NO. 251, January - March 2022 ISSN 0254-380X

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Marine Fisheries Information Service Technical & Extension Series

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No. 251, January–March, 2022
ISSN 0254-380X

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Marine Fisheries Information Service Technical & Extension Series

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Marine Fisheries Information Service
Technical & Extension Series

Mar. Fish. Infor. Serv., T & E Ser., No. 251, 2022

Published by

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

Seaweed harvested through raft culture

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From the Editorial Board

Warm greetings to all our esteemed readers

Seaweeds are a valuable trade commodity which finds use in food processing, pharmaceutical and wellness sectors, due to the products such as agar, algin and carrageenan that can be extracted from them. Reports from FAO suggest that global trade in seaweed and related products is expected to be around 26 million US$ by 2025. Considering the potential for seaweed farming in India, the Union Government has promoted farming, training and creation of infrastructure for the same through the Pradhan Mantri Matsya Sampada Yojana. The two articles on seaweeds presented in this issue of MFIS report significant findings during the lab and field experiments related to seaweed culture. Other articles included are that of batoid diversity in the elasmobranch landings that document important observations of this diverse and little documented group from Indian EEZ, as well as notes on dealing with fish health, marine biodiversity and other interesting information collected by the researchers.

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Note on some Batoid fishes (Elasmobranchii: Rhinidae, Rhynchobatidae, Rhinobatidae, Glaucostegidae and Dasyatidae) from the southeastern Arabian Sea

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Abstract

Batoid fishes representing families Rhinidae, Rhinobatidae, Glaucostegidae (Order: Rhinopristiformes) and Dasyatidae (Myliobatiformes), with limited information available from southeastern Arabian Sea off Karnataka coast are described. The distribution of five Rhino rays *viz., Rhynchobatus australiae*, *Rhynchobatus laevis*, *Rhinobatos punctifer*, *Glaucostegus granulatus, Rhinobatos lionotus* and twelve sting rays such as *Himantura leoparda, Himantura undulata, Himantura tutul, Maculabatis arabica, Neotrygon indica, Pastinachus ater, Pastinachus gracilicaudus*, *Pteroplatytrygon violacea, Pateobatis fai*, *Pateobatis bleekeri, Taeniurops meyeni* and *Urogymnus asperrimus* is reported. Further, based on spotting patterns recorded on dorsal surface and contour of ocellae, five morphotypes of *Himantura leoparda,* and two of *Himantura tutul* are illustrated. Observations on six species (*Rhinobatos punctifer, Rhinobatos lionotus, Himantura undulata, Himantura tutul, Neotrygon indica and Pastinachus gracilicaudus*) is given.

***Key words**: Batoid fishes, Wedgefish, Guitarfish, Stingrays, Arabian Sea, India*

Introduction

Chondrichthyes, which includes batoids (648), sharks (511) and chimaeras (49), represent *c.* 3.5% of the modern fish fauna across the globe (Weigmann, 2016). Elasmobranchs are characterized by a life-history of long life span, slow growth, late maturity and low fecundity, making them highly vulnerable in the marine ecosystem. Dulvy *et al*., 2014 reported that of 1041 species of global elasmobranchs assessed, ~17% of shark and ray species remain listed as Critically Endangered, Endangered and Vulnerable, 13% as Near Threatened, 47% as Data Deficient and 23% as Least Concern categories of the IUCN's Red List of Threatened Species. In Karnataka, elasmobranchs are mostly landed as incidental or as by-catch in multiday trawlers, tuna long liners, seines and gillnetters. Fishing in the rocky patches of seamount areas off Karnataka coast has resulted in landings of many lesser-known fishes in the region. These seamount areas vary in size and occur from 43 to 2300 m depth. The operational range of fishing along Karnataka coast in the seamount area is 43-200 m. The use of novel fishing methods with large meshed knotted monofilament gillnets and hooks & lines deployed from mechanized trawlers in recent years in these rocky patches and reefs along Karnataka coast resulted in landings of several rare and poorly known species (Rohit *et al*., 2021). The present study describes some of the batoid species which were, hitherto, poorly known from the southeastern

Arabian Sea off Karnataka, and which were recorded on various occasions during 2019-2021 period.

Methodology

Samples were collected from landings of trawl net, hook & line, tuna longlines, seine and gill nets at Mangaluru (12° 51' 10.8" N, 74° 49' 58.8" E) and Malpe (13° 20' 49.2" N, 74° 42' 3.6" E) fisheries harbours in Karnataka, during 2019-2021. Weekly samplings undertaken at Mangaluru and Malpe Fisheries Harbours, between 05:00 and 10:00 Indian Standard Time (UTC+5.30). All specimens were identified following Last *et al*. (2016) and Kizhakudan *et al*. (2018). Morphological measurements (disc width (DW) for batoids and total length (TL) (for Wedgefish & Guitarfish) were taken to the nearest mm, and sex and maturity stages were recorded.

Species composition

Poorly known batoids of seventeen described species, representing four families and eleven genera were examined. Details of species composition, and male and female size ranges are presented in Table 1. Overall, the most abundant species in landings by number were *Pteroplatytrygon violacea* (24%) followed by *Neotrygon indica* (~18%), *Maculabatis arabica* & *Pateobatis bleekeri* (10.2% each), *Pateobatis fai* (~9.0%) and *Rhynchobatus australiae* & *Urogymnus asperrimus* (6.2% each), comprising 82% of specimens recorded. The remaining species each accounted between 0.9% and 2.7% (Fig.1).

Rhynchobatus australiae (Bottlenose wedgefish) (Fig. 2A)

Five males (94.2 –140 cm TL) and two females (119.5 –178 cm TL) of Bottlenose wedgefish, *R. australiae* were recorded at Malpe Fisheries Harbour, Karnataka, India *R. australiae* is large sized wedgefish with bottle-shaped snout and attains 300 cm TL. *The IUCN Red List of Threatened Species* assessed the species as Critically Endangered (CR).

