NO. 248, April - June 2021 ISSN 0254-380X

MFiS

Marine Fisheries Information Service Technical & Extension Series

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Mar. Fish. Infor. Serv., T & E Ser., No. 248, 2021

Published by

Dr. A. Gopalakrishnan
Director
ICAR - Central Marine Fisheries Research Institute, Kochi

Trawler boats berthed in Mangalore Fisheries Harbour

Photo credit: Sujitha Thomas

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 the field.

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From the Editorial Board

The ornamental fish industry falls in three general categories that include Tropical freshwater (guppies, neon tetras), Temperate freshwater (Koi carps) and marine ornamentals (primarily reef fishes, shrimps and corals). The global ornamental fish trade is spurred by growing interest in aquarium keeping and reportedly includes more than 120 countries with around 2000 species, predominantly freshwater, traded. While the supply is mainly from Asia-Pacific, Europe and USA are key markets. The Government of India through its Pradhan Mantri Matsya Sampada Yojana (PMMSY) is encouraging the stakeholders to tap the economic potential offered by sustainable ornamental fish production and trade clusters. Development of an associated indigenous pet fish feed industry is vital to attain this goal and the lead article in this issue of MFIS shares some insights on this topic. Findings while empowering fishermen through appropriate techno-economic interventions are included. Coral reefs play a key role in enhancing and sustaining marine biodiversity and marine fisheries. The observations recorded during an underwater coral survey in the Andaman & Nicobar islands will also be interesting to our readers.

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Contents

Lead article

Status and prospects of ornamental fish and fish feed industry in Southern India

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Abstract

Ornamental fish culture, fish feed production and trade presents promising prospects for farmers and entrepreneurs, given the growing demand, and a renewed policy thrust in the sector. This article presents an overview of the dynamics of the ornamental fish and fish feed industry in Southern India based on a primary field survey focusing on the culture potential, demand for fish feeds, marketing systems and trade prospects.

***Key words**: Ornamental fish culture; ornamental fish feed; demand estimation; trade; Southern India*

Introduction

The global ornamental fish trade is estimated at US$ 18-20 billion which is supported by about 100 million hobbyists around the world enterprise and has been expanding at a rapid pace in recent years. India has considerable potential in production and trade of ornamental fish due to the rich biodiversity of species hailing from diverse aquatic ecosystems, a favourable climate and the availability of a huge pool of low-cost labour. There are about 5,000 ornamental fish producing units spread across the country, wherein about 80% are freshwater-based while the rest form brackishwater and marine. Despite these endowments, India still continues to be a marginal player in the global ornamental fish trade. A recent estimate of the Marine Products Export Development Authority of India (MPEDA) shows that there are one million fish hobbyists in India. The domestic ornamental fish trade is estimated to be about ₹500 crores while the export is close to US$ 1.4 million (2017-18). Presently, the industry grows at an average annual rate of 11-12 per cent. The *Pradhan Mantri Matsya Sampada Yojana* (PMMSY) has an allocation of ₹576 crores for catalysing the growth of ornamental fish industry.

West Bengal, Tamil Nadu and Kerala are the major hubs of ornamental fish production in India respectively constituting 55%, 30% and 5% of all units in the country. A large number of villages in the districts of 24 Parganas, Howrah, Hooghly and Nadia are major centres of ornamental fish culture in the state of West Bengal. In Tamil Nadu, ornamental fish business is mostly concentrated in Kolathur region near Chennai. This hub supports a plethora of economic activities ranging from large and small scale production of ornamental fishes, their distribution to domestic and international markets, related logistical activities, production and distribution of aquarium and its accessories, live and formulated ornamental fish feed, etc. together constituting an elaborate business network.

Feed has a prominent role to play in ornamental fish business as the fishes require balanced nutrition constituted by vitamins, micro nutrients, and other dietary components for good health, fast growth and for developing attractive colours. Though the industry thrived mainly on live feeds conventionally, formulated feeds have emerged in a big way in recent times. A variety of formulated feeds viz., flakes, tablets, granules and pellets prepared from a wide variety of agro-based raw materials constitute the

modern fish feed business. This study is mainly focused on understanding the dynamics of ornamental fish industry based in South India with particular focus on fish feed production and trade, intended to draw valuable insights for prospective entrepreneurs in the field.

Objectives and approach

The specific objectives of this study include understanding the business dynamics associated with the ornamental fish production and fish feed industry based in Kolathur, Tamil Nadu; to estimate the approximate demand for prepared/formulated ornamental fish feed emanating from Kolathur based fish industry; and to assess the present status of ornamental fish distribution and imports. The study is based on primary data collected from Kolathur, Athur and Devanpumedu regions near Chennai in Tamil Nadu during March 2021. The data was collected through structured interviews and focus group discussions by involving the operators engaged in large scale culture of ornamental fish in leased-in fields/water bodies in Athur and Devanpumedu villages of Tamil Nadu; small scale ornamental fish farming units based in Kolathur; fish marketing units; aquarium and accessories dealers; fish feed producing units; wholesale and retail sellers of ornamental fish feed and a few hobbyists. Together, the data collection covered a total of 75 respondents belonging to various categories as mentioned above and was carried out during a 10-day period between 10th to 20th March, 2021 with the help of a qualified and experienced researcher.

Ornamental Fish Production System based in Kolathur, Chennai

There are close to 1,850 ornamental fish producing units operating in Kolathur and adjacent regions of Athur and Devanpumedu, which supply ornamental fish to the Kolathur based wholesale market. Ornamental fish production system in this region involves three

Fig. 1. Ornamental fish tanks in a small-scale unit in Kolathur

Fig.2 . Packed red worms for feeding fish

Fig.3. Ornamental fishes for sale in plastic bags

major categories of stakeholders, one: hatchery units engaged in producing ornamental fish fries, two; small scale units engaged in grow-out using small tanks and glassware, and large scale ornamental fish farms growing saleable fishes in huge quantities. The next section elaborates each of these enterprises in more detail.

Ornamental fish hatchery units

Majority of the ornamental fish hatchery units in the study area are located in New Lakshmipuram and Vinayagapuram villages in Kolathur, Chennai. These units mainly deal with fish species such as Gold fish, Guppy, Angel, etc. Each hatchery unit operates in an average plot area of 20 cents, with around 16 to 20 tanks of 12x5 feet size. Some tanks are set apart exclusively for conditioning breeding activities and others for stocking. Almost all these units use own propagated artemia for feeding the fries. The fish fries are sold at a price range of ₹10 to 30 paisa per piece.

Small scale grow-out units

The small-scale grow-out units procure fish fries from nearby hatcheries and maintain them for about two months before selling them to wholesalers. The production units function in land area of about 20-30 cents with elaborate arrangements for grow-out. The fish fries procured are stocked in cement tanks which have attached facilities for water filtering and aeration. Each unit stocks about 25,000-30,000 numbers of fish fries per cycle in tanks, depending on the species grown. A small-scale grow-out unit on average employs two full time workers. Many of these units are operated by families, wherein women constitute a major workforce. The fries are fed twice daily (early morning and evening) with locally available red worms. Red worms (larvae of *Chironemus* spp.) are high protein-rich feed sourced from local water bodies using scoop nets. They are said to be an excellent source of nutrition that aid in fast growth and development of attractive colour for the stocked young ones of ornamental fish species. The red worms are sold in small packets priced at ₹50 (Fig.2). After attaining saleable size, the fishes are shifted to Kolathur wholesale market, where they fetch an average price of ₹5-10 per piece (Fig.3).

Large scale ornamental fish farms

Majority of the large scale ornamental fish farms operate in Athur village, which is located at about 9 km from Red Hills in Chennai, close to Chennai-Hyderabad high way. Around 100 acres of paddy cultivating land was converted to large scale ornamental fish farms by a group of farmers / entrepreneurs who realized the promising potential of ornamental fish business. Borewell is the main source of water farming purposes in this region. Commonly sought after ornamental fish species such as Gold fish, Shubunkin goldfish (SK), Angel, Tetra, etc. are cultured here in large scale. The average size of a pond in Athur is about 30 cents and 6 feet deep. Around 300 such ponds operate presently for ornamental aquaculture and each pond stocks about 10,000 to 30,000 ornamental fish fries, depending on the species, during a culture cycle (Table 1).

Table 1. Estimates of Kolathur-based ornamental fish production per annum

Particulars	Small scale units (Kolathur)	Large scale farms	
		Athur	Devanpumedu
Total number of fish producing units	150	300	1400
Commonly raised species	Goldfish, Guppy, Angel	Goldfish, SK, Tiger fish, Angel, Tetra	
Average number of fish stocked/unit/cycle ('000)	25	15	15
Total number of fish stocked in the region/cycle ('000)	3750	4500	21000
Survival rate (%)	70%	60%	50%
Total number of fish harvested /cycle ('000)	2625	2700	10500
Total number of fish harvested /year ('000)	15750	16200	63000
Grand total production/year ('000)	94,950		
Wholesale price in Kolathur market (₹)	5-10		
Total value of fish transacted /year (₹ crores)	47-95		

Source: Field survey

Another hub of large scale ornamental fish production that caters to the Kolathur wholesale market is the Devanpumedu village located in Gummidipoondi town of Tiruvallur District near Tamil Nadu-Andhra Pradesh border. Around 500 acres of ponds, which were previously used for Vannamei shrimp aquaculture, have been converted to commercial ornamental fish farms. Majority of the fish grown here finds market in Kolathur itself. The water in the ponds in Devanpumedu is relatively more saline compared to that of Athur and therefore culture practices differ slightly. Each pond is stocked with 10,000 to 20,000 fishes per cycle which are harvested in about 60 days' time. The ponds are of similar dimension as in Athur and require about 225-250 kg of the locally produced 'kali' feed per pond per month. At this rate, the overall monthly feed requirement in Devanpumedu farms would be around 350-375 tonnes.

The fishes grown in the ponds are harvested after a period of two months. Depending on the size of the fish and the species, each fish fetches a price ranging from ₹3-6 per piece at the farm gate. They are packed in plastic containers filled with water and are transported to Kolathur wholesale market as well as various other locations in south India.

In all these large farms, the fish feed is prepared locally and known as 'kali', which is a mix of dried fish, ragi, rice, corn bran dust, and related products. The exact specification of the feed mix is often kept a secret by individual farmers and is believed to play a significant role in determining the quality of the fish raised. The feed is dispensed in a container fixed inside the pond every morning and evening. The cost of production of such feed is estimated to range between ₹32-40 per kilogram. On an average, about 225 kilogram of feed will be used in a pond for a month period. At this rate, about 70 tonnes of feed is required by all the farms in the region spread in an area of 100 acres.

Given their expertise in cheap production of traditional fish feeds, the large fish farmers in Athur and Devanpumedu or those small holders based in Kolathur do not show any inclination towards formulated feeds. This is because, any such shift would completely alter the economics of fish production, thereby adversely affecting their market prospects. Rather than fish farms, the demand for formulated feeds mainly arises from those of the retail shops and hobbyists spread across all over the country. Most of the ornamental fish sold in the Kolathur market find their destination in major South Indian cities, from where they are further distributed to smaller towns and rural areas. Bangalore and Salem are the major markets for Kolathur fish, followed by other cities in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh.

Demand for formulated feeds

Most of the fish sold from the Kolathur wholesale market goes to small scale retailers and thereafter to home-based hobbyists through varying number of intermediaries. These market intermediaries and hobbyists mostly depend on formulated feeds to meet

the nutritional requirements of the fishes. Considering a post-sale mortality rate of 30% and that most of the surviving fishes are fed on formulated feeds, the total annual potential demand for ornamental fish feed arising from Kolathur-based production system is estimated to be about 13,200 tonnes (at an approximate rate of 200 gms/fish/annum). Taken evenly, this translates to a monthly demand of 1,100 tones and a daily demand of 36 tonnes. However, it is to be noted that, this estimate of feed demand is not limited to Kolathur/ Chennai region alone, but emanates from different parts of southern India where these fishes finally reach. Therefore, a significant part of this demand is met either by locally produced feeds or imported feeds. A large variety of formulated fish feeds with wide ranging price differentials are available in the market. Even though the quality of fish feed is utmost important to maintain the health, growth rate and attractiveness of the fishes, most of the small scale hobbyists remain oblivious to it, making them dependent on low quality imported feed. Still, there are a few major local feed manufacturing companies and small-scale units that produce quality feed thereby catering to the growing market demand.

Ornamental fish producers and sellers based in Chennai

Taiyo feed mill Pvt. Ltd. established in 2002, is a certified manufacturer, supplier and exporter of ornamental fish feed and also the largest ornamental fish feed producing company in South India. The company also deals with food products for other pets such as birds, dogs, turtles, cats and other small animals and birds. Besides catering to local demand, Taiyo feed mill Pvt. Ltd. currently generates 30 percent of its total annual revenue from export sales, to destination countries in Asia, Middle East, Singapore, Africa, Caribbean countries and many more. Taiyo has been rated by CRISIL, certified by ISO 9001: 2015 plant approved by CAPEXIL and permitted to sell and export its products. The total turnover of the company is about 100 crores, average production per year is 1500 tonnes worth about 33 crores rupees per annum. The company has 24 distributors in India selling a wide variety of Taiyo feed products and imported Aquarium items. Apart from the retail distributors of Taiyo feed mill Pvt. Ltd., several other fish feed suppliers and distributors operate from Chennai. The major ones include Aqua Star, Best Aquarium, Southern India Aquaculture and Aqua World who sell both domestically produced and imported products.

Ornamental fish feed import

Available estimates show that there is a huge gap in demand and supply of ornamental fish feed in the country. A part of the demand is being met by the import of feed ingredients as well as finished formulated feeds from countries such as Thailand, China, Singapore and others. The Chennai based dealers such as Aqua Star, Best Aquarium, Southern India Aquaculture and Aqua World import about 100-150 tonnes of ornamental fish feeds every year. On average, these companies import more than 20 variants of ornamental fish feed incurring expense about ₹ 40-50 per kg. The retail prices of these products after repacking and branding starts from ₹150 and goes as high as ₹1,500 per kg depending on the product quality. Besides, there are a number of local small scale units who blend imported feed ingredients to develop their own brand of feed products. The annual imports of finished ornamental fish feed by all importers across India ranges between 4000-9000 tonnes in recent years. It is however, not clearly known how much of this quantity is being sold in southern states.

