blackish pectoral fins. In comparison, *T. lepturus* has fang like teeth with barbs, a comparatively shorter head with deeper body and larger pectoral fins which are transparent without any blackish tinge (Figs. 1-3). Although a few stray specimens of the *T.auriga* were found in other transects nearby, the magnitude of the catch off Thiruvananthapuram was so enormous (around 8 -10 tonnes) that the net could not be heaved on - board. During same period *T. lepturus* was being landed by commercial trawlers operating off Kochi, which also included small sized juveniles of 30 - 50 cm total length (TL) size in stray numbers. The size range of the *T. auriga* caught during the FORV *Sagar Sampada* cruise 332 was 120 – 267 mm TL with the 230 mm size group dominating. Fully mature males and females at sizes of around 270 and 340 mm TL respectively have been reported but the present catch consisted of indeterminate or immature stage specimens only. According to Silas and Rajagopalan (1974), the huge catches of ribbonfishes during FAO – UNDP exploratory surveys in the deep-waters of slope region in the Arabian Sea could possibly have been only *T. auriga*. It is possible that the maximum abundance of *T. auriga* lies in the region off southern Tamil Nadu and southern Kerala coast where it is caught by fishermen operating trawls in deeper waters. Ribbonfishes play an important role in energy transfer in marine food webs. They are an important diet component of high unit value carnivorous marine fishes like tunas and rock cods which significantly contribute to the fisheries sector in India.

Social factors induces sex change in Orange spotted grouper, *Epinephelus coioides*

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Sex change (sequential hermaphroditism) is a normal part of the life history of many species of tropical coral reef fishes. Sex change can be either from male to female (protandrous) or it can be from female to male (protogynous). In the family Serranidae, protogynous hermaphroditism is the most common reproductive pattern. However, Orange spotted grouper is diandric, *i.e.*, they have two types of male: Primary males which are gonochorous (non sex changers) often with initial phase; and Secondary males which are derived from female to male initial phase.

Groupers are commercially important food fish in Southeast Asia. However, the expansion of grouper culture is stagnating because of the unavailability of seed for culture. The major bottle neck in this regard is the very slow progress in development of their breeding and larval rearing technologies. Since all groupers exhibit protogynous hermaphroditism, availability of males for spawning from the wild is very difficult. However, successful induced sex reversal with the help of various sex hormones and aromatase inhibitor has been reported. There are reports stating that social factors play a role in

determining sex change in groupers. It is reported that in all protogynous species, females are induced to change sex by removing a male from social system or by alterations in behavioral interactions between the sexes. In this backdrop, attempts were made to compare the influence of social factors on sex change in female grouper, *Epinephelus coioides* in two culture systems *i.e.*, open sea floating cage and Recirculatory Aquaculture System (RAS).

Forty five adult Orange spotted groupers (1.5 - 3 kg) were collected from wild and stocked in 6 m diameter floating cage with depth of 4 m. All fishes were female and each was tagged with Passive Integrated Transponder (PIT) tag to record its gonadal history. Fishes were fed with *Decapterus* sp., sardine and squid twice a day @ 5 % of body weight. The feed was fortified with vitamin E and C twice a week. The fishes were cannulated on a fortnightly basis to assess the gonadal development. After six months of stocking, the two biggest sized fishes (weighing 4 kg and 3.5 kg) were found to be oozing males and remaining smaller fishes were found to be females in different stages of gonadal development. This indicates that social factors are involved in changing the sex of the female fish to male. As there was no male in the same cage at the time of stocking it could have induced the biggest female fish to change its sex to male.

In the second experiment, ten female and ten sex reversed males (by hormonal and enzyme pellet implantation) were stocked and maintained in the RAS for breeding. The fishes were responding and fertilized eggs were obtained every month. After eight months, seven female fishes were isolated from the group and stocked in another re-circulatory tank. The gonadal development of all the seven females assessed before stocking into the tank were found to be in different stages. The fishes were fed with squid, twice a day. The feed was fortified with squid oil, cod liver oil, vitamin E and C twice in a week. These fish spawned after two months and eggs were found to be fertilized. When the fishes were checked for their gonadal assessment it was found that the biggest size fish (weighing 5 kg) was the oozing male. This study shows that by isolating mature females of the Orange spotted grouper, their sex change to male could be induced in the bigger size fishes.

The results from both the experimental studies reveal the influence of social control on sex change in *E. coioides* irrespective of the culture systems. This can assist in producing male Orange spotted grouper, which might speed up the development in breeding and larval rearing protocols for this grouper.