Rhynchobatus laevis (Smoothnose wedgefish) (Fig. 2B)

A female specimen of *Rhynchobatus laevis* of 270 cm TL was recorded at the Mangaluru Fisheries Harbour. The specimen was landed by trawl net, operating over sandy bottom in <35 m water depth. *Rhynchobatus laevis* is clearly identifiable based on the prominent black spot on each pectoral fin surrounded by 4-5 white spots (Fig. 3), spiracle with two skin folds, outer slightly larger than inner, pre-dorsal spot pattern not reaching to midline between pectoral marking and attains 300 cm TL. *The IUCN Red List of Threatened Species* assessed the species as Critically Endangered (CR).

Rhinobatos punctifer (Spotted guitarfish) (Fig. 2C)

The spotted guitarfish was recorded for the first time from Mangaluru and Malpe Fisheries Harbours, with observation of two males (69.0 –71.0 cm TL) and two females (91– 108 cm TL). The maximum size reported in the literature was 90.0 cm TL. The present study recorded the maximum length of 108 cm TL. *The IUCN Red List of Threatened Species* assessed the species as Near Threatened (NT).

Rhinobatos lionotus (Smoothback guitarfish) (Fig. 2D)

A female Smoothback Guitarfish, *Rhinobatos lionotus* of 105 cm TL was recorded at the Malpe Fisheries Harbour. The maximum size reported in the literature was 85.0 cm TL while the present study recorded 108 cm TL. Previously, the Smoothback guitarfish distribution was reported from the Bay of Bengal, east coast of India. The specimen reported here has

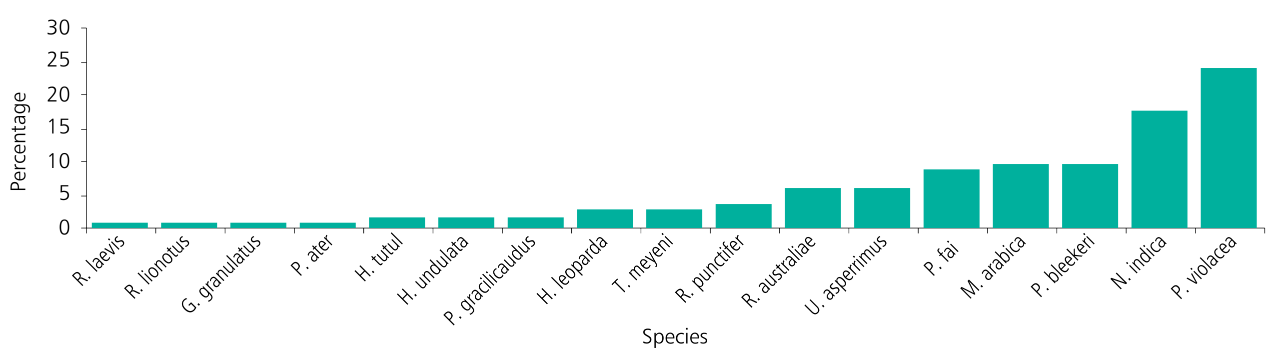

Fig. 1. Species abundance of batoids landed off Karnataka Coast, India.

Table 1. Summary of batoids recorded in Mangaluru and Malpe fish landing centres, Karnataka, India in 2019-2021. Size measurements are total length (TL) for wedgefish & guitarfish, and disc width (DW) for non-guitarfish batoids. 'n/a' denotes that calculations were 'not applicable' due to low sample sizes.

Order	Family	Species Identity	Common name	Size range (cm) (Mean+SD)	Depth distribution	Remarks
Rhinopristiformes	Wedgefishes Family: Rhinidae	*Rhynchobatus australiae* Whitley, 1939	Bottlenose wedgefish	94.2 –140 (119+22.0) (♂), 119.5 –178 (♀) n/a	coastal inshore to a depth of 60 m or more (Last *et al*., 2016)	Found in the Western Indian Ocean (WIO) off Karnataka, India. It was caught at 10-40 m depth in Multiday trawler.
		Rhynchobatus laevis (Bloch & Schneider, 1801)	Smoothnose wedgefish	270 (♂), n/a	0–60 m (Weigmann, 2016), 2-50 m Purushottama *et al*., 2020	Found in the WIO off Karnataka, India for the first time in our observation and caught at 35 m depth in Multiday trawler.
		Rhinobatos punctifer Compagno & Randall, 1987	Spotted guitarfish	69 –71 (♂) n/a, 91–108 (♀) n/a	Demersal inshore on continental shelf to 70 m depth (Last *et al*., 2016)	Observed for the first time in the WIO off Karnataka, India. Till now the distribution range was not included from the Arabian Sea in any literature. It was caught at 20-25 m depth in trawler.
		Rhinobatos lionotus Norman, 192	Smoothback guitarfish	105 (♀) n/a	Demersal inshore on the continental shelf to at least 70 m (Last *et al*., 2016)	Found in the Eastern Indian Ocean (EIO) (Bay of Bengal) in east coast of India, it was observed in Arabian Sea for the first time. It was caught in near shore area of sandy bottom at 10-20 m depth by using the single day trawler.
		Glaucostegus granulatus (Cuvier, 1829)	Sharpnose guitarfish	107 (♀) n/a	Coastal to mid-continental shelf, to at least 120 m depth (Last *et al*., 2016)	Although the species was distributed in the EIO and the WIO, it was collected for the first time in Karnataka, India. It was caught in gillnet, which was operated at 30-35 m depth in rocky area in eastern Arabian Sea.
Myliobatiformes		*Himantura leoparda* Manjaji-Matsumoto & Last, 2008	Leopard whipray	126 (♂) n/a, 161.2 – 170 (♀) n/a	Demersal inshore on continental and insular shelves, on soft substrates to at least 70 m depth (Last *et al*., 2016).	Out of four species complex, it is reported in the WIO off Karnataka, India for the first time. It was caught in Multiday trawler at 15-35 m depth.
		Himantura tutul Borsa, Durand, Shen, Alyza, Solihin & Berrebi, 2013	Fine-spotted leopard whipray	124 (♂) n/a, 120 (♀) n/a		First time found in the WIO off Karnataka, India in trawler at >25 m depth and in ring seine (12 m).
		Himantura undulata (Bleeker, 1852)	Honeycomb whipray	121 (♂) n/a, 146 (♀) n/a	—	Found in the WIO Off Karnataka, India. Now, the latitudinal distribution range extended from east coast to west coast of India. It was caught in the multiday trawler from the depth of 40-50 m.
		Maculabatis arabica Manjaji-Matsumoto & Last, 2016	Arabic whipray	17.5 –53.0 (47.0+17.0 cm DW) (♂), 54.3–70.0 (61.0+8.0 cm DW) (♀)	15 – 29 m (Last *et al*., 2016)	Found in the WIO Off Karnataka, India. It was caught in the multiday trawler and gillnet at 0-30 m depth.
		Neotrygon indica Pavan-Kumar, Kumar, Pitale, Shen & Borsa, 2018	Blue-spotted stingray	17.5 – 53 (29.0+8.0 cm DW) (♂), 22 -32.0 (28.0+4.0 cm DW) (♀)	0 – 170 m (Weigmann, 2011)	Earlier *Neotrygon kuhlii*, Pavankumar *et al*., 2018 described the new species as *Neotrygon indica* from Bay of Bengal. Now, the latitudinal distribution range extended to Arabian Sea.