Future prospects

Given the growing global demand and the government's policy focus to develop the sector with greater investments, the ornamental fish and fish feed industry in the India is poised for a rapid growth in the near future. ICAR-CMFRI is presently undertaking a number of research initiatives on brood stock development and standardization, breeding as well as larval rearing of marine ornamental fish species, apart from efforts to develop entrepreneurship among smallholders. Realizing the market prospects for formulated feeds, two new fish feed formulations namely, *Cadalmin Varna* and *Cadalmin Varsha* were developed by the institute. These research outputs are presently being promoted for commercialization and scale-up, wider adoption, and to gain popular acceptance so that the emerging opportunities in this promising sector can be harnessed to the extent possible. In this regard, technology incubation, skill up-gradation, promotion of start-ups and infrastructure development are certain domains where more emphasis is required in future.

Karnataka Trawl Fisheries: Decadal Analysis and Fishers' perspectives

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Abstract

Analyses of trawl fisheries in Karnataka was done from 2008-2019 as part of a project on 'Best practices in trawl fisheries'. The fishing days increased from 1 day trips to voyages of 14 days and depth of operation ranged from 11-200 m. Total area trawled ranged from 26324-45869 sq. km. Multiday trawl landings observed 269 taxa of which 224 species belonging to 111 families and 32 orders were identified. 68% were finfishes, followed by crustaceans (17%) and molluscs (14%) with major contribution from carangids (22 %), portunids (10%), clupeids (8 %), penaeids (7 %) and engraulids (6 %). Since 2017, percentage of pelagic fishes in trawl catch has increased. Based on a survey, stakeholder attitudes were also assessed on various socio-economic aspects.

***Keywords**: Fishing ground, Karnataka, species composition, Trawl*

Introduction

In India, mechanised sector contributes more than 80% of the marine fish catch and more than 50% is from trawl. Based on the FAO guidelines on the best practices in trawl fisheries, the present study was done as a part of developing best practices in trawling in India. Karnataka with a coastline of 300 km has 93 fish landing centres with five are major harbours. The gears operated are mainly seines, gillnets and trawl nets. Major gear contributing to the fishery in recent years is trawl which are operating from coast go up to Thane in Maharashtra to Kozhikode in Kerala and contribute 64% of the marine fish landings in Karnataka state. During 2018, the trawlers of Karnataka landed 293 thousand tonnes fishes of which 95% were caught by multiday trawlers and the rest by single day trawlers. In 2019, the total trawl landings showed a phenomenal increase to 440 thousand t with multiday trawlers contribution of 96%.

Methodology

In-situ data collected from 2562 cruise datasets of multiday trawlers during 2008-2018 was used for analyses of trawl fishing operations, spatial extension of trawling operation, species composition and the decadal changes in the composition. For understanding the fishers' perspective on trawl fishery, various stakeholders including traditional fishers and trawl operators were engaged using personal interviews, focus group discussions and using projective techniques. The attitude of respondents on the trawl fisheries of Karnataka was measured using Garret Ranking and a 3 point Likert's scale.

Genesis of trawl fishery in Karnataka

The trawlers were first introduced in the coast in 1957 mainly to exploit shrimps and the contribution by trawlers was minimum in the initial years. Wooden boats of 30-43

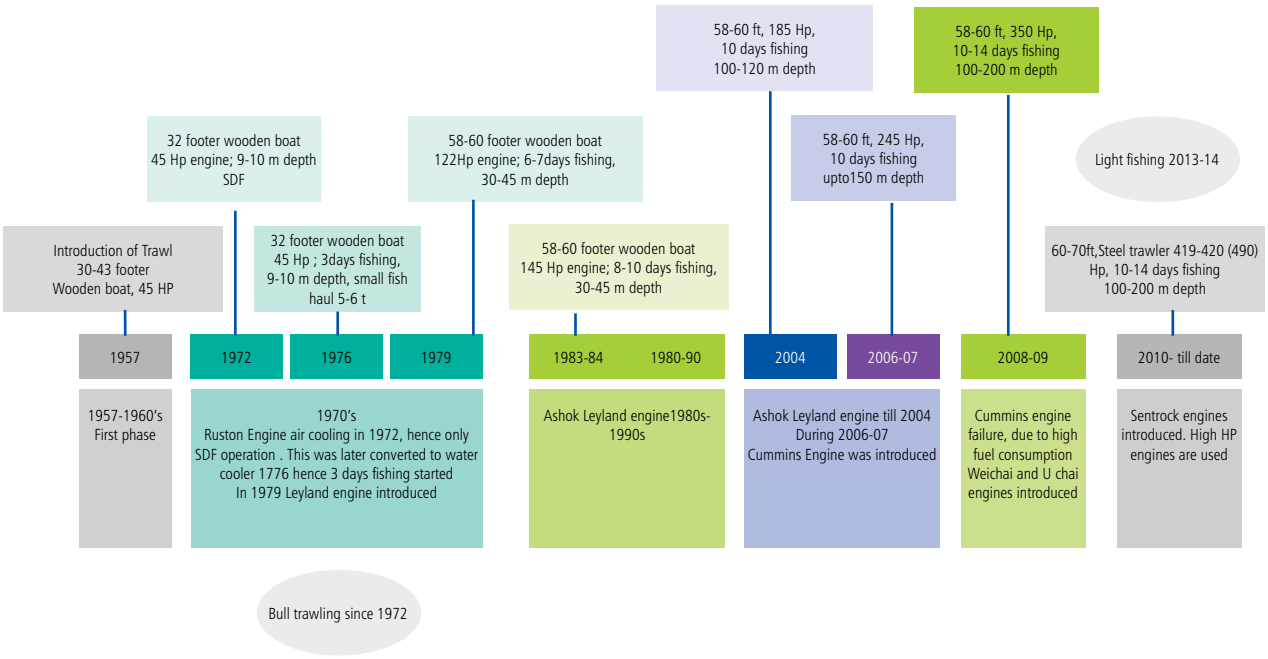

Fig 1. The timeline of trawl fisheries in Karnataka

ft and 45 hp engine were used and depth of operation was about 9-10 m in the early phase of the trawling. Trawling increased to trips of 3 days during 1972-79 period and changes in the engine make occurred during this period. Bull trawling was introduced since 1972. In 1980s and 1990s the engine hp increased to 122- 145 with size of the boat increasing to 50-60 ft. The fishing days increased to 6-10 days with operational depth of 30-45 m. Post year 2000 the depth of trawl operations increased to 100-120 m depth with 10 days of fishing and increase in hp to 185. Over the years the models and companies of the engine also changed. During 2006-07, the engine hp increased to 245, with depth of operation upto 150 m. During 2008-09 the trawlers of 58-60 ft had 350 hp Weichai and U chai engines and the depths operated increased upto 200 m with 10-14 days fishing. From 2010 steel trawlers of 60-70 ft length with depth of operation upto 200 m and 10-14 days fishing are in vogue (Fig. 1). Light fishing by trawlers started in 2013-14, which was banned in 2019 by Govt of Karnataka.

Marine fisheries census -1978 mentioned 246 trawlers which have increased over the years. According to 2016 census, 2,788 trawlers were estimated to be operational along Karnataka coast (CMFRI-DOF, 2020). In 2008, the minimum depth of operation was 9 m and maximum recorded was 200 m, while in 2018, it was 14 -150m. Minimum average depth of operation was 11 m and average maximum depth was 145 m during 2008-2018. The range of total area trawled during 2008-2018 was 26,324 to 45,869 sq km., average area of operation was 35,634 sq km. The area of operation during 2008 was from Kasaragod in Kerala to Goa, which extended from Kozhikode in Kerala to Thane in Maharashtra subsequently. Average extend of operation longitudinally (sq. km) was 746 and with advancement in engine capacity and days of fishing, the distance covered for fishing which was 498 km in 2008 extended upto 830 km in 2018 (Fig.2 & 3).

On an average 50% of the area available for the multiday trawl fishing (MDF) was trawled during 2008-2018 with the minimum area of trawling in 2011 and maximum in

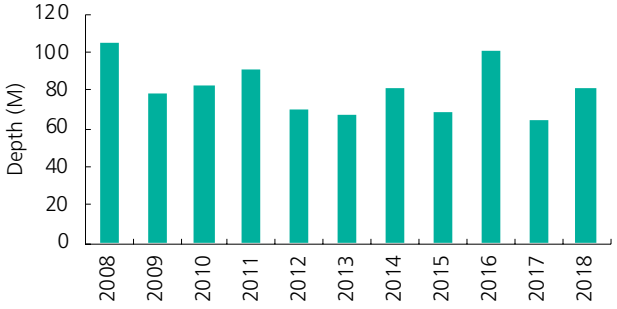

Fig 2. Average Depth of Operation of Multiday Trawlers (2008-2018)

2017 (Fig 4). From 2015 the trawled area increased above 50% of the area available. It was observed that in 2008 when bottom trawling was carried out, there was a gap in 100 m depth zone, caused by the presence of rocky patch (seamounts) which prevented trawling activity. However in 2018, when the pelagic trawl operations were widely adopted, these un-trawled areas could also be covered for trawl fishing (Fig.5)

About 269 taxa were observed in the multiday trawl landings in which 224 species of finfishes, crustaceans, molluscs, belonging to 111 families and 32 orders were identified.

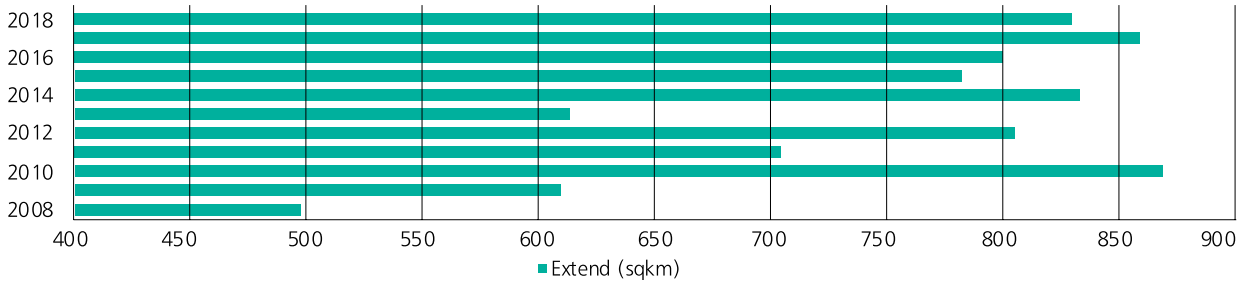

Fig3. Longitudinal extension of trawling area in Karnataka (2008-2018)