Status of marine fisheries of Kerala

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Introduction

Kerala with a coastline of 590 km is a significant contributor to the total marine fish landings of the country. A picture of the marine fisheries sector in Kerala during the years 2005 and 2010 is presented below (Table 1). With a continental shelf of about 40,000 km^2 marine fisheries plays a vital role in the livelihood of the people.

Table 1. Comparision of Marine Fisheries Census data for 2005 and 2010

	2005	2010
Marine fishing villages	222	222
Marine fish landing centres	178	187
Fishermen families	120486	118937
Total fisher population	602234	610165

Male	304308	220602
Female	297926	215820
Female to male ratio (for 1000 males)	979	966
Average Family size	5	5
Active fishermen	140222	145396
Full-time fishermen	124103	130922
Part-time fishermen	10488	10582

Craft and gear

Of the 21781 craft in the fishery of Kerala, 4722 are in the mechanised sector, 11175 in the motorised sector and 5884 in the non mechanised sector. Of the 4722 units in the mechanised sector, maximum number of units in operation are in Ernakulam district followed by Kozhikode (Table 2). This factor therefore plays a major role in the districtwise contribution to the landings.

Table 2. Details of district-wise mechanised vessels

District	Trawlers	Gill netters	Ring seiners	Liners	Purse-seiners	Total
Kollam	950	5	35	3	0	993
Alappuzha	30	0	8	0	0	38
Ernakulam	1020	403	90	15	60	1588
Thrissur	130	0	65	0	0	195
Malappuram	200	2	150	1	0	353
Kozhikode	950	0	110	5	0	1065
Kannur	237	50	33	5	0	325
Kasargod	161	0	4	0	0	165
Total	**3678**	**460**	**495**	**29**	**60**	**4722**

(Source: Census Report 2010)

Fish Production in 2014

The marine fish landings in Kerala during 2014 was estimated at 5.76 lakh tonnes (t) registering a decline of about 95,000 t (15%) from 6.71 lakh t landed during 2013. An analysis of the period 2002-2014, shows that the fishery was more or less stable during the period 2002 - 2010. In 2012, fishery showed a quantum jump which was mainly due to the very high oil sardine landings in the state. However the landings could not be sustained and the decrease in 2013 continued in 2014 also. Landings of all major demersal and pelagic resources declined in 2014.

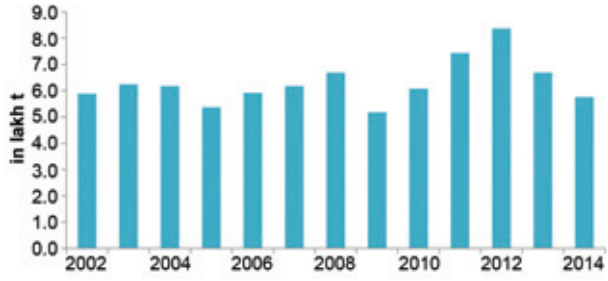

Fig. 1. Marine fish landings in Kerala during 2002 - 2014

Resource profile

The pelagic finfishes constituted 68%, demersal fishes 15%, crustaceans 9% and molluscs 8% of the total landings during 2014. The reduction in oil sardine landings caused the reduction in the pelagic finfish production to 3.91 lakh t in 2014 from 4.9 lakh t in 2013. The landings of the demersal resources also witnessed a decline which can be attributed to the reduction of about 18000 t in the landings of threadfin breams. An upward trend was noticed in the landings of crustacean resources, with an increase of about 9600 t in the landings of penaeid prawns. The contribution by molluscan resources showed an increase of about 6000 t, mainly due to the increase in squid landings in 2014.

Among the commercially important resources, fishery of oil sardine showed a decrease of about 92,000 t. Indian mackerel, penaeid prawns, cephalapods, tunas, soles etc. recorded increase in landings while threadfin breams, ribbonfishes, whitebaits, seerfishes, pomfrets and barracudas recorded a decrease in the landings during 2014.

Sectorwise contribution

Mechanised sector contributed 61% of the landings in 2014 which was about 1.23 lakh t less compared to the previous year. In the mechanized sector, the bulk of the landings were by trawlers, purse seines and ring seines. Ring seiners and gillnetters were the major contributors in the motorised sector. The proportion of landings in motorised sector increased to 38% in 2014. Non-motorised sector contributed only 1%.