Order	Family	Species Identity	Common name	Size range (cm) (Mean+SD)	Depth distribution	Remarks
		Pastinachus ater (Macleay, 1883)	Broad cowtail ray	70 (♂) n/a	Demersal on continental and insular shelves (Last *et al*., 2016)	Found in the EIO and the WIO, off Karnataka, India. It was caught in single day trawler at 20-25 m depth.
		Pastinachus gracilicaudus Last & Manjaji-Matsumoto, 2010	Narrowtail ray	38.5– 70.0 (♂) n/a, 54.3 (♀) n/a	Demersal inshore on continental insular shelves (Last *et al*., 2016)	The distribution range from EIO and WIO was unknown. Now, it was caught in gillnet and single day trawlers off Karnataka, India at 0-25 m depth.
		Pteroplatytrygon violacea (Bonaparte, 1832)	Pelagic stingray	41.0 –63.5 (48.0+7.0) (♂), 32.0 – 77.0 (♀) n/a	1 – 381 (Mundy, 2005)	Earlier this species was reported from Arabian Sea (6°-22° N), Bay of Bengal (10-19° N) and Andaman and Nicobar waters (5°-14° N)(Somavanshi *et al*., 2009, Purushottama *et al*., 2018). It was caught in deep sea multiday trawlers at 50 m depth off Karnataka, India in Arabian Sea.
		Pateobatis fai (Jordan & Seale, 1906)	Pink whipray	86.5 –115 (♂) n/a, 72.0 – 136 (92.0+21.0) (♀)	Nearshore to at least 70 m depths (Last *et al*., 2016), 0-200 m (Fricke *et al*., 2011)	The distribution range from EIO (Bay of Bengal) and the WIO off Karnataka, Goa and Maharashtra is confirmed from the present study. It was caught in multiday trawler, gillnets at 70-100 m depth.
		Pateobatis bleekeri (Blyth, 1860)	Bleeker's whipray	41.2 –88.0 (63.0+17.0) (♂), 18.0 –89.0 (60.0+28.0) (♀)	depths of at least 40 m (Last *et al*., 2016)	The present study recorded the species off Karnataka, India at 40-70 m depth in trawler and gillnet.
		Taeniurops meyeni (Müller & Henle, 1841)	Blotched stingray	41.0 (♂) n/a , 41.0 –148.5 (♀) n/a,	Mainly inshore but reported from more than 400 m depth (Last *et al*., 2016)	Although the distribution is confirmed in the EIO and WIO, this species was landed for the first time in Karnataka, India. It was caught in multiday trawler at 100-200 m depth.
		Urogymnus asperrimus (Bloch & Schneider, 1801)	Porcupine whipray	94-116 (♂)n/a, 84-95 (♀) n/a	15 – 217 m (Fricke *et al*., 2011)	Even though found in the EIO and the WIO fishing areas. The species was caught from sandy and rocky areas of 15-100 m depth in ring seine and gillnet in Karnataka.

indicated occurrence of this species in the Arabian Sea on west coast of India as well. *The IUCN Red List of Threatened Species* assessed the species as Data Deficient (DD).

Glaucostegus granulatus (Sharpnose guitarfish) (Fig. 2E)

Granulated/Sharpnose Guitarfish, *Glaucostegus granulatus* female of 107 cm TL was recorded at the Mangaluru Fisheries Harbour. The specimen was landed by gillnet, which operated between 30 and 35 m depth in rocky area in the eastern Arabian Sea. The maximum size reported for the species globally was 229 –230 cm TL. However, the maximum size of 250.5 cm TL was observed in West Bengal, east coast of India (Swatipriyanka Sen, *Pers. comm.*). Also, the occurrence indicates the presence of this species along west coast of India.

Himantura leoparda (Leopard whiprays) (Fig. 2F a, b, c, d & e).

Himantura uarnak species complex comprised of at least four species: *H. uarnak, H. undulata*, *H. tutul, and H. leoparda.* A male of 126 cm DW and two females of 161.2 –170 cm DW were recorded from Malpe Fisheries Harbour. The specimens were caught in gillnets and trawlers, at a depth range of 15- 35 m. The maximum size reported globally was 140 cm DW but in the present study sizes up to 170 cm DW was recorded. Distribution is currently confirmed only from the Arabian Sea, west coast of India. *H. leoparda* is a large and uncommon whipray species of conservation concern and *The IUCN Red List of Threatened Species* assessed the species as Vulnerable (VU).

Himantura tutul (Fine-spotted leopard whipray) (Fig. 2Ga & b)

Male and female specimens in length range of 120-124 cm DW were landed by trawlers, ring seine and gillnetters operating at depth range of 12-25 m. The Malay word 'tutul' means 'spotted', referring to leopard-like markings on the dorsal surface of large specimens. The maximum size reported globally was 115 cm DW and the present reported specimen had size of 124 cm DW. Distribution is currently confirmed only from the Arabian Sea, west coast of India. *The IUCN Red List of Threatened Species* assessed the species as Not Evaluated (NE).