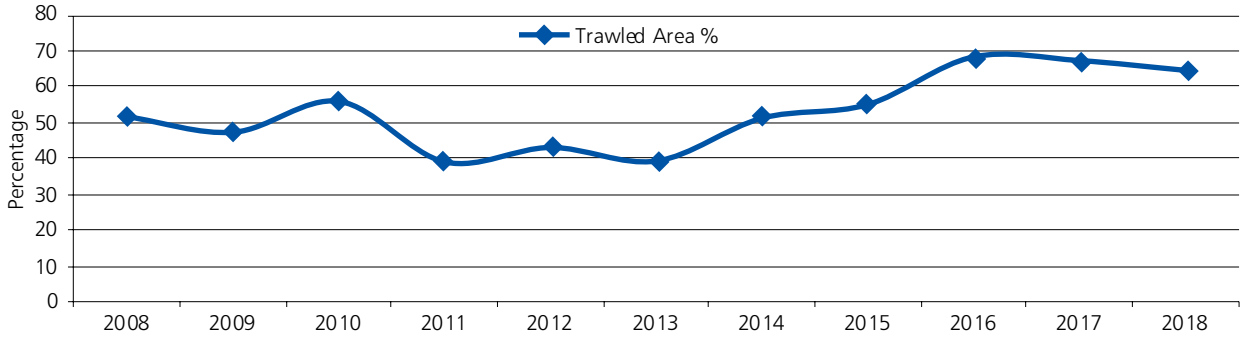

Fig 4. Percentage of Trawled area during 2008-2018

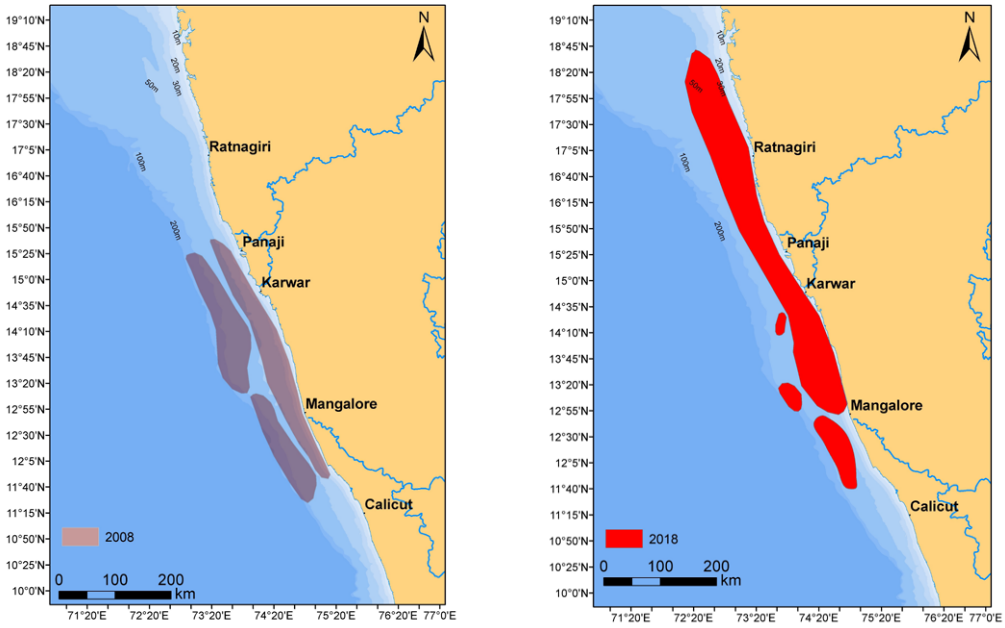

Fig 5. Comparison of trawled area during 2008 &2018

Table 1. List of species occurring in multiday trawlers in Karnataka

FINFISHES

Family	Species	Family	Species
Acanthuridae	*Acanthurus* sp	Haemulidae	*Pomadasys* sp.
Ambassidae	*Ambassis* sp	Hemiramphidae	*Hemiramphus lutkei*
Antennaridae	*Antennarius pictus*	Holocentridae	*Sargocentron rubrum*
Apogonidae	*Apogon* sp	Lactariidae	*Lactarius lactarius*
Ariidae	*Arius arius*	Leiognathidae	*Leiognathus bindus*
	Osteogeneiosus militaris		*Leiognathus splendens*
Balistidae	*Abalistes stellaris*		*Leiognathus brevirostris*
	Balistes sp		*Secutor insidiator*
	Odonus niger	Lethrinidae	*Lethrinus* sp
Bothidae	*Bothus* sp	Lophiidae	*Lophiomussp*
Bregmacerotidae	*Bregmaceros mcclellandi*	Lutjanidae	*Lutjanus* sp
Caesionidae	*Caesio* sp		*Pristipomoides multidens*
Callionymidae	*Callionymus margaretae*	Menidae	*Mene maculata*
Carangidae	*Alectis indicus*	Monocanthidae	*Aluterus monoceros*
	Alepes sp		*Aluterus monoceros*
	Alepes djedaba	Mugilidae	*Mugil cephalus*
	Alepes kleinii		*Mullet* sp
	Alepes mate	Mullidae	*Upeneus* sp
	Atropus atropos	Muraenesocidae	*Muraenesox* sp
	Atule mate		*Muraenesox cinereus*
	Caranxsp	Muraenidae	*Gymnothorax* sp
	Carangoides chrysophrys	Nemipteridae	*Nemipterus japonicus*
	Carangoides coeruleopinnatus		*Nemipterus randalli*
	Carangoides sp		*Parascolopsis aspinosa*
	Caranx sexfasciata		*Scolopsis vosmeri*
	Decapterus macrosoma	Ophidiidae	*Brotula multibarbata*
	Decapterus russelli	Paralichthyidae	*Pseudorhombus* sp
	Decapterus tabl	Pinguipedidae	*Parapercis* sp
	Decapterus sp	Platycephalidae	*Platycephalus* sp
	Megalaspis cordyla	Polotosidae	*Plotosus* sp
	Other carangids	Polynemidae	*Polynemus* sp
	Parastromateus niger	Pomacantridae	*Pomacentrus* sp
	Scomberoides lysan		*Neopomacentrus* sp
	Scomberoides tol	Priacanthidae	*Priacanthus hamrur*
	Selar crumenophthalmus	Pristigasteridae	*Pellona ditchella*
	Selar mate	Psettodidae	*Psettodes erumei*
	Seriolina nigrofasciata	Rachycentridae	*Rachycentron canadum*
	Uraspis sp	Scaridae	*Scarus* spp
Carcharhinidae	*Scoliodon laticaudus*	Scatophagidae	*Scatophagus argus*
Centrolophidae	*Psenopsis intermedia*	Sciaenidae	*Johnius* sp
Cepolidae	*Acanthocepola indica*		*Otolithes cuvieri*
Chaetodontidae	*Chaetodon* sp		*Otolithes ruber*
	Heniochus sp		*Protonibea diacanthus*
Chirocentridae	*Chirocentrus* sp	Scombridae	*Auxis rochei*
Clupeidae	*Amblygaster sirm*		*Euthynnus affinis*
	Anodontostoma chacunda		*Rastrelliger kanagurta*
	Dussumieria acuta		*Scomberomorus commerson*
	Opisthopterus tardoore	Scorpaenidae	*Pterois russelii*

FINFISHES

Family	Species	Family	Species
	Sardinella albella		*Gobius* sp
	Sardinella fimbriata		*Trypauchen vagina*
	Sardinella longiceps		*Pterois volitans*
	Sardinella gibbosa		*Scorpaenodes* sp
Colocongridae	*Coloconger* sp		*Scorpaenopsis* spp
Coryphaenidae	*Coryphaena* sp	Serranidae	*Cephalopholis* sp
Cynoglossidae	*Cynoglossus bilineatus*		*Epinephelus chlorostigma*
	Cynoglossus macrostomus		*Epinephelus diacanthus*
	Cynoglossus puncticeps	Siganidae	*Siganus canaliculatus*
Dactylopteridae	*Dactyloptena* sp		*Siganus vermiculatus*
Dasyatidae	*Dasyatis* sp	Soleidae	*Solea* sp
Diodontidae	*Cyclichthys* sp		*Zebrias* sp
	Diodon sp	Sphyraenidae	*Sphyraena fosteri*
Echeneidae	*Echeneis naucrates*		*Sphyraena jello*
Engraulidae	*Encrasicholinadevisi*		*Sphyraena obtusata*
	Stolephorus commersonnii		*Sphyraena putnamae*
	Stolephorus baganensis	Syngnathidae	*Hippocampus* sp
	Stolephorus indicus	Synodontidae	*Saurida tumbil*
	Stolephoruswaitei		*Saurida undosquamis*
	Thryssa mystax		*Synodus indicus*
	Thryssa vitrirostris		*Trachinocephalus myops*
Ephippidae	*Platax orbicularis*	Terapontidae	*Terapon jarbua*
Exocoetidae	*Hirundichthys cormandelensis*		*Terapon theraps*
Fistulariidae	*Fistularia petimba*	Tetraodontidae	*Lagocephalus inermis*
Gerreidae	*Gerres limbatus*	Triakidae	*Iago omanensis*
	Gerres filamentosus	Trichiuridae	*Trichiurus lepturus*
Gobidae	*Bathygobius* sp	Uranoscopidae	*Uranoscopus guttatus*
	Ctenotrypauchen microcephalus		

CRUSTACEANS

Family	Species	Family	Species
Parthenopidae	*Cryptopodia angulata*	Leucosiidae	*Myra fugax*
Calappidae	*Calappa gallus*	Cirolanidae	*Cirolana fluviatilis*
Calappidae	*Calappa granulata*	Squillidae	*Harpiosquilla harpax*
Calappidae	*Calappa lophos*	Squillidae	*Lysiosquilla* sp
Calappidea	*Matuta planipes*	Squillidae	*Oratosquilla nepa*
Portunidae	*Charybdis feriatus*	Palinuridae	*Panulirus homarus*
Portunidae	*Charybdis hoplites*	Scyllaridae	*Thenus orientalis*
Portunidae	*Charybdis lucifera*	Glyphocrangonidae	*Glyphocrangon* sp
Portunidae	*Charybdis smithii*	Solenoceridae	*Solenocera choprai*
Portunidae	*Charybdis riversandersoni*	Penaeidae	*Trachypenaeus* sp
Portunidae	*Podophathalmus nacreus*	Penaeidae	*Parapenaeopsis stylifera*
Portunidae	*Podophthalmus vigil*	Penaeidae	*Parapenaeus fissuroides*
Portunidae	*Portunus pelagicus*	Penaeidae	*Metapenaeopsis stridulans*
Portunidae	*Portunus sanguinolentus*	Penaeidae	*Metapenaeus affinis*
Portunidae	*Thalamita crenata*	Penaeidae	*Metapenaeopsis andamanensis*
Majidae	*Doclea hybrida*	Penaeidae	*Metapenaeus dobsoni*
Majidae	*Doclea ovis*	Penaeidae	*Metapenaeus monoceros*
Xanthidae	*Etisus levimanus*	Pandalidae	*Heterocarpus gibbosus*
Leucosiidae	*Leucosia anatum*		

MOLLUSCS

Family	Species	Family	Species
Carditidae	*Cardita* sp	Potamididae	*Telescopium*
Pholadidae	*Pholas*	Rostellariidae	*Tibia curta*
Veneridae	*Pitar*	Rostellariidae	*Tibia delicatula*
Bursidae	*Bursa spinosa*	Strombidae	*Strombus listeri*
Calyptraeidae	*Crepidula*	Terebridae	*Terebra*
Cassidae	*Phalium canaliculatus*	Tonnidae	*Tonna dolium*
Conidae	*Conus*	Turridae	*Turri* ssp
Fasciolariidae	*Fusinus nicobaricus*	Turritellidae	*Turritella* sp
Ficidae	*Ficus gracillis*	Xenophoridae	*Xenophora solarioides*
Melongenidae	*Pugilina pugilina*	Loliginidae	*Uroteuthis Photololigo duvaucelli*
Muricidae	*Drupa*	Loliginidae	*Uroteuthis Photololigo edulis*
Muricidae	*Murex trapa*	Octopodidae	*Octopus* spp
Muricidae	*Thais tissoti*	Sepiidae	*Sepia elliptica*
Nassariidae	*Nassarius*	Sepiidae	*Sepia pharaonis*
Naticidae	*Natica*	Sepiidae	*Sepiella inermis*
Olividae	*Olivia*		

Sixty-eight percentage of the species were finfishes, followed by crustaceans (17%) and molluscs(14%). Major families contributing to the trawl landings were Carangidae (22 %), Portunidae (10%) ,Clupeidae (8 %), Penaeidae (7 %) and Engraulidae (6 %) (Table 1).

Change Analysis of trawl Fisheries (2017-2019)

Average multiday trawl catch during 2017-2019 in Mangalore was about 3,29,180 t in which low value catch (LVC) formed about 25-34 %. Major group/species contributing to the low value catch were juveniles of *Odonus niger, Sardinella gibbosa, Megalaspis cordyla, L. inermis, Therapon* spp. *Trichiurus lepturus* and *Nemipterus randalli*. The LVC was highest in October followed by November-December and September (Fig.6). Major portion of juveniles in LVC observed in the trawl was contributed by *L.inermis*, followed by *D. russelli* and *Trichiurus lepturus* (Fig. 7).

Introduction of pelagic trawling in 2015 resulted in the change of species composition in multiday trawlers. The percentage of pelagic fishes in commercial as well as LVC category has increased in recent times as compared to 2008. The increase in *Decapterus russelli, Rastrelliger kanagurta* and other pelagic species and diminished contribution by demersal species were

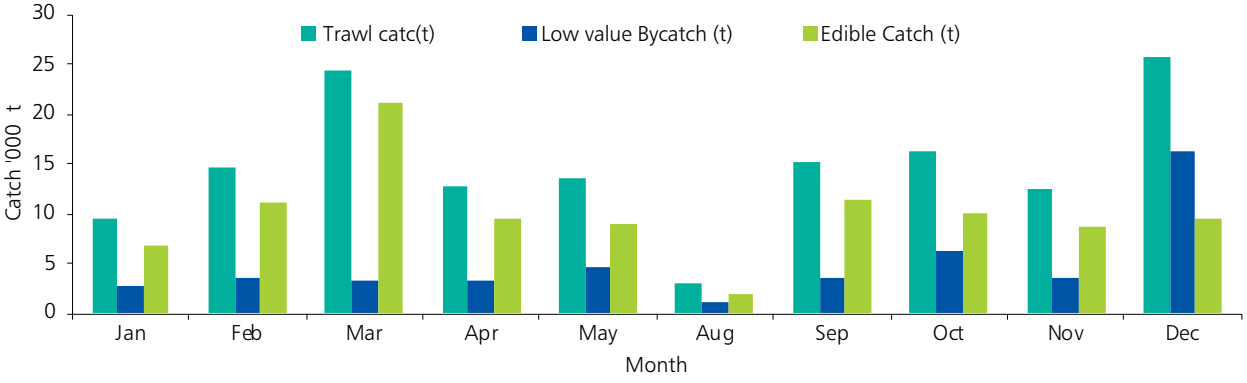

Fig 6. Total Catch, edible catch and low value catch in MDT during 2017-19

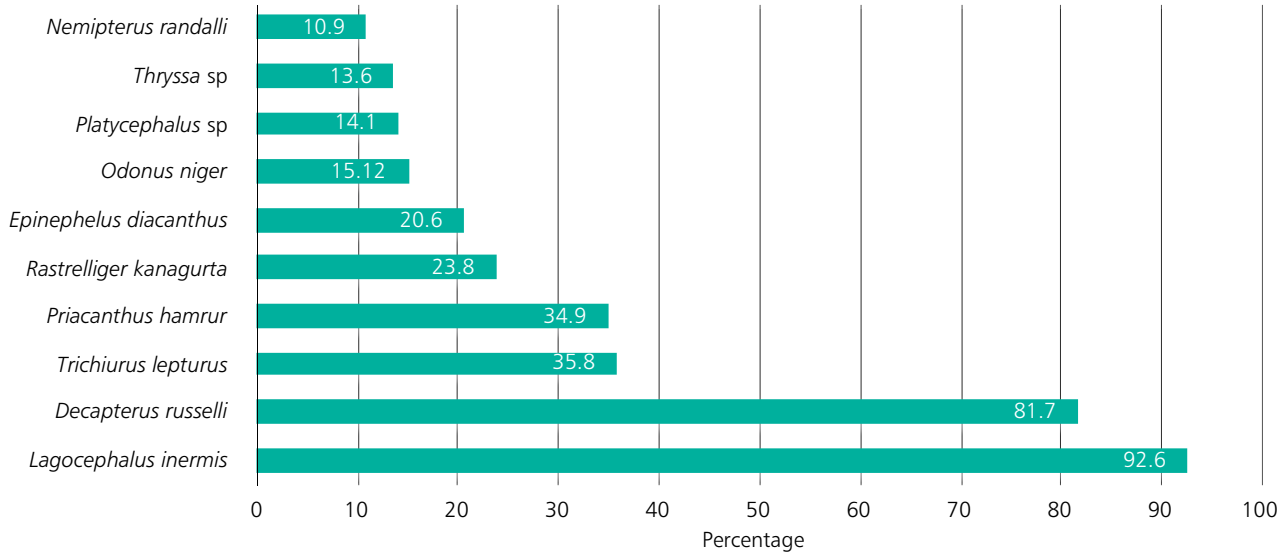

Fig 7. Percentage contribution of juveniles in LVC of major species in the MDT catch

observed in catches from 2017 onwards as compared to 2008 indicating an organised shift towards pelagic trawling (Figs. 8 &9)

Fishers Perception on trawl fisheries

Respondents in the traditional sector (n=30) who operate indigenous gears and outboard engine crafts were of the opinion that there is conflict among the fleets. Majority of the respondents (33.2%) had a medium level of attitude towards monsoon ban. The unanimous opinion was that the monsoon ban should continue and the mesh size regulations should be strictly implemented. All were of the opinion that boundaries should be implemented for the mechanized sector and the bycatch which include juveniles of fishes which sustains the traditional sector should be prevented.