The major gears which contributed to the landings in Kerala were trawl nets, seine nets and gill nets. Multi-day trawl landings accounted for 2.16 lakh t during 2014 with the catch per hour (CPH) being 49 kg which has decreased noticeably during 2014. The major resources caught in trawl net were threadfin breams, penaeid prawns, cephalopods, lizard fishes and ribbon fishes. Ring seine units operated in both mechanised and motorised sectors. Oil sardine and mackerel were the major contributors in the mechanised sectors. The unit operations of the mechanised ring seines declined by 50 %.

Table 4. Catch and Catch rates (CPUE or CPH) of major gears operated during 2014

Gear	Catch	CPUE	CPH
Multiday trawlnet (MDTN)	216054	1866	49
Mechanised gillnet (MGN)	1231	1689	22
Mechanised hook & line (MHL)	948	1877	11
Mechanised others (MOTHS)	32653	3585	30
Mechanised purse seine (MPS)	4039	4252	1904
Mechanised ring seine (MRS)	73033	2223	828
Mechanised trawl net (MTN)	20033	223	31
Outboard boat seine (OBBS)	7592	165	70
Outboard gillnet (OBGN)	35206	78	20
Outboard hook & line (OBHL)	11000	83	22
Outboard ring seine (OBRS)	162235	1083	515
Outboard trawl net (OBTN)	1881	65	19
Outboard others (OBOTHS)	1849	795	22
Non-mechanised (NM)	7891	27	13

Pelagic resources

Total pelagic fish landing during the year 2014 was 380043 tonnes which formed 66% of the total marine fish landing in Kerala. Pelagic fishery was supported mainly by sardines, anchovies, other clupeids, mackerel, carangids, ribbonfishes, seerfishes, tunas, billfishes, barracudas etc. Clupeids including oil sardine contributed 57.4 % of the pelagic fish catch. Other dominant resources were mackerel (13.7%), carangids (14.4%) and ribbonfish (6.8%). Landings of pelagic resources showed an increase from 2009 to 2012, but declined

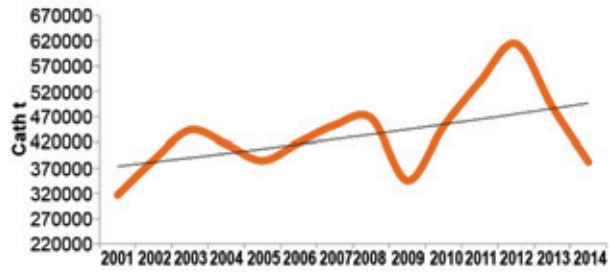

Fig. 2. Total pelagic fish landings (t) along Kerala coast during 2001 - 2014

thereafter. Contribution of pelagic resources to the total marine fish production during 2001-2014 varied between 61.7 and 74. 2%. Fishery occurred almost round the year with peak during September - October period.

Demersal Resources

The total demersal fish landings in Kerala in 2014 registered a decline of 14% compared to 2013. It was constituted by over 19 groups of which the dominant groups were threadfin breams, lizard fishes and elasmobranchs. Sharks, rays, groupers and snappers showed increase in the landings.

Elasmobranchs: An estimated 7054 t of elasmobranchs was landed during 2014 forming 1.2% of total marine fish landings and 8.6 % of demersal landings of the state. Sharks contributed 61% of the elasmobranch landings, followed by rays (36%) and guitar fishes (3%). More than 30 species were observed in the shark landings by Mechanised Driftnet Hook and Line (MDNHL) at Kochi. The major share was contributed *by Carcharhinus falciformis* (35%), *C. longimanus* (12%), *Sphyrna lewini* (8%), *Alopias pelagicus* (9%), *A. superciliosus* (5%), *Galeocerdo cuvier (*6%), *Isurus oxyrinchus* (7%), and *Triaenodon obesus* (6%). Landings of deep water species have showed an increase during the last few years. Among rays landed during 2014, *Mobula japanica* was the dominant species (54 %) followed by *Himantura fai*, *Taeniura meyeni*, *Pteroplatytrygon violacea, Mobula tarapacana, Dasyatis microps, Rhinoptera javanica* and *Aetomylaeus vespertilio*. *Mobula japanica* is completely utilised as its tail, liver are collected

and sent to Thoothukudi in Tamil Nadu for fishmeal preparation. Gill filaments locally called 'flower' fetched high price especially those of *Mobula tarapacana* called 'white' and *Manta birostris* known as 'black'.