Himantura undulata (Honeycomb whipray) (Fig. 2H)

Male and female specimens measuring 121cm DW and 146 cm DW were landed at Mangaluru Fisheries Harbour by trawlers operating at depth range of 40-50m. The maximum size reported globally was 150 cm DW. The present observation confirmed the distribution in the Arabian Sea. *The IUCN Red List of Threatened Species* assessed the species as Endangered (EN).

Maculabatis arabica (Arabic whipray) (Fig. 2Ia)

Seven males [21.0 –68 cm DW (47.0+17.0 cm DW)] and three females (54.3–70.0 cm DW (61.0+8.0 cm DW)] were recorded at Malpe Fisheries Harbour. Further, juvenile of *M. arabica* was landed in cast nets (having 13.0 mm mesh size and measuring 5.0 m length and 17.0 m circumfrence). Characteristic whip-like tail, without skin folds and banded in young ones (Fig. 2Ib) was recorded. The maximum size reported globally was 61.0 cm DW. The present study confirmed the distribution of the species from the Arabian Sea, south-west coast of India. *The IUCN Red List of Threatened Species* assessed the species as Critically Endangered (CR).

Neotrygon indica (Indian Ocean blue-spotted maskray) (Fig. 2J)

Thirteen males [17.5 –53.0 cm DW (29.0+8.0 cm DW)] and seven females (23.0–32.0 cm DW (28.0+4.0 cm DW)] were recorded at Malpe Fisheries Harbour. The depth of operation was around 120-150 m in the north-west coast direction in the Arabian Sea. Specimens ≥ 30 cm DW were observed to be mature. Earlier, the same species was referred as "*Neotrygon kuhlii*". However, it is currently known as *Neotrygon indica after* confirmation by molecular taxonomy (Pawan-Kumar *et al*., 2018*). The IUCN Red List of Threatened Species* assessed the species as Not Evaluated (NE).

Pastinachus ater (Broad cowtail ray) (Fig. 2K)

A male measuring 70 cm DW was recorded at the Malpe Fisheries Harbour. The specimen was landed by the trawl net, which was operated at 20- 25 m depth, in sandy bottom. The maximum size reported globally was 200 cm DW. The present study confirms the distribution from the Arabian Sea, south-west coast of India. *The IUCN Red List of Threatened Species* assessed the species as Vulnerable (VU).

Pastinachus gracilicaudus (Narrowtail stingray) (Fig. 2L)

Two specimens a males and a female measuring 38.5-70 cm DW and 54.3 cm DW, respectively, were recorded at both landing center. These specimens were landed by trawl nets and gillnets operated at <25 m depth. *The IUCN Red List of Threatened Species* assessed the species as Endangered (EN).

Pteroplatytrygon violacea (Pelagic stingray) (Fig. 2M)

Eight males [41.0 –63.5 cm DW (48.0+7.0 cm DW)] and nineteen females (32.0–68.0 cm DW (50.0+11.0 cm DW)] were observed in the landings. These specimens were landed by the trawl nets, which operated between 100-150 m depth. The maximum size reported globally was 80 cm DW. The occurrence of pelagic stingrays has been previously reported from Arabian Sea (6°-22° N), Bay of Bengal (10°-19° N), Andaman and Nicobar waters (5°-14° N) and Maharashtra in India. *The IUCN Red List of Threatened Species* assessed the species as Least Concern (LC).

Pateobatis fai (Pink whipray) (Fig. 2N)

Three males (86.5 –115 cm DW) and seven females (22.0–136.0 cm DW (92.0+21.0 cm DW)] were recorded during the period. These specimens were caught in the trawl net, which operated at 100-150 m depth. The

2A. *Rhynchobatus australiae*

2B. *Rhynchobatus laevis*

2C. *Rhinobatos punctifer*

2D. *Rhinobatos lionotus*

2E. *Glaucostegus granulatus*

2Fa. *Himantura leoparda*

2Fb. *Himantura leoparda*

2Fc. *Himantura leoparda*

2Fd. *Himantura leoparda*

2Fe. *Himantura leoparda*

2Ga. *Himantura tutul*

2Gb. *Himantura tutul*

2H. *Himantura undulata*

2Ia. *Maculabatis arabica*

2Ib. *Maculabatis arabica* (juvenile)

2J. *Neotrygon indica*

2K. *Pastinachus ater*

2L. *Pastinachus gracilicaudus*

2M. *Pteroplatytrygon violacea*

2N. *Pateobatis fai*

2O. *Pateobatis bleekeri*

2P. *Taeniurops meyeni*

2Q. *Urogymnus asperrimus*

Fig. 2, The sampled species pictures of batoid fishes in eastern Arabian Sea. (A) *Rhynchobatus australiae*, (B) *Rhynchobatus laevis*, (C) *Rhinobatos punctifer*, (D) *Rhinobatos lionotus*, (E) *Glaucostegus granulatus,* (F: a, b, c, d & e) *Himantura leoparda*, (Ga & b) *Himantura tutul*, (H) *Himantura undulata*, (Ia &b) *Maculabatis arabica*, (J) *Neotrygon indica*, (K) *Pastinachus ater*, (L) *Pastinachus gracilicaudus,* (M) *Pteroplatytrygon violacea*, (N) *Pateobatis fai*, (O) *Pateobatis bleekeri*, (P) *Taeniurops meyeni* and (Q) *Urogymnus asperrimus*.

Fig. 3. Pectoral spot forms in *Rhynchobatus laevis*. A) Juvenile, B) Adult.

maximum size reported globally was 146 cm DW. *The IUCN Red List of Threatened Species* assessed the species as Vulnerable (VU).

Pateobatis bleekeri (Bleeker's whipray) (Fig. 2O)

Five males [41.2 –88.0 cm DW (63.0+17.0 cm DW)] and six females [18.0 –89.0 cm DW (60.0+28.0 cm DW)] were recorded during the period from trawlers and gillnetters operating at depth range of 40-70 m. The maximum size reported globally was 119 cm DW. *The IUCN Red List of Threatened Species* assessed the species as Endangered (EN).