All the mechanized sector respondents (n=35) favoured bull trawling operations , mesh size regulations for avoiding the catch of fish juveniles and the use of high speed engines. "Garret Ranking" employed to rank the attributes in order of magnitude influencing the overcapacity of the fishing fleets indicated that, open access regime was ranked as foremost in importance leading to overcapacity of fishing fleets, followed by provisions in subsidy and unexploited deep sea resources. While ranking the measures suggested for fishing effort regulation, mesh

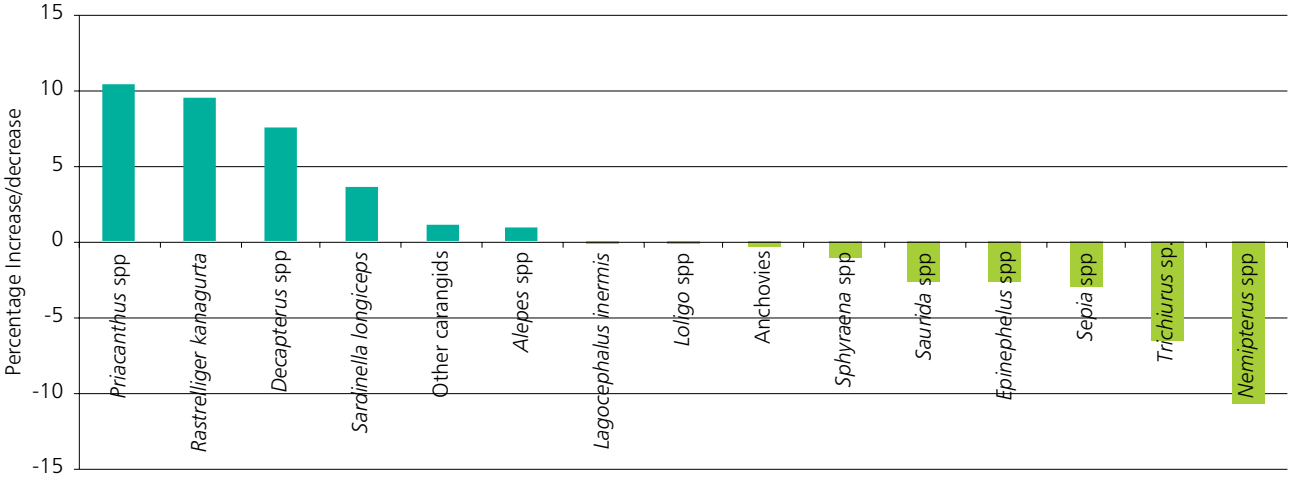

Fig 8. Comparison of percentage contribution of commercial species between 2008 and 2018

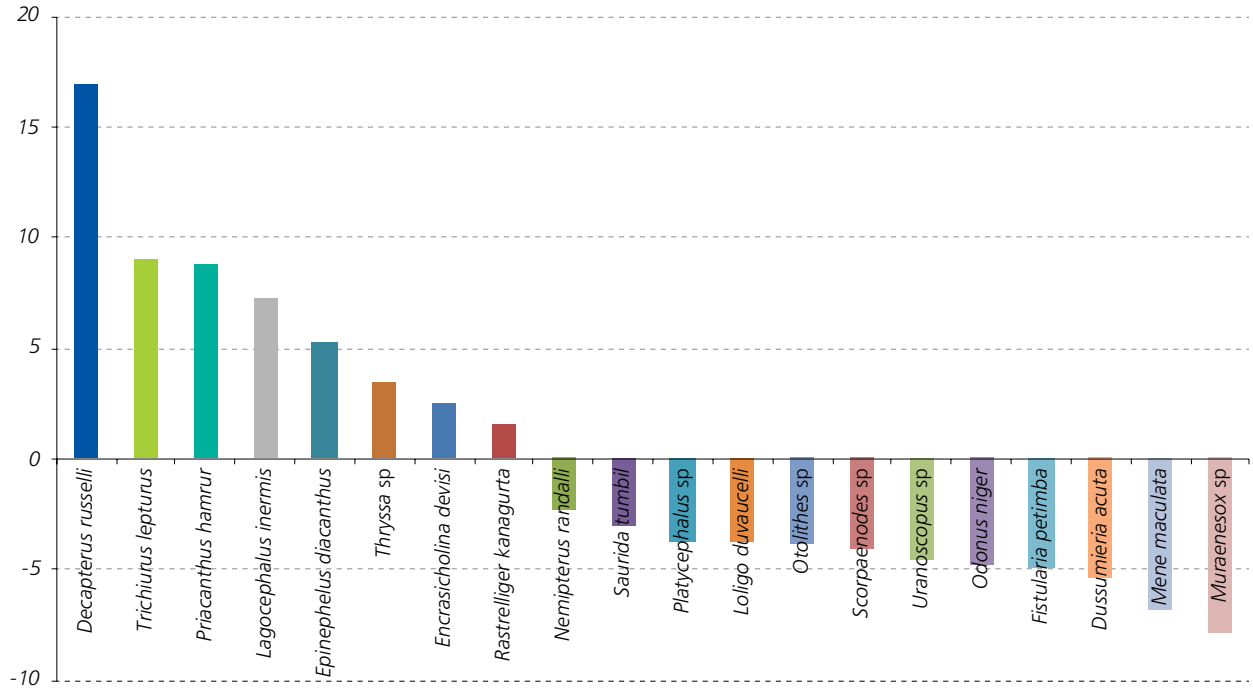

Fig 9. Comparison of species contribution in LVC between 2008 and 2018

size regulation (for avoiding the capture of juveniles) was ranked first followed by minimum harvest size. While analysing the perception of fishermen towards bycatch reduction devices (BRDs), the results of the analysis revealed that most of the fishermen (60%) had a low level of perception towards the BRD with a scoring of 26, which is below 50 that indicates satisfactory perception level. Although the perception level was low, all were of the opinion that conservation is required. Mechanised sector fishers had a medium level of attitude towards willingness to collaborate in conservation measures. The Garret Ranking also revealed that as a source of finance, co-operative societies were the first preference, followed by public banks, private banks, money lenders and self-help groups (SHGs). Attitude of trawl owners towards over capitalisation (using a 5-point Likert's scale) showed that, 67 per cent had medium level of perception towards over capitalisation and viewed it was as more of a threat rather than a beneficial phenomenon. Ghost fishing was perceived as a man-made disaster which can be managed by timely interventions of the fisher community as a whole. For participatory approach to management of the marine fisheries in Karnataka, these perceptions also have to be considered.

Reference

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Adoption of ingenious fishing method to augment fish catch in coastal karnataka

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Abstract

Gillnets are one of the important gears contributing to the marine fish landings of Karnataka. A variety of gillnets (drift, bottom set, encircling and entangling), are deployed in the fishery. The smaller monofilament gears are operated by small non-motorized and motorized crafts. The larger polyamide high-density polyethylene nets are operated from large mechanized crafts. The use of large meshed knotted monofilament gillnets deployed from mechanized trawlers is a novel introduction and has enabled fishers to operate over submerged banks, rocky patches and reefs. Use of these nets have resulted in good catch that included several commercially valuable species of elasmobranchs, snappers, groupers, surgeonfishes, lobsters and also less valuable perchlets, bandfish, blowfish, porcupine fish, sack fish, gurnards and stargazers resulting in better income for the fishers in the region.

***Keyword**: Knotted monofilament gillnet, Karnataka, submerged banks, discards*

Introduction

Karnataka is one among the top five coastal states in marine fish production of the country with around 5 lakh tons landed annually on an average during the past five years. However, the marine fishing activities and marine fish landings in coastal Karnataka has been on a decline with poor catch of commercially important fishes since 2020. The reasons for these subdued activities in the marine fishing sector and fish production are several, including loss of fishing days as a result of the lockdown declared in the wake of the COVID19 pandemic, inclement weather conditions, shortage of migrant labour force employed as crew, steep hike in fuel price, disruptions in domestic and export marketing links, etc. In the wake of these limitations, the fishers in coastal Karnataka have now started using a knotted monofilament net suitably modified to operate over reefs, submerged rocky patches and sea mounts and effectively exploit commercially valuable fishes. The net deployed, is an improved version of the basic monofilament gillnet used mostly for exploiting small and medium sized pelagic fishes (sardines, mackerel, white sardine, engraulids, other clupeids), some demersal fishes (sciaenids, ladyfish) and crustaceans (prawns and crabs). However, the new monofilament gillnet used is knotted and with thicker diameter (1.8 mm). Unlike the knotless finer monofilament gillnet commonly used, this net is modified in such a way that it just hovers almost like a blanket close to the bottom/ rocky patches/ seamount area, depending on the area of deployment. In addition to the thicker diameter, the weights and limited floats rigged to the net ensures that the gear does not drift far away from the point of deployment and neither does it stand up vertically like a meshed panel wall in the water column. The gear therefore behaves more like an entangling bottom set gillnet (traditional *negarbale* / *jeppubale*) than a drift gillnet, entangling the fishes/shellfishes/and other resources residing close to bottom/ rocky patches/ seamount area. The report provides firsthand information on the details of the gear, mode of operation, resources landed, utilization, marketing and concerns on the

probable impact on large scale operation of this type of targeted fishing on the fishery of the region.

Fishery

The monofilament (1.8 mm diameter) knotted mesh panel has 200 mm mesh size (knot to knot). The standard size of the gear panel has a width of 20 m and length of 3000 m or more. The total length of the gear varies from 3-4 km depending on the area of operation. Such knotted panels are readily available in the market and fishers procure it as per their requirement. The monofilament does not absorb water when soaked and therefore will continue to be light and maintain its original weight. Lead weights of 200 g are attached to the foot rope (12 mm diameter nylon rope) of the panel at an interval of 1 m. Small cork floats are attached to the head rope (10 mm diameter nylon rope) of the panel at an interval of every 10 m. This enables the net to sink to a desired depth and also allows it to spread loosely in the area (@ 2-3 nmi) of operation (Fig.1). This gear is deployed from the large multi-night trawlers which is fitted with a small hydraulic stainless steel power block (Fig.2) that assists in hauling of the net. The fishing voyage generally extends to 10-12 days with one haul made during nights of halt. There are 10-11 crew members for fishing operations. As this is new technique being adopted in Karnataka, skilled fishers from Tuticorin, familiar with handling and operating this type of fishing gear are engaged.

There are a number of submerged rocky patches, knolls, reefs and seamounts off Karnataka Coast between 12° N-14° N and 71° E -72° E and the largest of these seamounts, 'Manchappara (Bassas de Pedro Bank)' is located around 120 nmi off Mangalore and extends from Kasargode in the south to the Coondapur in the north (Fig.3). This is one among the 5 submerged banks which comes under the Union Territory of Lakshadweep. The knotted monofilament

Fig.1 The knotted monofilament net used by fishers of coastal Karnataka

Fig.2. Hydraulic power block fitted to a trawler for operating the knotted monofilament gear

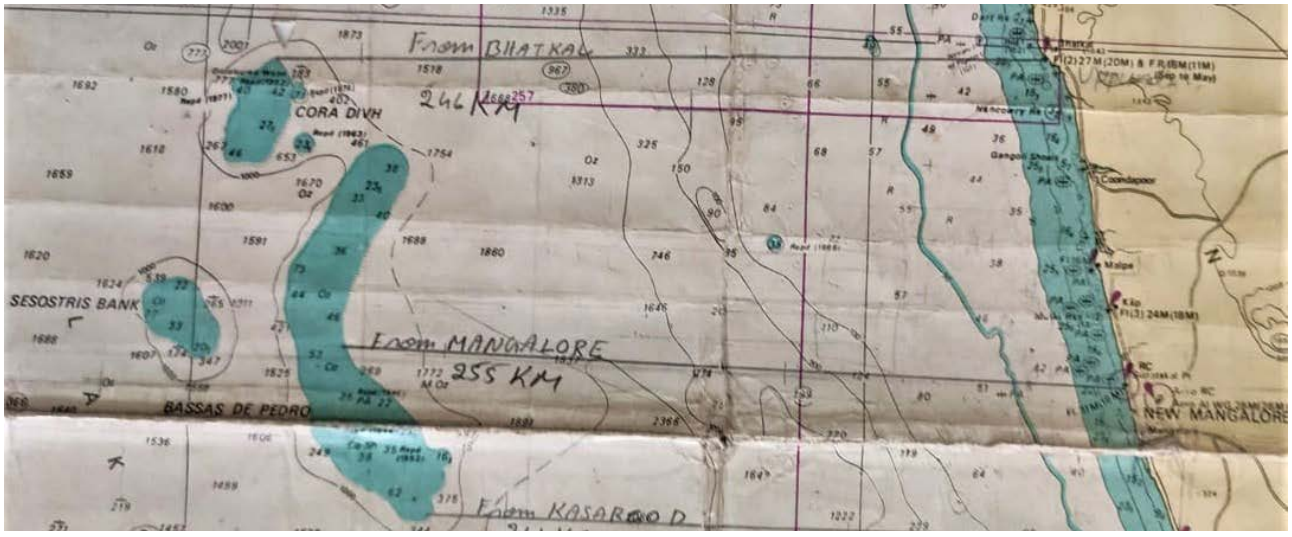

Fig.3. Location of fishing grounds off Mangalore

gear is operated in this region, over the seamount and submerged rocks, at depths ranging from 50 to 70 m.