Threadfin breams: An estimated 23585 t of threadfin breams were landed mainly by trawls forming 4.1 % of total marine fish landings of Kerala. Landings declined by 43.82 % compared to that of 2013. Fishery was mainly constituted by two species. *Nemipterus japonicus* (53%) and *Nemipterus randalli* (47%).

Groupers: Groupers which contributed to 3.39% of the total demersal landings increased by 34.1% compared to 2013. *Epinephelus diacanthus* was the dominant species in the trawler landings as well as in hooks and lines. Contribution of *Variola louti, Epinephelus longispinis, E.areolatus, E.flavocaeruleus, Cephalopholis miniata* to the commercial landings increased during 2014 compared to the previous years.

Snappers: Eleven species of snappers in six genera contribute to the commercial fishery in Kerala. The dominant species were *Lutjanus bohar* (34 %), *Pristipomoides typus* and *Lutjanus gibbus*. Landings of *L. bohar* increased considerably during 2014. The other species in the commercial fishery were *Pristipomoides multidens*, *P. filamentosus*, *Aphareus rutilans, A.virescens, Lutjanus kasmira*, *L. lutjanus*, *L. bengalensis* and *L. rivulatus*.

Flatfishes: An estimated 12,318 t of flatfish was landed in 2014 and formed 15.17% of the total demersal landings. *Cynoglossus macrostomus* (78.4 %) was the most important species in the fishery followed by *C. macrolepidotus* and *C. bilineatus*.

Sciaenids: An estimated 5619 t was landed in during 2014 which formed 6.9% of the demersal landings and landings showed a decline of 5.67% over 2013. Along the Malabar coast they were exploited by trawls, gillnets and ringseines. *J.sina* was the dominant species (50%) found in all the gears followed by *Otolithes ruber*, *O. cuvieri*, *Johnius belangeri* and *Nibea soldado* . Off Cochin *Otolithes ruber* was the dominant species found in all the gears. Other important species in the fishery here were *Johnius glaucus*, *O. cuvieri*, *Johnius belangerii*, *Nibea soldado* and *J. macropterus*.

Lizard Fishes: The lizard fish landings increased by 35% compared to the previous year. They were mainly exploited by trawls (96%). Fishery occurred throughout the year with peak landings in the post monsoon months of August to October. Four species were recorded of which *Saurida tumbil* dominated (60%) followed by *S. undosquamis* (34%), *Trachinocephalus myops* (4%) and *Synodus variegatus (*2%).

Priacanthids: Priacanthid landings increased by 21% compared to 2013. *Priacanthus hamrur* (87%) and *Cookeolus japonicus* (13%) were the species landed.

Crustacean resources

An estimated 45,500 t of shrimps comprising of 39499 t of penaeid and 6001 t of non-penaeid shrimps was landed in Kerala during 2014. The increase in the landings of *Parapenaeopsis stylifera* was 47%. Rapid stock analysis of penaeid shrimp landings for the period 1998 to 2014 of Kerala revealed that they are in the 'Abundant' category.

During 2014, the estimated 3561 t of marine crabs landed in Kerala recorded an increase of 44% from 2013. Multiday trawlers accounted 68.9% of the catch. Among crabs landed, *Charybdis feriatus* dominated the landings followed by *Portunus sanguinolentus*, *C. lucifera* and *P. pelagicus*. Lobsters like *Panulirus homarus* in the fishery had a size range of 113 -118 mm and were mainly exploited by bottom set gill nets at Vizhinjam.

Molluscan resources

There was decrease in the percentage contribution of squids in Central Kerala while the percentage contribution of cuttlefish and octopuses showed an increasing trend during 2007-2014. Among squids the main species exploited was

Uroteuthis (P) duvauceli followed by *U (P) sibogae* and *U (P) singhalensis*. Among cuttlefishes, 4 species belonging to the genus *Sepia* were exploited and fishery was predominated by *Sepia pharaonis*. Among octopus, *Amphioctopus neglectus* and *A. marginatus* were the most dominant followed by *Cistopus indicus*. The increase in total production of cephalopods was not corresponding to increase in effort. Major gear exploiting cephalopods was trawl (70-80%), while other artisanal gears such as beach seines, handjigs, lines and gillnets were in use. In Central Kerala, cephalopods showed maximum abundance during the post-monsoon months of August, September and October with catch rates exceeding 15 kg/h. During these periods, peak breeding occurs in both cuttlefishes and squids and therefore there exists great danger of recruitment overfishing. In the Malabar region, the total landings of cephalopod was contributed by squids (50%), cuttlefishes (47%) and octopus (3%).