Taeniurops meyeni (Round ribbontail ray) (Fig. 2P)

A single male measuring 41.0 cm DW and two females (41.0 cm DW & 148.5 cm DW) were observed in the landing centers. These specimens were landed by trawl nets operated between 100-200 m depth. The maximum size reported globally was 180 cm DW. *The IUCN Red List of Threatened Species* assessed the species as Vulnerable (VU).

Urogymnus asperrimus (Porcupine whipray) (Fig. 2Q)

Three males (94-116 cm DW) and four females (84-95 cm DW) were recorded at Malpe. These specimens were caught off the north west side of the St. Mary's Island using seine or encircling nets operated between15-20 meters depths at a the distance of ~20-25 km from the coast and in other occasion these were caught in the gillnet, which were operated at <100 m depth (sea mount areas). This species is rarely landed in Karnataka and local fishermen have informed that this species strays into estuarine waters occasionally. The maximum size reported globally was 115 cm DW but our investigation has reported a DW of 116 cm. This is protected under the Indian wildlife (Protection) Act, 1972.*The IUCN Red List of Threatened Species* assessed the species as Vulnerable (VU).

The present study describes the occurrence of many batoid species with scantly reports/publications during a literature review from the region. The species were identified using classical taxonomy relying on morphometrics. However, molecular taxonomy has been initiated to elucidate the ambiguities among the cryptic species. The reason for the sudden emergence in these species in considerable quantity could be due to the changes in the fishing pattern involving monofilament nets which are operated in almost all the rocky regions including the seamount areas which were otherwise not exploited by the regular trawlers.

Acknowledgement

We thank the fishers and traders who supported data collection along Karnataka coast. The authors thank Ms. Rithu J. Koshy for editing the images of batoid fishes presented in this manuscript.

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A pilot study on the growth performance of red seaweed, *Gracilaria corticata* in different salinities

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ABSTRACT

Gracilaria, the third largest genus in the red algal group Rhodophyta is a diverse genus with cercial significance for agar production. Present work was carried out under controlled indoor conditions, to determine the optimal salinity requirement for *G. corticata*. Raft culture in plastic crates using different salinity levels was employed. The vegetative thalli of *G. corticata* were collected from the intertidal region during low tide from Thikkodi, Kozhikode. Ten polypropylene ropes were tied parallel at 10 cm intervals on the plastic rafts and introduced into the rectangular plastic crates of 60 x 40 x 30 cm^3. About 100 g of *G. corticata* were used as seeding material on rafts and are introduced to different salinities viz 5, 10, 15, 20, 25, 30 and 35 ppt in triplicates for 30 days. Thalli growth was recorded the fastest in crates containing full strength seawater (35 ppt) and successively slower in crates with lower salinities. After 30 days of culture period, mean weight of seaweed harvested from each treatment was 108±8.5 g (20 ppt), 155±12.5 g (25 ppt), 156±10.2 g (30 ppt) and 160±12.8g (35 ppt). The results indicated that *G. corticata* can be cultured using raft method at salinity above 25 ppt. The reduction in the level of nutrients like ammonia, silicate and phosphate in the culture system indicated that the nutrients were utilized by *G. corticata* for their growth. Future studies with *G. corticata* in field trials in integrated multi-trophic aquaculture (IMTA) would prove its feasibility in nutrient load reduction in the estuarine as well as coastal waters.

***Keywords**: Red seaweed, Gracilaria corticata, salinity, raft culture*

Gracilaria corticata is one of the commercially important red seaweed available in India in the marine environment and it is widely present in the estuarine waters of Kozhikode. *G. corticata* has applications in industrial and biotechnology sectors due to the presence of important constituents like α-(1,4)-3,6-anhydro-l-galactose and β-(1,3)-d-galactose which is one of the main component of agar. *Gracilaria* spp. was once considered unsuitable for agar production due to their low gel strength but later it was observed that pre-treatment with alkali prior to extraction produced agar with higher gel strength. This innovation resulted in harvesting a variety of wild species of *Gracilaria* in Chile, Argentina, Indonesia and Namibia. Experiments on cultivation of various species like *G. asiatica* (stake-net culture), *G. sjoestedtii*, *G. lichenoides* (pond culture), *G. tenuistipitata* (raft culture), *G. domingensis* (stake-rope culture), *G. vermiculophyla* (IMTA tanks), have been successfully attempted in many countries.

The estuarine waters of Kozhikode, Kerala on the west coast of India has a wide range of seaweed diversity and *G. corticata* is one of the dominant species present. The present work was carried out to determine the optimal salinity requirement for *G. corticata* in raft culture in plastic crates under controlled indoor conditions in different salinity levels. The vegetative thalli of *G. corticata* were collected from the intertidal region during low tide from Thikkodi and cleaned with a brush and tissue paper to remove the epiphytes and other attached

Gracilaria corticata

G. corticata in plastic crates maintained in different salinities

Bleaching observed in 5-15 ppt salinity

Bleaching and algal infestation observed in 5 ppt salinity

Bleaching and algal infestation observed in 10 ppt salinity

Bleaching observed in 15 ppt salinity

organisms/dirt. The trials were carried out in rectangular plastic crates of 60 x 40 x 30 cm^3. PVC pipes of 0.5 inch diameter were used for fabricating these rectangular rafts. Ten polypropylene ropes were tied parallel at 10 cm intervals on these rafts and introduced into the plastic crates (Plate 2). The 50 L plastic crates were filled with 20 L sterile seawater. Salinities tested were 5, 10, 15, 20, 25, 30 and 35 ppt that were chosen to mimic the natural conditions that the seaweed would experience in the natural habitat. Fronds of *G. corticata* weighing 100 g were used as seeding material on rafts. The trials were carried out in triplicates for 30 days by providing a photoperiod of 12:12 (L: D) with continuous aeration using air pumps. The culture crates were also stocked with a known quantity (100 g) of seaweed for determining colour, growth, *etc*.