The craft sets out for fishing during the morning hours around 3 AM and around 15 hours is required to reach the fishing ground which is about 120 nmi from the shore, when cruising at a speed of 8-9 knots. On reaching the fishing ground, the net that is pre-adjusted to hover at a depth of 50 -70 m is slowly released into the water over the identified part of seamount or submerged rocks with the craft moving at a slow speed of 2 knots. After the net is deployed, the craft is anchored nearby till the time of next operation the following evening. The time taken to shoot the net is around an hour and a half. The net is left soaking for about 8 hours and hauled with the help of the power block fitted in the boat. The hauling and untangling the net process takes around 2-3 hours depending on the size of the net and quantity of catch. Bigger sized fishes were lifted onboard using a gaff hook.

The net, which settles close to the seamount/rocks as a loose sheet of meshed panel, actually entangles the fish and other species that reside and move around the reefs/ seamounts/rocky patches. When hauled up with help of the power block, the meshed panel comes up like a rope with fishes and other organisms entangled within (Fig.4). Therefore, removal of the entangled organisms and spreading of the net panel takes several hours. The vessel after a voyage of 7-10 days, returns back to base cruising for 14-15 hours.

Fig.4. Monofilament gear appears as a thick rope when hauled up using the power block

The catch comprised of an array of elasmobranchs, bony fishes, shellfishes and several other reef/ rock associated fauna and flora. Each voyage yielded on an average 6 t with around 200-300 kg being discarded. The catch depending on their market value are either stored in ice in the inbuilt fish hold of the craft or discarded into the sea (Table 1). Details of discarded items were collected through enquiry and some photographs provided by the crew. Discards mainly comprised groups such as octopus, starfishes, gastropods (mainly Horned Helmet ,*Cassis cornuta*), seafans, seaweeds, gorgonids, sponges and corals)

Table 1: Catch recorded in the monofilament gear

Commercially important Flora/Fauna landed		
Sl. No.	**Groups/ Genus /speceis**	**Common name**
I	Rays	
i	*Taeniurops meyni*	Round ribbontail ray
ii	*Dasyastis* spp.	Stingray
iii	*Himantura fai*	Pink whipray
iv	*Neotrygon* spp.	Spotted maskray
v	*Urogymnus asperrimus*	Porcupine whipray
vi	*Mobula* sp.	Devil ray
II	Guitarfishes	
i	*Rhynchobatus* spp.	Guitarfish
ii	*Rhinobatos obtusus*	Widenose guitarfish
iii	*Rhina ancylostoma*	Bowmouth guitarfish
III	Sharks	
i	*Rhizoprionodon acutus*	Milk shark
ii	*Chyllioscyllium* spp.	Bamboo shark
iii	*Nebrius* spp.	Nurse shark
iv	*Galeocerdo cuvier*	Tiger shark
v	*Stegostoma fasciatum*	Zebra shark
IV	Snappers	
i	*Lutjanus lutjanus*	Bigeye snapper
ii	*Lutjanus russellii*	Russell's snapper
iii	*Lutjanus madras*	Indian snapper
V	Rock cods/Groupers	
i	*Epinephelus flavocaeruleus*	Blue-and-yellow grouper
ii	*Cephalopholis sonnerati*	Tomato hind
i	*Aethaloperca rogaa*	Red mouth grouper
ii	*Epinephelus* spp.	Grouper
VI	Surgeon fish	
I	*Acanthurus xanthopterus*	Yellowfin surgeonfish
Ii	*Naso annulatus*	Whitemargin unicornfish

Commercially important Flora/Fauna landed

Sl. No.	Groups/ Genus /speceis	Common name
iii	*Naso vlamingii*	Bignose unicornfish
VII	Parrotfish	
ii	*Cetoscarus bicolor*	Bicolour parrotfish
iii	*Chlorurus* spp.	Parrotfish
iv	*Scarus* spp.	Parrotfish
VII	Wrasses	
i	*Cheilinus undulatus*	Humphead wrasse
IX	Perchlets	
i	*Chelidoperca* spp.	Perchlet
X	Bandfishes	
	Acanthocepola indica	Bandfish
XI	Triggerfish	
i	*Abalistes stellaris*	Starry triggerfish
ii	*Odonus niger*	Red-toothed triggerfish
iii	*Balistoides viridescens*	Titan triggerfish
XII	Squirellfishes/Soldierfishes	
i	*Sargocentron* spp.	Squirellfish
ii	*Ostichthys* spp.	Soldierfish
XIII	Blowfishes	
i	*Arothron* spp.	Pufferfish
XIV	Porcupine fishes	
i	*Diodon hystrix*	Spot-fin porcupinefish
ii	*Diodon holocanthus*	Long-spine porcupinefish
iii	*Cyclichthys* spp.	Burrfish
XV	Stargazers	
i	*Uranoscopus* spp.	Stargazer
XVI	Gurnards	
i	*Satyrichthys welchi*	Robust Armoured Gurnard
XVII	Duckbills	
i	*Bembrops caudimacula*	Duckbills
XVIII	Snake mackerels	
i	*Neoepinnula orientalis*	Sackfish
XIX	Flounders	
i	*Chascanopsetta lugubris*	Pelican flounder
XX	Lobster	
i	*Puerulus sewelli*	Arabian whip lobster,

Table 2. Details of operating cost for a single voyage

Item	Quantity	Cost (₹)
Fuel	1200 litres @ ₹ 83/litre	99,600
Ice	5 t	50,000
Salary of crew	10-11 members	50% of income generated from sale of catch
Ration	@ ₹ 1000/day	15,000
Other expenses	₹ 500/day	5,000

Economics of the new fishing method was evaluated. The existing large mechanized multi-day trawlers were modified and fitted with a small hydraulically operated power block costing ₹2 lakhs. The cost of net material (₹18000 @ ₹350 per kg) and additional lead weights (₹60,000 for1000 numbers @ ₹20/kg), cork floats (₹2,000 @ ₹5 per cork) and labour charges for fixing them (₹9,000/-, 3 persons for 3 days labour @ ₹1000 per person per day). A uniform rate of ₹ 120 per kilogram for fishes with high commercial value and Rs. ₹24 per kilogram for fishes not preferred for direct consumption. The average income generated per trip assuming an average landing of 6 t, was estimated to be around ₹7.5 lakhs. Of the total income generated, 50% is shared by the crew and 50% is for the boat owner. The boat owner, invests for the modifications of the craft, the gear, fuel, ice, ration and other miscellaneous expenses.

The fishing using large drift gillnets and hook and line by fishers from Tamil Nadu over the seamounts located off Karnataka has been described in detail by Bineesh *et al*. (2014). This is for the first time that a few fishers from Karnataka have initiated fishing using this knotted monofilament gear. Though, the yield is observed to be good, indiscriminate fishing of reef-based resources may not be a healthy fishing practice. The damages caused to the reefs/sea mounts/submerged rocky patches during this type of fishing and anchoring are likely to have a cascading and deleterious impact on the region's ecosystem. Further, several unconventional resources, which includes protected and endangered organisms, are harvested during this type of fishing a discarded as it does not fetch any value. Therefore, though this type of fishing brings in good catch and remuneration to the fishers, it should be properly monitored and regulated, if necessary.

Reference

Bineesh, K. K. et al., 2014. *Indian J. Fish*., 61(3): 29-34.

Acknowledgement

The authors thank the fishers and crew who provided details of the operation, photographs of discarded flora and fauna and marketing agents who facilitated collection of fish and other fauna samples.

Coral reef biodiversity of selected sites in Andaman & Nicobar Islands

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Abstract

SCUBA assisted under water surveys were carried out during 2018-2019 in selected coral reefs sites of the Andaman & Nicobar Islands. Biodiversity of Havelock Island (Nemo, Elephant and Turtles beaches), Neil Island (Lakshmanpur1), Northern Bay and Wandoor were documented. The diverse species of corals, coral reef fishes, sponges, sea urchins, holothurians, gastropods and giant clams were recorded during the surveys. It included 124 species of reef building corals, 82 species of reef fishes and four species of giant clams, besides holothurians and sea urchins.

Keywords: *Coral reef, Biodiversity, Giant clams, Andaman Nicobar Islands*

The Andaman and Nicobar Islands, situated along the northeast Indian Ocean is an Archipelago of India in the Bay of Bengal. There are nearly 300 islands bestowed with the rich coral reefs, dominated by fringing reefs and few barrier reefs, harboring rich diversity of corals, gorgonids, ornamental fish, giant clams, echinoderms and rare marine species. Under water survey of Coral reef sites of Andaman's & Nicobar Islands was carried out in the Andaman Islands during October 2018 at different sites in Havelock Island (Nemo, Elephant and Turtles beaches), Neil Island (Lakshmanpur1) and Northern Bay. Under water photographs and video recordings was done to study the resilience of coral reefs. In November, 2019, two sites in Havelock Island, Elephant Beach and Havelock and one site in Wandoor, Port Blair were also surveyed (Fig.1).

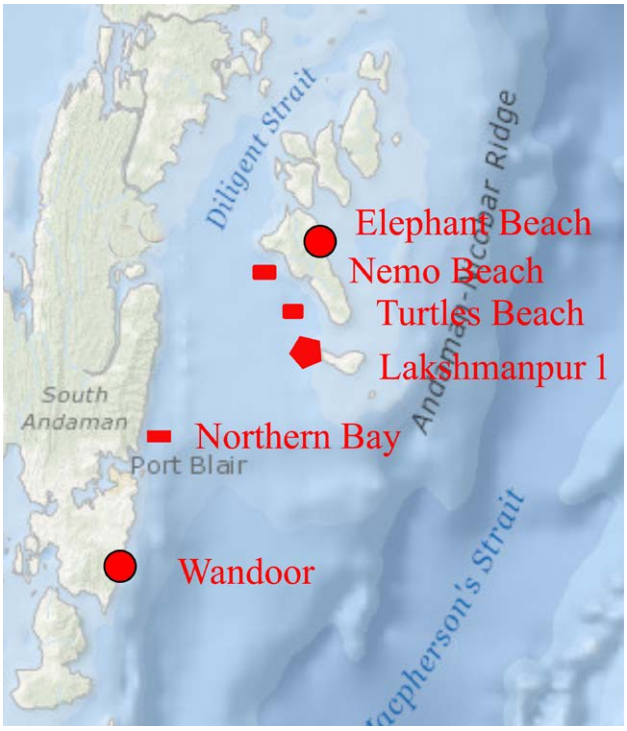


Fig.1. Underwater survey sites in Andamans & Nicobar islands

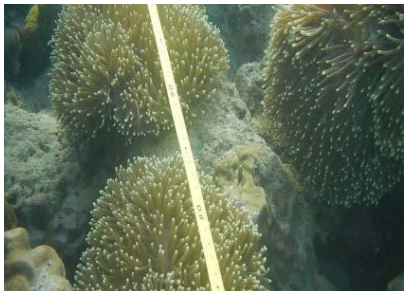
Hard corals were identified tentatively from the images and videos taken during underwater surveys. The objective of the coral survey was to provide an inventory of the coral species growing on reefs. Heavy sedimentation was observed in most of the sites with large scale mortality. A total of 124 species under 37 genera belonging to 15

Acropora florida

Acropora humilis

Pavona frondifera

Diploastrea heliopora



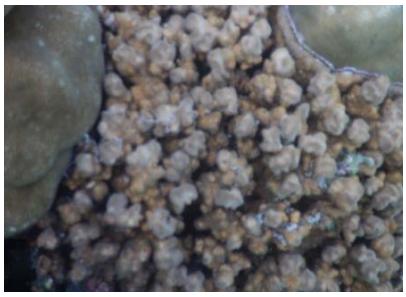
Euphyllia glabrescens

Goniopora minor

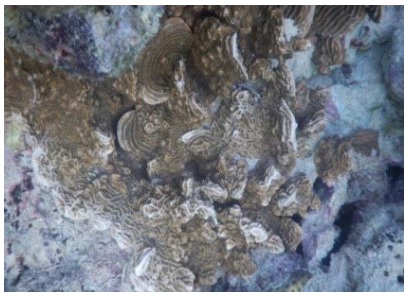
Leptastrea purpurea

Lobophyllia hataii

Montipora tuberculosa



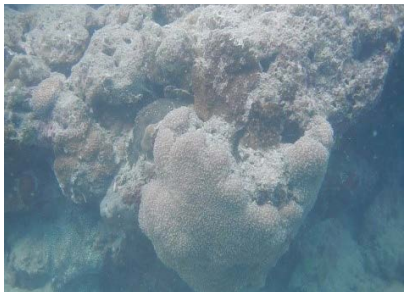
Psammacora obtusangura



Pachyseris gemmae

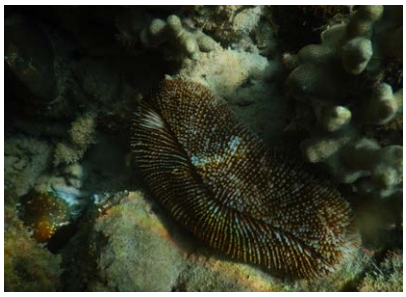
Pachyseris rugosa

Pachyseris speciosa



Physogyra licensteini

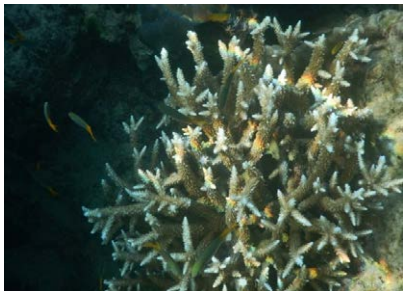
Pterogyra sinuosa



Ctenctis crassa

Platygyra lamellina

Verrucella cerasina



Acropora microphthalma

Acropora cytherea

Symphyllia recta

Fig.2. Diversity of coral and gorgonid species identified during the underwater survey

families of reef building corals were recorded in the survey. The list includes the non scleractinian blue coral, *Heliopora coerulea*. Acropora dominated the recorded hard corals with 28 species followed by Porites (09) Favites (07), Montipora (07),Dipsastrea (07) and five each in Platygyra and Lobophyllia . The major corals identified tentatively from underwater images are *Acropora aspera, A. muricata, A. grandis, A. abratanoides, A. millepora, A. florida, A. tenuis, A. gemmifera, A. humilis, A. nasuta, A. nobilis, A. valenciennsi, A. lamarcki, A. monticulosa, A. polystoma, Ctenactis echinata, Fungia fungites, Diploastraea heliopora, Dipsastraea pallida, Dipsastraea favus, Favites halicora, Goniastrea edwardsi, Goniastrea pectinata*, *Coelastrea aspera, Leptastrea purpurea, Psammacora contigua, Psammacora obtusangula, Psammacora profundacella, Porites lutea, P.lobata, P.murrayensis, P.monticulosa, P. rus, P. monticulosa*, *Lobophyllia hemprichi* and *Plerogyra sinuosa.*(Table 1). Lesions following infestations by the sabellid and trematode worms, fish bites and due to exposures were also observed in all the coral reefs. Among soft corals, two species of gorgonids were observed, of which, *Verricella ceraseria* is recorded as a rare one (Fig.2). Four species of sponges were also recorded (Fig.3).