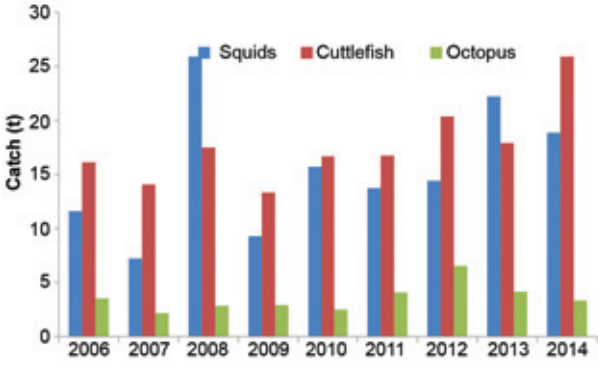

Fig. 3. Cephalopod landings in Kerala during 2006-2014

Economics

Analysis of economics of fishing operations of mechanised trawlers in Kerala showed that the capital productivity was highest for the multiday trawlers (2-5 days) operating with Indigenous engine. Better economic performance than multiday trawlers (with Chinese engines) with high capital productivity, Net-profit Earnings ratio (NE ratio) and Return on investment (ROI) was observed. The gross value of marine fishes at landing centre level was ₹ 6,340 crores. The value increased by 67% at landing centre level when compared to the year 2010.

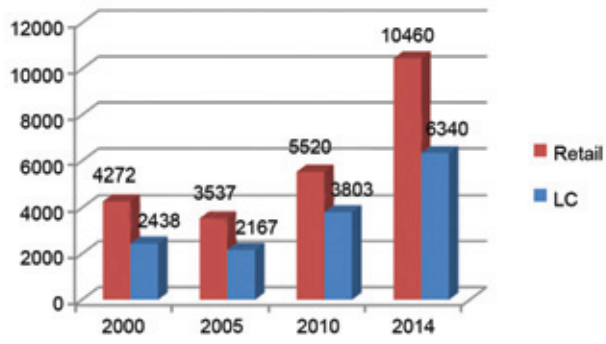

Fig. 4. Growth in nominal value of marine fish at Landing Centre (LC) and Retail levels (₹crores) during 2000-2014 period

Price behaviour analysis showed that the highest prices were recorded for lobsters (₹ 740/kg) seerfishes (₹ 320/kg) and silver pomfrets (₹ 320/kg) for the year 2014 and the lowest prices were recorded for oil sardines, flatfishes (₹ 45/kg) and stomatopods (₹ 25/kg). Analysis of trends in marine fish prices for the period 2000-2014 showed that the highest growth were shown by pomfrets, seer fishes and ribbonfishes at landing centre level and pomfrets and seerfishes at retail level.

Summary

Landings in Kerala have decreased by over 30% compared to 2012 and 22% when compared to 2011. The main decrease seen is in the catch of oil sardine and threadfin breams. An interesting phenomenon is the increase in landings of oceanic sharks and rays mainly at Cochin Fisheries Harbour. The stock status indicates stock of 11 resources in declining phase and only 6 in abundant state. Overcapacity has been noted in the motorised and mechanised gillnets and there is urgent need to reduce effort through government intervention. The implementation of the Minimum Legal Sizes (MLS) is expected to go a long way in the conservation and sustainable utilization of the resources. The price increase in cephalopods (23%), tunas (175%), seerfish (40%), mackerels and pomfrets and moderate increase in other fishes is a positive step towards economic improvement of the fishery sector, but the increasing margin concentrating in the hands of the middlemen is a matter of concern.

A new record of deep-sea caridean shrimp *Heterocarpus chani* (Decapoda: Pandalidae) from the southern coast of India

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Heterocarpus genus belong to the family Pandalidae (Decapoda, Caridea) which are common in deeper waters. Some species are of commercial value or fishery potential by their large size. They are characterized by rostrum armed with teeth on both margins; carapace with postrostral carina extending nearly to posterior margin and with 1 or more longitudinal lateral carinae; pereopods with 2nd pair distinctly unequal and dissimilar. The species *Heterocarpus chani* was recorded from various fishing harbours on the south coast (Sakthikulangara Fishing Harbour; Kalamuku Landing centre (Kerala) and the Thoothukudi and Nagapattinam Fisheries Harbours Tamil Nadu) from the deep-sea catches taken at depth of 200 – 350 m. The distinguishing characters of *Heterocarpus chani* Li, 2006 are as follows:

Rostrum extending beyond scaphocerite, curved upwards above antennular peduncle, dorsally armed with 8 or 9 teeth including 5 teeth on carapace posterior to orbital margin, ventrally armed with 13- 15 teeth along entire length, tooth size progressively reduced distally, abdomen unarmed posteriomedially on all somites, third somite with blunt longitudinal dorsomedian carina, with lateral margins slightly convex; pleura of 4th and 5th somites with acute posteroventral tooth; telson with 4 pairs of dorsolateral; third maxilliped stout, extending beyond scaphocerite, exopod reduced but distinct and strap-like epipod present.

Fig. 1. *Heterocarpus chani*

Body orange-red, with dorsal parts more orange-red while ventral parts including pleopods and tail fan generally reddish. Eyes black-brown. Flagella reddish. Anterior 2 pereiopods varied from reddish to pinkish. Posterior 3 pereiopods with dactylus and distal portion of propodus always reddish, carpus and distal portion of merus as well as proximal portion of propodus always pinkish to light pink. Eggs are dark green.

Distribution: Southern South China Sea, Bohol and Sulu Seas of the Phillippines, at depths of 382-888 m, Bay of Bengal, Arabian Sea, India at depths of 200-350 m.

This species is closely related to *Heterocarpus gibbosus* Bate, 1888. The exopod of third maxilliped of *H. chani* is rudimentary while that of *H. gibbosus* is well developed. It can be distinguished from *H.gibbosus* by having a broader dorsomedian carina on the third abdominal somite.

Cutting remains from Fish Cutting Centres - A feed source for fish farming in estuaries of Karnataka

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Demonstration of small scale cage culture of finfishes in coastal waters initiated by Mangalore Research Centre of ICAR- CMFRI during 2008- 2009 period has resulted in large scale adoption of the technology (Fig.1). The fish production through finfish culture in small cages in Uppunda village of Udupi district in Karnataka increased from an estimated 1.2 tonnes (t) during the 2009-10 period to 14 t in 2013-14. The success of cage farming in estuarine areas which was launched as a pilot project in Uppunda village of Udupi district has extended to other estuaries. The fishermen gained experience and confidence in finfish farming which encouraged them to continue fish culture in cages using seeds collected from the wild as well as hatchery bred fingerlings. The fishermen living nearAlvekody, Kundapura and Mulky estuaries have adopted the technology which has augmented fish production and provided alternate livelihood options as well as nutritional security to the fishermen.

Fig. 1. Battery of small scale fish farming cages in estuaries of Karnataka

Considering the availability of around 8000 ha brackish water area in Karnataka it is estimated that a minimum of 260 cages can be installed without affecting the coastal environment. This can augment the fish production from these cages to about 260 t of fish every year which would generate an income of around ₹ 10 crores annually. In India, unavailability of cost effective feed,especially for rearing carnivorous fishes is a major problem. However, since the existing farming practice is being carried out at low stocking densities, feed related issues are not reported by these farmers of Karnataka. But considering the pace of adoption of the small scale cage farming technology and government interventions to ensure sufficient fish seed supply, an annual production of 250 to 300 t fishes from small scale cage farming in estuaries of Karnataka can be anticipated in the immediate future. Foreseeing the fresh feed demand in such a scenario, the Mangalore Research Centre of ICAR-CMFRI carried out extensive surveys to find alternate options for sourcing fresh feeds.

The surveys revealed that lot of Fish Cutting Centres are established for pre-processing of fish for *Surimi* plants and frozen fish exports in Karnataka. Around 25 such centres are functioning in Mangaluru, Malpe, Kundapur and Karwar that process pink perch, lizardfish, ribbonfishes, lesser sardines etc. These centres generates enormous amount of cutting remains (head and tail portion) which is approximately 20-30% of total fish weight, based on the species of fish being processed. Those with more than 10% meat was found to be excellent for feeding of seabass and snappers. Most of the fish cutting sheds have the capacity to produce 10-15 t of processed fish daily during peak fishing season when raw material is available in plenty. As much as 35 to 40 thousand tonnes of fishes are being processed annually by these Fish Cutting Centres which generates around 8000 t of cutting remains.Presently it is being diverted for fish meal preparation. If some portion of these cutting remains can be used for feeding the high value marine fishes being farmed locally in the estuarine cages, it will meet the demand for feed and augment fish production from Karnataka.

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