While natural seawater contains many of the necessary trace elements needed for seaweed culture, the quality and amount of nutrients can be variable and insufficient during the indoor culture. Therefore the sterilized seawater

Growth observed in 20 ppt salinity

Growth observed in 25 ppt salinity

Growth observed in 30 ppt salinity

Growth observed in 35 ppt salinity

was enriched with a concentrated nutrient solution (ammonium sulphate-1.0 gm, urea-0.5 gm, single super phosphate-0.5 gm) once in weekly basis.

Water quality parameters (pH, salinity, temperature, dissolve oxygen, ammonia, phosphate and silicate) of culture water were determined every seven days along with growth measurements during the culture period. The growth measurements were recorded after draining the crates, removing all the dead material and blotting dry the thalli. Gross weight of the seaweed in each crate was also determined. Water was completely replaced during the time of growth measurements at weekly intervals. Before refilling the crates, it was scrub cleaned using fresh water, rinsed thoroughly and filled with water of appropriate salinity.

Fastest thalli growth was recorded in crates containing full strength seawater (35 ppt) and successively slowed down in crates with lower salinities. The low salinity samples showed signs of deleterious effects on seaweed growth. The thalli turned white and dead tissue were visible in areas where the thalli was damaged. After the second week of culture, the thalli began to show a green tinge in lower salinities as opposed to dark red colour at higher salinities. During the trial, treatments with higher salinity showed growth in the form of branching with growth of new thalli at apices and all along the thalli. Growing apices were lighter in colour and tended to be light to deep red.

After five days of culture period bleaching and infestation with green algae were observed in *G. corticata* maintained at 5-15 ppt salinity. Plants could barely survive below 10 ppt, with very low daily growth rate. Increase in weight gain was observed from 20 to 35 ppt salinity. After 30 days of culture period, mean weight of seaweed harvested from each treatment was 108 ± 8.5 g (20 ppt), 155 ± 12.5 g (25 ppt), 156 ± 10.2 g (30 ppt) and 160 ± 12.8g (35 ppt) (Fig.1). There was no significant difference between the final growth of *G. corticata* in 25, 30 and 35 ppt salinities. Earlier studies reported mean growth for *G. corticata* at different seasons. A 90 days culture with initial seed material of 500 g during winter season (October-December) recorded 1058.70 ± 63.82 g and during summer season (February-April) 1248.82 ± 80.75 g by raft method. Similarly a mean daily growth

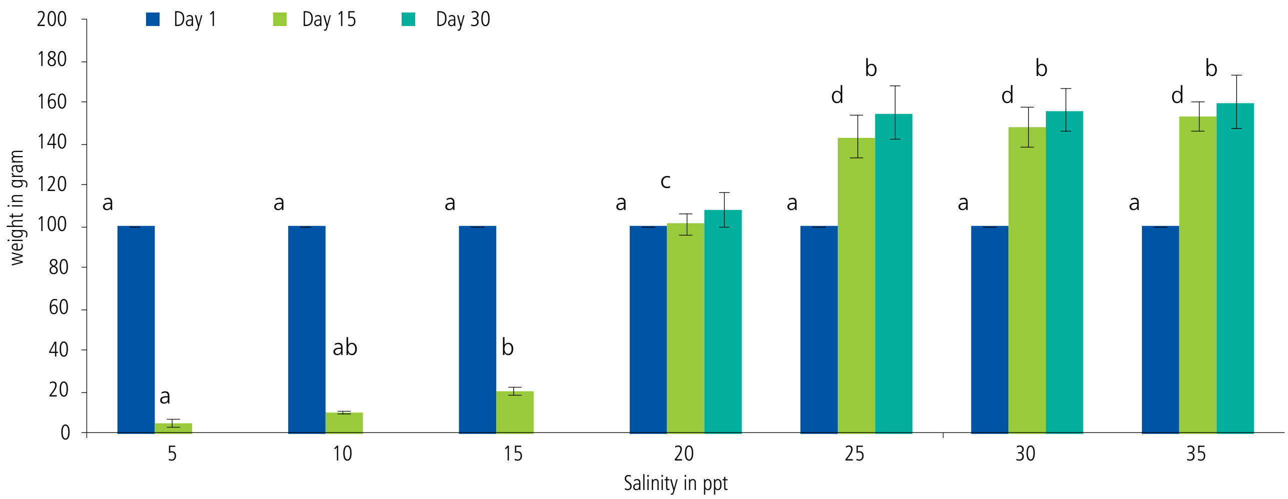

Fig.1. Mean growth rate of *Gracilaria corticata* in different salinity during 30 days culture

Table 1. Water quality parameters during 30 days experimental trials:

	WEEK I							WEEK II							WEEK III							WEEK IV						
SALINITY (ppt)	5	10	15	20	25	30	35	5	10	15	20	25	30	35	5	10	15	20	25	30	35	5	10	15	20	25	30	35
TEMPERATURE (ºC)	28	28	28	28	28	28	28	-	-	-	26	26	26	26	-	-	-	27	27	27	27	-	-	-	29	29	29	29
PH	8.4	8.2	8.4	8.3	8.6	7.9	8.4	-	-	-	8.2	8.2	8.1	8.1	-	-	-	8.3	8.3	8.2	8.0	-	-	-	8.4	8.2	8.0	8.0
ALKALINITY (ppm)	156	148	150	144	132	124	126	-	-	-	146	132	120	122	-	-	-	132	140	130	136	-	-	-	146	132	106	122
DO (ppm)	7.1	7.2	7.3	7.4	7.5	7.4	7.3				7.4	7.3	7.1	7.2				6.9	7.0	7.0	6.8				7.0	7.1	7.3	7.2
AMMONIA (ppm)	0.7	0.6	0.8	0.7	0.8	0.9	0.8	-	-	-	0.4	0.4	0.5	0.5	-	-	-	0.3	0.3	0.1	0.1	-	-	-	0.2	0.1	0.1	0.1
SILICATE (ppm)	3.9	3.4	3.7	2.9	2.8	2.7	2.0	-	-	-	2.1	0.9	0.5	0.4	-	-	-	2.7	1.7	1.2	1.1	-	-	-	2.3	1.5	1.1	0.9
PHOSPHATE (ppm)	0.7	0.6	0.7	0.6	0.6	0.6	0.6	-	-	-	0.6	0.5	0.4	0.4	-	-	-	0.5	0.5	0.4	0.3	-	-	-	0.4	0.4	0.3	0.3