A healthy fish fauna was found associated with the corals. 82 species of reef fishes under 50 genera belonging to 23 families were identified from the photographs and videos. Pomacentridae with 21 species and Labridae with 13 species dominated the recorded reef fishes. Nemipteridae and Chaetodontidae followed with 05 species each Acanthuridae, Siganidae, Caesionidae represented by 04 species each followed by Scaridae, Haemulidae, Lutjanidae, and Carangidae (03 spp.). The coral reef fishes recorded include *Halichoerus lunaris*, *Chromis viridis*, *Abudefduf bengalensis, Pomacentrus pavo, Gnathodentex aurolineatus, Chaetodon trifasciatus, Scarus gibbus, Hemigymnus melapterus, Chrysiptera unimaculata, Chromis atripectoralis, Coris caudimaculata, Spratelloides* sp., *Amphiprion sebae, A. percula, Plectroglyphidodon lacrymatus, Stegastes nigricans, S. insularis, Acantholabrus bollonii, Pomacentrus moluccensis* (Table 2).

The significant feature was the very high density of giant clams in all the sites. Four species of giant clams, *Tridacna crocea, T. maxima, T. gigas* and *T. squamosa* were found to be distributed in all the coral reef sites. These species are protected under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and listed in the IUCN Red List of Threatened Species. *Tridacna crocea* Lamarck, 1819 the smallest of the giant clams, reaching about 15cm burrows and completely embedded in the rocky reef substrate. It is abundant in the Havelock Island. *Tridacna maxima* (Röding, 1798), grows up to 35 cm, has close set scutes and is partially embedded in the reef substrates. *Tridacna squamosa* Lamarck, 1819, grows

Table 1. Genus wise representation of corals

Family	Genera	No. of Species	Family	Genera	No. of Species
Acroporidae	Acropora	28	Merulinidae	Coelastrea	1
	Astreopora	1		Cyphastrea	1
				Dipsastrea	7
	Isopora	1		Echinopora	1
	Montipora	7		Favites	7
Agariciidae				Goniastrea	4
	Pavona	4		Paragoniastrea	2
	Coeloseris	1		Hydnophora	1
Astrocoeniidae				Paramontastraea	1
	Stylocoeniella	1		Platygyra	5
Coscinaeridae				Merulina	3
			Plerogyridae		
Diploastreidae				Physogyra	1
	Diploastrea	1		Plerogyra	1
	Coscinaraea	1			
Dendrophyllidae			Pocilloporidae		
	Turbinaria	1		Pocillopora	3
Euphylliidae				Stylophora	1
	Euphyllia	1	Poritidae		
				Goniopora	1
Fungiidae				Porites	9
	Ctenactis	2	Psammocoridae		
	Cycloseris	2		Psammacora	1
	Danafungia	1	Siderastreidae		
	Fungia	1		Siderastrea	1
	Lithophyllon	3		Scleractinia incertae sedis	
Lobophylliidae				Leptastrea	3
	Echinophyllia	1		Pachyseris	3
	Lobophyllia	5			
			Helioporidae	Heliopora	1

Table 2. Genus wise representation of reef fishes

Family	Genera	No.of species	Family	Genera	No. of species
Acanthuridae	Acanthurus	2	Lutjanidae	Lutjanus	3
	Ctenochaetus	1	Mugilidae	Mugil	1
	Zebrasoma	1	Muraenidae	Gymnothorax	1
Apogonidae	Cheilodipterus	1	Mullidae	Upeneus	1
Ballistidae	Psuedoballistes	1		Parupeneus	1
Blennidae	Plagiotremus	1	Nemipteridae	Scolopsis	5
Caesionidae	Caesio	2	Pinguipedidae	Parapercis	1
	Paracaesio	1	Pomacentridae	Abudefdef	2
	Pterocaesio	1		Pomacentrus	3

Family	Genera	No.of species	Family	Genera	No. of species
Carangidae	Carangoides	1		Chromis	3
	Seriolina	1		Neopomacentrus	3
	Gnathonodon	1		Acanthochromis	1
Chaetodontidae	Chaetodon	5		Dischistodus	1
Haemulidae	Plectorhincus	2		Premnas	1
	Diagramma	1		Amphiprion	1
Labridae	Labroides	1		Chrysiptera	3
	Thalassoma	3		Dascyllus	1
	Anampses	1		Stegastes	2
	Hemigymnus	2	Scaridae	Scarus	2
	Diproctacanthus	1		Hipposcarus	1
	Haliochoeres	3	Serranidae	Plectropomus	1
	Cheilineus	1	Scorpaenidae	Pterois	1
	Coris	1	Siganidae	Siganus	3
Lethrinidae	Gnathodentex	1	Tetradontidae	Arathron	1
	Lethrinus	1	Zanclidae	Zanclus	1

Fig. 3. Diversity of sponges recorded during the underwater surveys

Tridacna maxima

Tridacna gigas

Tridacna squamosa

Fig.4. Diversity of giant clams observed in the underwater survey.

up to 40 cm and has large well-spaced scutes. *Tridacna gigas* (Linnaeus, 1758) is the largest of the giant clams, growing up to 1 m. They are elongate and have distinct triangular projections on the upper shell margin and are abundant in Neil Island (Fig.4). While the first three species are listed as lower risk / least concern in IUCN list, the *T. gigas* is considered as vulnerable. In India, also they are protected under wildlife Protection Act (1972). The giant clams were abundant and formed dense populations in all coral reef ecosystems. The giant clams an important role in the coral reef ecosystems with the shell serving as substrate for colonization by epibionts, the clam tissue serves as food for several predators and scavengers and the discharge of live zooxanthellae, faeces and gametes form food for opportunistic feeders nearby. Bleached and dead clams were also noticed.

The coral reefs of the Andaman Nicobar Islands have been recorded as the Islands with richest coral diversity among the Indian reef zones. A recent survey has reported 418 species of corals from Andaman and Nicobar Islands and a record of 44 mushroom corals (Ramakrishna *et al.*, 2010 a, b). The surveyed sites are all popular tourist spots and therefore characterized by heavy anthropological influences and impacts on the coral reef ecosystems, Bleached and dead clams were also noticed in the sites which also indicates the influence of climatic changes. In 2016, there was a loss of more than 23% corals off the coast of Andaman and Nicobar Islands when the sea-surface temperature rose due to El-Nino effect, which is the irregular periodic warming of the eastern Pacific Ocean that affects the climate in the tropical and sub-tropical regions. In a single year, the reef cover went down from 52.27% of all corals in India, to 39.94%. In 2016, the coral cover estimated at the study sites was analyzed separately to determine the extent of bleaching and coral health. It was found that the percentage of bleached corals (partially bleached, fully bleached but not dead and dead corals) as a component of total estimated data (excluding sand and algae) was maximum at Ross Island (88.7%) followed by Havelock (86.2%), North Bay (84.1%), Chidiyatapu (82.4%), Neil (77.0%) and Jolly Buoy (43.3%). The percentage of healthy corals was maximum at the Jolly Buoy (36.8%) followed by Neil (18.5%), Havelock (13.7%), North Bay (12.2%), Ross (6.5) and Chidiyatapu (5.8%). Bleaching was not only confined to the reef building corals, but also observed in some of the reef community members like the sea anemones and giant clams which have a symbiotic association with the zooxanthellae (Sarkar and Ghosh, 2013).

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Community development of fisherfolk at Nagnathwada, Karwar through open water cage culture: A success story

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Abstract

Fisherfolk from Nagnathwada, Karwar were trained to take up open water cage culture in Kali estuary. Karnataka. Demonstration of Asian seabass farming in fixed cage and box type floating cage were carried out initially for technology dissemination. After attaining confidence, open water cage culture was taken up in commercial scale by the fisherfolk with the technical support from ICAR-CMFRI and financial assistance from National Fisheries Development Board, Hyderabad. Fisherfolk benefited from the cage farming and are continuing the activities for better livelihood. Issues such as fish seed and feed availability for farming and dealing with natural calamities need to be addressed for sustaining the farming practices.

Keywords: *Asian Seabass, Fixed cage, Box cage, Karwar.*

Introduction

Open water cage culture is an emerging aquaculture activity in maritime states of India that helps in the economic and social upliftment of coastal communities. ICAR-CMFRI has actively involved in the expansion of open water cage farming of several marine finfishes in different part of the country through various developmental schemes. Karwar regional station of ICAR-CMFRI successfully implemented the open water cage culture of finfishes in the coastal fishing village at Nagnathwada, Karwar of Uttara Kannada district. The village is well connected with Karwar Town by road with easy access to fish markets in Karwar and Goa. The village has around 108 fisherman families who are mainly depending on fishing in the Kali river and nearby estuarine areas for their livelihood. Fishermen are involved in inland fishing activities using different fishing gears such as cast nets, angling and gill netting. Most of the fisherwomen are involved in collection of oyster and other live molluscs and selling it in local markets for their daily monetary needs. Many of the fisherwomen are also involved in fish vending and fish cutting activities in and around Karwar. Most of the fisherfolk are also members of various local fisherman co-operative societies.

Phase I: Training the fisherfolk

During the financial year 2018-19, three training programmes were conducted at Karwar Regional Station of ICAR-CMFRI with fifty participants in each batch nominated by the Department of Fisheries, Govt of Karnataka. Hands-on training on various aspects of marine and coastal water cages with various topics such as site and species selection for marine and coastal cage culture, materials used for cage culture, cage designing and fabrication, mooring and deployment of cages, cage culture management, net exchange and feeding protocols, nursery rearing of fish seed, fish diseases and environment monitoring in cages, harvesting and marketing of farmed fish was imparted. Practical knowledge on marine cage

farm management by arranging field visits to the marine farm at Karwar was given to trainees with the hands on experience so that they can directly initiate cage culture activities at suitable sites near to them. Class room lectures and practical demonstrations were handled by various resource persons including scientists and technical staff of ICAR-CMFRI and experts from Department of Fisheries, Government of Karnataka. Of the 70 people (30 men and 40 women) who participated in the training programme, majority expressed their willingness to initiate coastal water cage farming in Kali estuary. Since they were residing on the banks of the river, accessibility to the site, ease of management and watch and ward, availability of cheap feed resources such as the by-catch and low value fishes from their daily fishing activities were favorable. The participants also ensured that they will form Self-Help Groups with 5 to 10 members and will voluntarily involve in all the activities starting from the site selection, cage installation and watch and ward for the cages.

Phase II: Open water cage culture demonstration

A team of scientists and technical staff visited the sites for demonstrations and assessed various parameters required for a good coastal water cage culture demonstration site. Two sites were identified based on the site survey and the willingness of fishermen to participate in the demonstration programme; one at Nagnathwada and the other at Small Masjid. At Nagnathwada, cages of 6 4 $\times$ 2 m made with galvanized iron frames were tied to casuarina poles erected on the estuarine bottom. The nets were placed about 0.5 m above from the estuarine bottom. The 4 m depth nylone net webbing was tied to the frame in such a way that at lowest low tide 1 m water will be retained in the cages and almost 1 m of the net will be always exposed above the water level in order to prevent the escapement of the fishes. Since the quantity of fouling was less, the net exchange was done rarely. The cages were stocked with 700 numbers of nursery reared Asian seabass fingerlings of 40 g size. The fishes were reared from February to July and they reached an average marketable size of 575 g in 133 days. The low value fishes collected by the fishermen as by-catch during their fishing cruises were chopped and fed to the farmed fishes at 5 to 7 % of their body weight daily in two rations (morning and evening). The fishes were stocked in the cages, such a way that the harvested fishes can fetch a better market price during the fishing ban period. A total production of 203 kg was obtained from the cage with a survival of 67 % and an FCR of approximately 1: 3.1 and the average weight of the fishes (575 g) was ideal for marketing. The harvested fishes were packed in crates with ice and transported to Goa fish market. A successful harvest could be taken from the demonstration yielding profit to the farmers.

At Small Masjid, a fishermen group led by Mr. Shyam Kumtekar achieved the successful farming of Asian seabass in box type cages. A cage of 2.5 m x 2.5 m x 2 m fabricated by the farmer using Galvanised iron pipes, Netlon net and nylon nettings was attached with floats and anchored to the bottom with anchors of 45 kg. The total volume of the cage was only 12.5 m^3. The cage was provided with a small door at the top for feeding and could be locked for security. The cage was stocked

Fig. 1. Seed stocking in the low cost fixed cages.