rate (DGR %) of 0.95, 0.707 and 0.799 during winter and 1.52, 1.38 and 1.24 during summer was reported for raft method, polythene bag method and long-line method respectively indicating that the raft method is the best in both seasons when compared to other methods (Tandel *et al*., 2017). In the present study, the mean daily growth rate (%) observed for *G. corticata* was 0.25 (20 ppt), 1.46 (25 ppt), 1.48 (30 ppt) and 1.56 (35 ppt). DGR of 1.56 (35 ppt) is almost similar to the previous report of 1.52 during the summer season for 90 days culture (Tandel *et al.,* 2017). The present trials confirm that *G. corticata* can be cultured using raft method at salinity above 25 ppt.

The water quality parameters measured weekly also shows reduction in the level of nutrients like ammonia, silicate and phosphate (Table 1) as the culture progressed that indicated nutrient utilisation. In coastal as well as in estuarine waters, high levels of nutrient load can trigger harmful algal blooms and contribute to excessive growth of unwanted macrophytes, which in turn have serious negative consequences on coastal ecosystems and the economy. These nutrients could instead be used to support the growth of economically important seaweeds. *G. corticata* can be incorporated in small-scale integrated multi-trophic aquaculture (IMTA) for effective nutrient extraction from the farming system to reduce the excess nutrient load in the ecosystem. Trials conducted indicate the suitability of *G. corticata* in IMTA in estuarine as well as coastal waters. Further field trials in IMTA would prove its feasibility in nutrient load reduction in the estuarine as well as coastal waters.

Reference:

Tandel K. V. *et al.,* 2017. *Eco. Env. & Cons.*, 23 (2): 837-842.

Successful experimental cultivation of *Kappaphycus alvarezii* along Odisha coast

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Odisha is one of the maritime states on the north-east coast of India (17.75" N and 22.5" N and 81.5" E and 87.6" E). With a coast line of about 480 km (8% of the coast line of India), continental shelf area of about 25,000 km^2 (4.5% of Indian total continental shelf area), mangrove wet land area of 215 km^2 and heavy nutrient influx from three major, six medium and one minor river systems, Odisha represents one of the most productive marine ecosystem of India. The frequent cyclonic weathers and storms in Bay of Bengal along Odisha coast and mandatory fishing bans for the conservation of wild life greatly hampers the livelihood options of fishermen. Since the capture based marine fish production in Odisha is also showing early signs of fatigue or stagnation. It is necessary to develop alternative as well as additional livelihood options to improve the socio-economic status of the fishermen and increase production from marine ecosystem. As such alternative, experimental sea weed farming was conducted during November 2020 to February 2021 by ICAR-CMFRI to assess its feasibility, under a project funded by Fisheries & Animal Resources Development Department, Government of Odisha. The Four coastal districts selected were Balasore, Jagatsingpur, Puri and Ganjam each having two locations selected based on suitability of physico-chemical and other required oceanographic parameters (Table 1)

After the site selection process was completed with the help of Assistant Directors of Fisheries (ADFs-Marine Fisheries) of the respective districts by scientists of ICAR-CMFRI in November, 2020. Seed material of *Kappaphycus alvarezii* was obtained from Rameshwaram in Tamil Nadu packed in gunny bags adequately moistened with sea water of 35 ppt salinity. These were transported to Bhubaneswar (Odisha) by train which took nearly 48 hours to reach. It was then transported to Chandrabhaga hatchery, which is nearly 45 km from Bhubaneswar, by road. The seed material upon arrival appeared to be healthy even after about 50 hours of transportation. Nevertheless, the materials were acclimatized for 24 hours to ease out any stress from transportation in a

Table 1. Locations of seaweed farming experiment sites along Odisha coast.

District	Experimental Location	Geo-coordinates	Nature of Location	Seeding date
Balasore	Balarampur	21⁰16'19''N; 86⁰52'36''E	Receding tidal area	24.02.2021
	Chandipur	21⁰26'29''N; 87⁰02'50''E	Receding tidal area	25.02.2021
Jagatsingpur	Noliasahi, Gadakujanga	20⁰11'00''N; 86⁰31'34''E	Open sea area	24.02.2021
	Patharabandha, Paradip	20⁰17'32''N; 86⁰42'58''E	Bar mouth	25.02.2021
Puri	Ramachandi Muhana, Chandrabhaga	19⁰51'16''N; 86⁰03'59''E	Bar mouth	16.02.2021
Puri	Nuagarh, Astaranga	19⁰58'30''N; 86⁰20'28''E	Bar mouth	17.02.2021
Ganjam	Markandi	19⁰11'03''N; 84⁰49'57''E	Bar mouth	19.02.2021
Ganjam	Puruna Bandha area	19⁰22'42''N; 85⁰04'56''E	Bar mouth	19.02.2021

well aerated and lighted tank circulated with running sea water (salinity: 35 ppt). The seeding materials were subsequently transported to the respective experimental locations by packing them in gunny bags adequately moistened with sea water. Sea water was also carried along to rehydrate/ moisten the gunny bags which carried nearly 25-35 kg of seaweed of *Kappaphycus alvarezii* each at regular intervals.

Three square shaped bamboo rafts (3 x 3 m) were fabricated at each experimental site for planting the sea weed. Poly-vinyl ropes (diameter: 10 mm) were tied between the two parallel side arms of the raft at an approximately distance of 30 cm from each other to create multiple lines for seeding. Approximately, 7.5-10.0 kg of seed material was introduced in each raft for experimental cultivation. The seed material was tied to the Nylon rope using an innovative tying method with nylon zip ties. Unlike traditional rope tying method, this considerably reduced the time and effort for seeding the rafts.