Fig. 2. Harvest obtained from the low cost fixed cage.

with nursery reared Asian seabass fingerlings of 40 g size at 32 numbers / m ^{3} supplied by ICAR-CMFRI for demonstration purpose (Fig.3). The fishes were reared from February to July and they reached an average marketable size of 575 g in 133 days. The fishes were fed with low value fishes collected by the fishermen as by-catch during their fishing cruises. The chopped fishes were given to the farmed fishes at 5 to 7 % of their body

Fig. 3. Seed stocking in box type floating cages.

weight daily in two rations (morning and evening). Partial harvesting of the cage was done twice depending on the market demand. The total production was 244 kg with 84 % survival rate which can be considered as a record production from a low volume cage for a carnivorous fish such as Asian seabass within a short duration of 133 days. The farming demonstrations turned into a huge success with good profit to the farmers and motivated them to expand the farming activities and undertake coastal water cage farming of Asian seabass at Nagnathwada.

Phase III. Popularisation of open cage farming through extension aids

On the occasion of the fish farmers day a Harvest Mela was organized at Naganathwada, and fishermen involved in the cage culture activity were felicitated during the function. Mr. Sudhir Sarang, fishermen group leader said that earlier they were only familiar with catching fish from the wild and acknowledged ICAR-CMFRI's efforts for bringing them towards fish farming. He also said that they are now confident enough to farm the fishes in cages and earn money for securing the future of their children. The Station has given wide publicity for the successful implementation of coastal water cage culture in Nagnathwada village through various local daily news papers covering all the relevant aspects of the farming (Fig.4).


ಜೆಲ್ಲೆಯ ಆಳವೆಯಲ್ಲಿ ಮಾಡಿದ ಮೊದಲ ಪ್ರಯೋಗದಲ್ಲೇ ಯಶಸ್ಸು: ವಿಜ್ಞಾನಿಗಳ ಸಂತಸ

ಪಂಜರದಲ್ಲಿ 2.5 ಕ್ವಿಂಟಲ್ ಮೀನು ಫಸಲು!

ಮುಖ್ಯಾಂಶಗಳು

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- ₹ 15 ಸಾವಿರದಿಂದ ₹ 20 ಸಾವಿರ ಬಂಡವಾಳ ಅಗತ್ಯ

ಎಲ್ಲೆಲ್ಲಿ ಬೆಳೆಯಬಹುದು?

Fig. 4. Publicity in local newspapers for wider dissemination among stakeholders

Phase IV: Expansion of coastal water cage farming under NFDB subsidy scheme for open water cage culture

Trained fisher folk received subsidy for carrying out cage farming in Kali river estuary area from the National Fisheries Development Board, Hyderabad through the ICAR-CMFRI. The beneficiaries for the scheme was identified by the Department of Fisheries, Karnataka. The project was implemented as direct benefit transfer (DBT) to the farmers. A total of 18 fisher women who were otherwise involved in other fisheries related activities such as fish selling, oyster and clam collection were benefitted by the scheme.

For the project the farmers constructed square cages of 4m X 4m x 3m with galvanized iron frames supported with floats and anchors. The cages were deployed in identified sites at Kali estuary. The nets were placed about 0.5 m above from the estuarine bottom. The 4 m depth nylon net cage was

hung from the frame in such a way that at lowest low tide 1 m water will be retained near the cages and almost 1 m of the net will be always exposed above the water level in order to prevent the escapement of the fishes. The cages were stocked with Asian seabass fingerlings of 30 to 60 g size transported in syntax tanks from private firms at 30 numbers /m^3. The fishes were fed with low value fish procured from local market and were reared from November to July. The fishes were fed with chopped fishes at 6 % of their body weight daily in two rations (morning and evening). Water temperature and salinity near the cage site varied between 28-32^{0}C and 15-30 ppt respectively.

Even though, uniform stocking density was adopted for the farming, variation in the size and quality of the stocking material received effected the farming of Asian seabass. The production was also influenced by the perception and the proper adoption of the farming practices by the individual farmers. The farming practises varied among the farmers considerably and they have reached an average marketable size of 700 g to 1.2 kg in 6 to 8 months. A total of around 3 tonnes of fish production recorded from this village with a total revenue of Approximately Rupees 12 Lakhs. in one crop.

Technical assistance from the fabrication of cage till harvesting of the cages was provided by ICAR-CMFRI. At the end of the farming the fisherfolk opined that open cage culture activity is a success venture and they want to continue the same with the help of Department of Fisheries, Karnataka. According to the beneficiaries, the financial assistance for carrying out the cage culture was a great help for initiating a new venture for additional income other than fishing this will pave a new way for the social upliftment of their community and will help even the upcoming generation to have more livelihood options. Selected farmers from the group were felicitated at the centre during the National Fish Farmers day celebration.

Phase V: Present status of open water cage culture activities at Nagnathwada

After the completion of the subsidy scheme also many of the farmers have taken up the farming of Asian seabass in their cages with the financial aid for seed stocking from the Department of Fisheries, Govt. of Karnataka. Most of the farmers are interested to continue fish farming as a major stake for their livelihood. More over the farmers are interested to diversify farming by stocking various candidate species for open water cage culture such as red snapper, silver pompano and pearl spot since these fishes fetches good market price in this region.

A follow up survey was conducted among the NFDB beneficiaries of Open water cage culture of the village in December 2020. Majority of the beneficiaries were involving in inland fishing using various fishing gears

Fig. 5. Cage culture of Asian seabass: Inauguration to harvest

such as gill nets, cast nets and angling. Fisherwomen were involved in oyster collection and some of them were regular fish venders in the local market. They have informed that the daily earning for each family varies from these activities is only ₹ 200 to ₹ 500 which also varies seasonally. Family size of the participated beneficiaries range from 3 to 6.Majority of the beneficiaries have restocked the cages with Asian sea bass with varying stocking rates (700 to 2500 numbers per cage) with the financial assistance received from Department of Fisheries, Govt of Karnataka through blue revolution scheme during 2019–2020. The beneficiaries informed that the subsidy amount was limited up to ₹50000 per cage for seed stocking. Majority of the farmers have gone for partial harvesting of the fishes after attaining 700 g to 1 kg size. Most of the farmers informed that the farming practice is profitable and are willing to continue the farming in future years. But few of the farmers are still expecting financial assistance from Government to continue the farming. The major issues reported by the beneficiaries doing farming in Kali estuarine area are unexpected release of freshwater from the Khadri Dam in the upper stretches of Kali river, drifting of cages in monsoon season, net damage due to drift wood and otters, fluctuating feed availability and the marketing issues related to the present COVID 19 pandemic situation.

Prospects and Challenges

Market demand for fresh fishes at Uttara Kannada and Goa region is an added advantage for expanding the cage farming activities. Routine and daily availability of low value fish bye-catch for the fisherfolk will help to meet the much needed fish feed resources for the farming activities. Farmers can adopt Capture based Aquaculture (CBA) practices by stocking the live fishes caught in their gear. Availability of seed and fluctuating seed price are major bottleneck for the expansion of open water cage culture. By setting up commercial hatchery and nursery rearing facilities in public private partnership may be a viable solution to mitigate this issue. Exploitation of the farmers by middlemen involved in fish seed supply also need to be checked. Continuous supply of feed and storage of feed are major issues since presently majority of the farmers use low value fish as feed for cage farming. Development of commercial pellet feed in adequate quantity is the only sustainable solution for solving this problem. Carrying capacity studies to find out the potentials for expanding the farming activities need to be carried out to make the open water cage farming a sustainable practice. Environmental impact assessment studies also need to be taken up along way. Issue related to farming registration/ licence for farming and leasing policy for long term farming practices need to be legalised. Policies for utilising the open water resources need to be looked into before expanding the farming practices. Strong market supply chain and minimum support price need to be developed for making the open water cage farming a lucrative venture. Systems for intimating the environmental calamities and adverse climatic disasters well in advance need to be developed to avoid total loss for the farmers. Policies for crop insurance and other benefits for the farmers are required to safe guard the produce of the open water cage farmers.

Brief Communications

pH induced flocculation of microalgae, *Chaetoceros calcitrans*

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Microalgae are important in aquaculture as live feed and often the preferred food source, even if several alternatives like yeast and micro encapsulated feeds are available. Major genera of microalgae for larval

feeds include *Chaetoceros*, *Thalassiosera*, *Tetraselmis*, *Isochrysis* and *Nannochloropsis*. In "green water" feeding technique, microalgae are added as suspension and are grown simultaneously in tanks with fish larvae. The microalgae has several benefits such as positive effect on weight gain, improved resistance to disease and decreased nitrogen output into the environment. The mass culture of microalgae is a necessity for various mariculture operations in most hatcheries. However, the infrastructure requirements and the high costs involved for continuous production of the algal culture are major constraints. Recent developments reveal that fresh microalgae can be substituted with concentrated preserved algal mass for green water applications. Intensive cultivation for production of large quantities of microalgae biomass requires a proper harvesting technique. Flocculation as a method of microalgae harvest is comparatively more cost and energy efficient. Harvest by flocculation with pH adjustment for *Chaetoceros calcitrans* a small, fast-growing marine diatom used widely in aquaculture industries for culture of several marine filter feeders was successfully tested.

Axenic cultures of *Chaetoceros* was used for the flocculation study. Microalgae were cultivated in 3L Hauffkin flask with Guillard F/2 as culture medium at salinity of 30 ppt, under continuous day and night illumination by white fluorescent (2500 lux average). Cells were harvested at late logrithmatic growth phase (after 5days) and flocculation experiments performed with the adjustment of pH (8.4 – 11.9) using 5N NaOH. The pH varied from for the present study. The experiment was done in 500 ml beaker and the base was mixed to the culture at higher rate (200 rpm) by agitation using magnetic bar stirrer, to allow for steady increase and homogeneity in pH. When the required pH was reached, mixing was slowed (50 rpm) to allow for settling under gravity. Flocculation efficiency was estimated by measuring the optical density of the aliquot of the medium collected after 4 hours of flocculation. The optical density of the aliquot was measured using UV spectrophotometer (Biotech Epoch 2) at wave length of 750nm. The flocculation efficiency (%) was calculated using the formula,

$(1-B/A)*100$, where A is the optical density of the initial culture medium and B is the optical density of the sample, both at 750 nm.

Cell viability test was done using Evan's Blue stain with flocculated sample of 0.1ml diluted to 1ml and centrifuged for 5 minutes. The supernatant was discarded and 100 μl of 1% Evans blue stain was added to the pellet. The sample was incubated at normal temperature for 30 minutes after which pellets were washed and suspended in fresh filtered sea water. The cells were observed under the microscope ("Lynx" Lawrence & Mayo) and photographs taken. Broken cells appeared blue, as Evans Blue solution diffused into their protoplasm region and stained the cells blue.

Results indicated that when the pH was adjusted with 5N NaOH, the flocculation efficiency showed significant increase from an initial pH of 8.4 to the induced pH of upto 10.2 and then, it was reduced at pH of 10.3 and subsequently, became stationary upto pH of 11.9. The flocculation efficiency increased from 23% (8.4 pH) to 75% (10.2 pH). The sedimentation height also followed the same trend as that of flocculation efficiency. It varied from 0.035-0.053 mm / minute with the maximum recorded at pH of 11.9. The present study revealed that additional bases increased the precipitation and led to the formation of loose flocs. The Evans Blue staining confirmed that the cells are individually dispersed upto the induced pH of 10.2, without taking any stain, and hence the microalgal cells are intact with good viability and the culture can progress from the flocculated cells. In the cells flocculated with induced pH of 10.3 to 11.9, the cells were aggregated and the Evan's blue solution diffused into their protoplasm region and stained the cells blue in colour. It is therefore concluded that induced pH of 10.2 is optimum with better flocculation efficiency and sedimentation height for the harvesting of *Chaetoceros calcitrans* and that the microalgal culture is able to progress from the flocculated cells.

Demonstration and successful harvest of cage farmed marine fishes under NFDB scheme in Malabar, North Kerala

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Lates calcarifer, commonly known as seabass has been commercially cultivated in freshwater and brackish water ponds and marine cages, mostly in Southeast Asia. One of the most sought after table fish in Kerala it commands good market value. Hence imparting training and on-field demonstration of the scientific cage farming of marine fishes for encouraging the beneficiaries in adopting small-scale cage culture operations at Malabar, North Kerala was initiated. Under the ICAR-CMFRI-NFDB Direct Benefit Transfer (DBT) scheme on "Open water cage culture in selected Districts in Kerala and Karnataka" Calicut Regional Station of ICAR- CMFRI organised on-field demonstration and training on "Sea Cage Farming" for 50 fishermen beneficiaries at Atholi, Kozhikode (29-05-2019 to 31-05-2019) and Punjakkad, Kannur (07-08-2019 to 09-08-2019). As part of the NFDB Skill Development Programme, Hands-on training in cage fabrication and installation and lectures on site selection, species selection, feed management, disease management, stocking of fingerlings in cages and cage maintenance were delivered by resource persons from ICAR-CMFRI.

Following this, a total of 13 galavanized iron (GI) cages of 4×4 m with a depth of 3 m were installed at selected locations in January, 2020. It comprised 9 cages at Kavvayi backwaters of Kannur and 2 cages each in Malappuram

On-field practical demonstration on GI cage fabrication

GI cages installed at Punjakkad, Kannur

and Kozhikode districts. Under the scheme, women and SC beneficiaries were provided 60 % subsidy (approximately ₹148,000) and 40% subsidy (approximately ₹98,000) to the general category to meet the expenditure of cage culture operations. Thousand numbers of hatchery-produced seabass fingerlings and 200 pearl spot (*Etroplus suratensis*) fingerlings with an average initial size of 10 cm were stocked in the square GI cage during January 2020 and fed with low-value fishes during the culture period.

The outbreak of COVID-19 pandemic a few months later, created operational challenges for the 13 farmers. Among the 13 beneficiaries, only nine carried out the culture for the entire180 days as planned. Due to the COVID-19 lockdown, the farmers faced difficulties in feeding fishes due to scarcity of low value-fishes and the increase in the cost of the available low-value fishes. Six months culture recorded an average individual weight of 700-1450 g for seabass and 300-500g for pearl spot. Survival rate of 65% for seabass and 95% for pearl spot were observed in cages. The salinity recorded during the culture period ranged between 0 and 28 ppt. Seabass and pearl spot were sold at ₹600 and ₹550 per kg respectively. The harvested of seabass (260 kg) and pearl spot (40 kg) generated an income of ₹178,000. The culture carried out only for 4 months indicated about 80% survival of seabass and 90% survival of pearl spot stocked. The harvest of seabass (150 kg) and pearl spot (30 kg) generated an income of ₹ 1,06,500. During the lockdown, the farmed fish had a huge market demand due to restricted fishing activities and resulting scarcity of marine fish landings. Even though the harvest volumes were low, the cage culture carried out during the COVID 19 lockdown was a strong economic support to the farmers. These results indicate the prospects of mixed culture of seabass and pearlspot in cages in coastal waters of Kerala to meet the demand for food fish.

Women beneficiary feeding trash fish for seabass

A note on the gastropod fishery along Chennai coast

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Gastropods fishery has gained its importance due to the demand for edible molluscs and ornamental shells. Along Tamil Nadu coast gastropods are exploited from Gulf of Mannar, Poompuhar, Nagapattinam and Chennai and are sustaining many shell craft industries nearby. In Chennai Fisheries Harbour, ornamental gastropods except *Babylonia* spp. are mainly landed as by-catch along with other resources in the trawl landing. Gastropod shells are segregated from the trash landing and used for commercially for edible and ornamental purposes. *Babylonia* locally called as *Puramuttai* forms a targeted fishery along Chennai coast. They are being exploited in the Ennore to Thiruvanmyur area mainly by FRP boats (9-10 m length) with special type nets employed at 10m depth. The whelk trap consists of a net bag supported on an iron frame of circular shape (30cm diameter) locally called as *Kutchha*. The bag net is made up of 2 mm twine with mesh size of 16 to 20 mm and secured to the circular frame. Baits (generally dried carangids such as *Selar* and *Alepes* spp.) fastened to the net are used to attract *Babylonia* during the fishing operation. About 35 to 40 traps with bait are released in a row at intervals of 5 m distances. After laying all the traps along a line, the boat returns to first trap and starts hauling one by one. The traps are allowed to remain in seabed for 20 minutes before hauling. The whelk caught in traps are transferred to the basket and another set of traps are set again in the sea bottom, repeating the same procedure for 3 to 4 times a day. Nearly 4 to 6 boats go for Babylonia fishing on regular basis when sea is calm and start fishing during early hours of the day by 6am and continue till 2 pm. During favourable condition catch rate was observed to be around 40 to 100 kg per boat.

During 2016 to 2019 the landing of ornamental gastropod

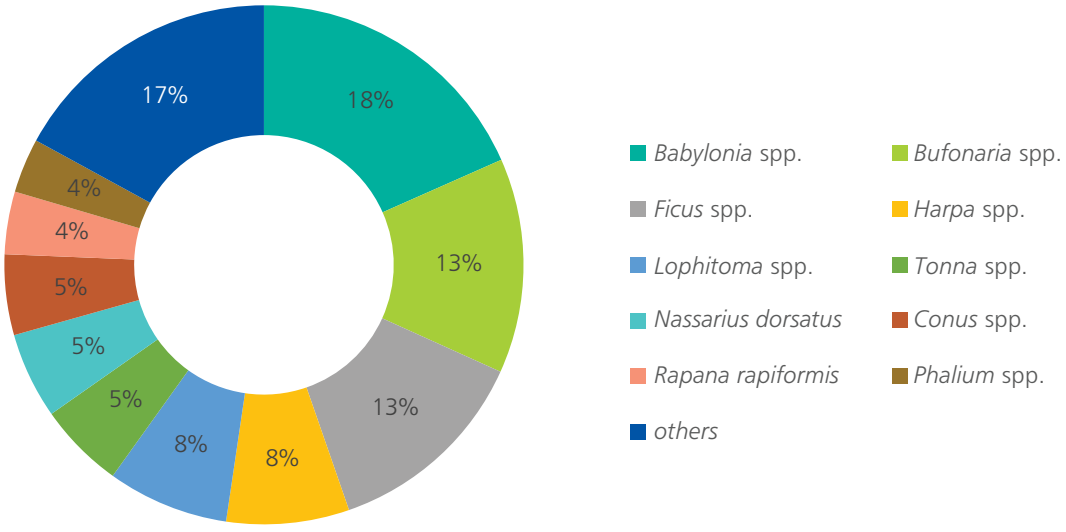

Fig.1. Species composition of gastropods in the trawl bycatch landed in Chennai

Table 1. Gasropod species landed as trawl by-catch at Chennai fisheries Harbour.

Family	species	Common name
Buccinidae	*Babylonia spirata* (Linnaeus, 1758)	Spiral babylon
	Babylonia zeylanica (Bruguière, 1789)	Indian babylon
Bursidae	*Bufonaria echinata* (Link, 1807)	Spiny frog shell
	Bufonaria rana (Linnaeus, 1758)	Common frog shell
	Bufonaria crumena (Lamarck, 1816)	Purse frog shell
Turritellidae	*Turritella* sp.	Screw shell
Ficidae	*Ficus* sp.	Fig shell
Conidae	*Conus* sp.	Cone shell
Muricidae	*Rapana rapiformis* (Born, 1778)	Rock snail
Nassariidae	*Nassarius dorsatus* (Röding, 1798)	dog whelks
Tonnidae	*Tonna dolium* (Linnaeus, 1758)	Spotted tun
Cassidae	*Phalium canaliculatum*	Gray bonnet
	Phalium glacum	helmet snails
	Phalium bisulcatum	Japanese bonnet
Melongenidae	*Volegalea* sp.	Spiral Melongena
Ranellidae	*Distorsio reticularis*	Reticulate distorsio
Harpidae	*Harpa* sp.	Harp snail
Turridae	*Unedogemmula indica* (Röding, 1798)	Indian Turrid
Turbinellidae	*Tudicla spirillus*	Spiral tubica
Aplustridae	*Hydatina zonata* (Lightfoot, 1786)	Paper bubble
Pisaniidae	*Canthras tranquibaricus*	Tranquebar goblet
Marginellidae	*Volvarina angustata*	Narrow marginella
Olividae	*Oliva* sp.	olive snails
Turbinellidae	*Turbinella pyrum*	Chanks
Muricidae	*Thais* sp	Rock shell
Cymatiidae	*Gyrineum natator*	Tuberculara Gyre Triton
Muricidae	*Murex* sp.	rock snails
Volutidae	*Melo melo*	Indian volute

has shown increasing trend with an estimated average landings of 32 t. The maximum landing was observed during 2019 (69 t) while the lowest was in 2017 (11 t). The fishery is comprised of about 30 species of gastropods and *Babylonia* spp. forms the major component (37%) of the total gastropod landing (Table1). The other species which are regularly landed in by catch in the trawl landings were *Ficus* spp., *Turittella* spp., *Tonna dolium*,*Nassarius dorsatu, Conus* spp., *Phalium* spp., *Rapana rapiformes*.

Gastropods along with trawl by catch landed in Kasimedu Fisheries Harbour are segregated from the trash landing and sold to the local agent for further processing before marketing. Whelk landing from the FRP boats are similarly sold to local agents who are involved in whelk exports supply chain. Whelks collected from other districts of Tamil Nadu and other maritime states are also being transported to the Kasimedu as there is a huge demand for *Babylonia* in counties like China, Hongkong and Thailand. They are traded under the name "Baigai". The whelks are washed and placed in perforated trays and depurated by immersing for 3 hours in tanks containing clean seawater. After this , they are transferred to cleaning drums with chilled water with aeration for 20 minutes and then placed in thermocol boxes and sealed. These are exported from India as chilled whelk. The trend of whelk exported from Chennai port during 2008 to 2018 indicated maximum volumes during 2009-10 (Q: 2,299 t, V: 2,127.36 Lakh ₹) and minimum (Q:593 t , V:1108.78 Lakh ₹) during 2015-16 (Source: MPEDA). The quantity of whelk exported has declined over the years. About 40% of country's export of *Babylonia* were from Chennai port while 93% of whelk exported from Tamil Nadu

Gleaning seagrass meadows of Gulf of Mannar for ornamental seashells and its ecological impacts

Seagrass meadows harbour plenty of molluscan shells and Mandapam in the Gulf of Mannar is well known site for seashell collection. Ornamental shells like milky white *Tellina angulata*, Paper shell (*Arca* sp. and *Cardium* sp.) are collected from several locations in the local seagrass meadows. In the earlier days, seashells were collected from the surf zones and beach sand by sieving sand using hand-made circular sieves and was used as food (shellfish meat), construction (shell lime) and also for making shell ornamentals. Shell collection through wooden dredge is deployed presently. A triangular-wooden dredge fitted on a 3 m long wooden pole and a net bag of 5 mm mesh size at the bottom called *Mutharipan kacha* by locals is operated manually during low tides. By moving the dredge perpendicular to the coast over a seagrass meadow, from shallow depths to the shore, shells and other organisms encountered are collected. Using this dredge one person can mow up to 0.8 km within two hours, and 5-7% of catch can be seagrass shoots. Recently there has been a shift to use of motorized metal dredge as the quantity of shells collected through the manually-operated wooden dredge is very low while the demand for ornamental shells are ever increasing. Though the shape and function of this dredge is similar to the wooden dredge, the base made of hard metal bar (approximately 8 kg), is operated on motorized canoes from either sides. This gear can cover a distance of one km in 10- 15 minutes resulting in higher damage to seagrass meadows by uprooting the grass and often damaging the substratum. Meiobenthic sedentary organisms, eggs and larvae of commercially important marine resources are also found damaged and displaced from the seagrass beds through this destructive operation for a paltry income of ₹140 per kg of shells (Figs. 1-2).

This undesirable gear is popular among the fishers who are unaware of the significance of seagrass meadows and their ecosystem services. Instead of employing dredges and other gears for shell collection, reef gleaning without disturbing the seagrass ecosystem may be encouraged. The State Department of Fisheries should check the indiscriminate use of these gears and also create awareness among the fishers on the importance of existence of seagrass meadows in general and the harmful effects of current ornamental shell mining methods.

(Reported by: P. Kaladharan*, R. Jeyabaskaran and S. Kanmaniraji | ICAR-Central Marine Fisheries Research Institute, Kochi-682 018, Kerala)

Fig. 1 Metal dredges used for ornamental shell fishing

Fig. 2. Shells sorted from the catch

Semiya Paasi is not seaweed but a bryozoan

Bryozoans found in marine environments are commonly called sea mats, moss animals or lace corals and are found from the intertidal zone to some of the deepest parts of the ocean. There are about 6,500 recognized living species worldwide and about 257 species have been documented from India forming 4 percent of the total global bryozoans' diversity. Thirty species of bryozoans belonging to 19 families have been documented from the Gulf of Mannar. They reproduce by budding new parts asexually and these new additions which contain functioning individuals called 'zooid' are attached to the parent but capable of feeding independently.

Entangled biomass of *Semiya Paasi* and a close-up view of *A.verticillata*

During the regular survey in July 2020 along the Palk Bay coast on shore seine landings at Dhargavalasai in Ramanathapuram district of Tamil Nadu, a seaweed like entangled mass was collected from the fishing nets. Local fishermen called it '*Semiya Paasi*' means a vermicelli like seaweed. The sample were brought to the laboratory and identified as bryozoan *Amathia verticillata* (della Chiaje, 1822). Formerly known as *Zoobotryon verticillatum,* it is typical of many ctenosome bryozoa on account of colony size and colour. It has irregular tripartite branching and a propensity to tangle once removed from the water. *A. verticillata* attaches to a wide range of substrata apart from natural surfaces including quay walls and boat hulls. In the present case, *A. verticillata* was discarded by fishermen in heaps from the shoreseine operations and its invasive nature needs further study in this region. Globally, some potentially exciting pharmaceutical applications of bryozoans have been reported, in particular the bioactive compounds such as bryostatin-1 and janolusimide B which have a range of anti-cancer, anti-fouling and anti-fungal properties.

(Reported by R. Saravanan*, I. Syed Sadiq and K. K. Joshi | Mandapam Regional Centre of ICAR-CMFRI)

A case of encysted endoparasitic copepods in the Spiny cheek grouper

During the routine biological investigations on *Epinephelus diacanthus* (Spiny cheek grouper), a fish with a pair of cysts attached to the abdominal musculature was observed. The cysts were oval, thin-walled, dark grey coloured, measured approximately 3 cm in diameter, and located adjacent to each other. The cysts were firmly attached to the abdominal musculature and contained black cystic fluid. Microscopic examination of the wet impressions of the cystic fluid revealed the presence of large numbers of nauplii of copepods. Histopathologically, the cystic wall consisted of fibro-collagenous and adipose tissue. The copepods were found attached to the walls of the cyst. Preliminary studies involving amplification of a 1000 bp region of internal transcribed spacer-2 of rRNA indicated the resemblance of observed copepods to *Tigriopus* sp. While the occurrence of copepod parasites in fish is common, reports on endoparasitic copepods are rare and this is the first report from Indian waters. The cysts usually will be visible only when fish are filleted. The encysted parasitic copepods may not be harmful to fish, but they may adversely affect consumer preference and lead to fillet rejections.

(Reported by: S. R. Krupesha Sharma*, Rekha J. Nair, T. G. Sumithra, Aswathy Joshy, Reynold Peter and B. Santhosh | ICAR-Central Marine Fisheries Research Institute, Kochi-682 018)

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