Sea weed biomass of Balarampur and Chandipur, Balasore District showed very low to moderate growth after deployment. The rafts in Chandipur had been deployed in shallow pool like areas, which remained partially exposed to the direct sun light and atmosphere during low tides. Further lack of adequate water depth caused the sea water in these pools to become over heated which adversely affected the sea weeds leading to gradual degeneration in biomass. Nevertheless, the growth of sea weed at Balarampur was moderately better than Chandipur probably due to greater water depth available at the site even during low tide. A biomass of 15-20 kg was obtained from an initial stocking biomass of 7-8 kg after 45 days of cultivation.

In the experimental units deployed at Nuagarh (Astaranga) and Ramachandi Muhana (Chandrabhaga),

Fig. 1. Acclimatization of seeding materials at Chandrabhaga hatchery (Odisha)

Fig. 2. Fabrication and seeding of rafts with *Kappaphycus alvarezii* using zip tie method

low to moderate growth of *K. alvarezii* was noticed; other opportunistic algae like *Ulva intestinalis* over infested the rafts. The former site being situated at bar mouth gets a heavy river flow from Devi River, one of the principal tributaries of Mahanadi especially during low tide. Similarly, the latter site is influenced

Fig. 3. Deployment and installation of rafts seeded with *Kappaphycus alvarezii*

Fig. 4. Sea weed, *Kappaphycus alvarezii* growth in rafts at Balarampur, Odisha after 45 days of culture

Fig. 5. Low to moderate growth of Sea weed, *Kappaphycus alvarezii* and overwhelming infestation by *Enteromorpha sp.* at Nuagarh, Odisha after 45 days of culture

Fig. 6. Sea weed, *Kappaphycus alvarezii* growth at Markandi, Odisha after 45 days of culture

Fig. 7. Sea weed, *Kappaphycus alvarezii* growth at Noliasahi, Odisha after 45 days of culture

by Kushabhadra River, another tributary of Mahanadi. Moreover, the bar mouth opening is quite constricted which might have reduced the salinity at the site during low tide and there by facilitated the luxuriant growth of the opportunistic *Enteromorpha* sp., significantly arresting growth of *K. alvarezii*. A sea weed biomass of about 15-25 kg was produced from an initial stocking biomass of 7-8 kg during the culture duration of 45 days.

Units deployed at Purana Bandha area and Markandi showed moderate to high growth of sea weed. Puruna Bandha was situated in the river bar mouth area of Rushikulya River while Markandi was situated on a minor water outlet from nearby swampy area that provided optimum salinity due to lesser fresh water influx. About 25-30 kg of sea weed biomass was produced from an initial stocking biomass of 7-8 kg during the culture duration of 45 days in these experimental sites.

Growth of sea weed at Patharabandha (Paradip) was poor, mainly due to strong water current of the Mahanadi River. The steep decline in salinity due to heavy freshwater during low tides further affected the sea weed growth. Remarkable luxuriant growth of *K. alvarezii* was observed at Noliasahi (Gadakujanga) where about 70-120 kg production was made from each raft at an Initial stocking weight of 7-10 kg, within a culture duration of 45 days. The site located in the river bar mouth area of Jatadhari River probably got the minimal freshwater influx and maintained the ideal salinity throughout the culture duration. Based on the encouraging results obtained from Noliasahi

Table 2. Cost benefit based on the experimental farming of seaweed in Noliasahi, Gadakujang, Odisha.

Input cost

Item	Quantity	Amount (₹)
Seed material from Rameswaram to the site including transport	100 kg	10,000
Preparation of raft	10 numbers	10,000
Miscellaneous expenditure	10 rafts	4,000
Total		24,000

Output cost

Item	Production (kg) & value(₹)/ raft	Total Production (kg) & Value(₹)
Production from each raft during one culture cycle	80 kg	800 kg
Quantity with 35% moisture	28 kg	280 kg
Value of dried seaweed @ ₹.50/kg per cycle	1,400/raft	14,000
Value of dried seaweed for 3 cycles in a year	4200/ raft	42,000
Profit per annum		18,000

(Gadakujanaga, Odisha), an economic model for successful sea weed cultivation in Odisha has been worked out (Table 2).

One culture cycle for sea weed is 45 days. Considering all adverse situations especially during monsoon season, if the ideal 4 months (January to April) is utilized for cultivation, there could be 3-4 culture cycles possible using the same raft in a year which will give an approximate profit of ₹18,000 per annum from 10 rafts.

Evidently, growth of sea weed in coastal areas of Odisha is mainly influenced by salinity, which is greatly affected by the heavy fresh water influx from its vast riverine systems. Frequent adverse cyclonic weathers and storms also make the sea rough and unsuitable, especially during monsoon season. However, because of the heavy nutrient influx, a unique opportunity for seaweed cultivation for almost 4 months of the year during January to April is available along Odisha coast. The encouraging results obtained, especially from Noliasahi Gadakujanga clearly indicate that the farming of *Kappaphycus alvarezii* is feasible. Wherever a competitive inhibition of *K. alvarezii* was observed due to *Enteromorpha* sp. Infestation, the possibilities of cultivating other low salinity tolerant species like *Gracilariopsis longissima* can be explored. The experiment also showed prospects for diversification of species like *Enteromorpha, Caulerpa* and *Gracilariopsis longissima* for cultivation which can be used for human consumption. The receding tidal areas like Chandipur and Balarampur in Balasore district could be efficiently utilized for seaweed farming with certain structural modifications by digging the area to retain the water at least 2 ft during receding tide period. Onshore collapsible seaweed farm can be established on the seashore with regular supply of seawater. Most of the river bar mouth area provides ideal condition for sea weed farming as the sand strips neutralize the heavy tidal action of the open sea. Proper dredging of the bar mouth connection to sea and deployment of mechanical pumps to prevent salinity drops during low tide could give very encouraging results. The experimental location at Noliasahi, Gadakujanga (Jagatsingpur, Odisha) was found to be ideal for mass culture of *Kappaphycus alvarezii* and therefore, fisherfolks should be encouraged to participate in sea weed farming by forming self-help groups (SHGs). Popularization of cultivation technique and large scale participation will open up new avenues for the sea weed industry in Odisha.

Fish diversity in shallow water diving sites in Malvan Marine Sanctuary in Maharashtra

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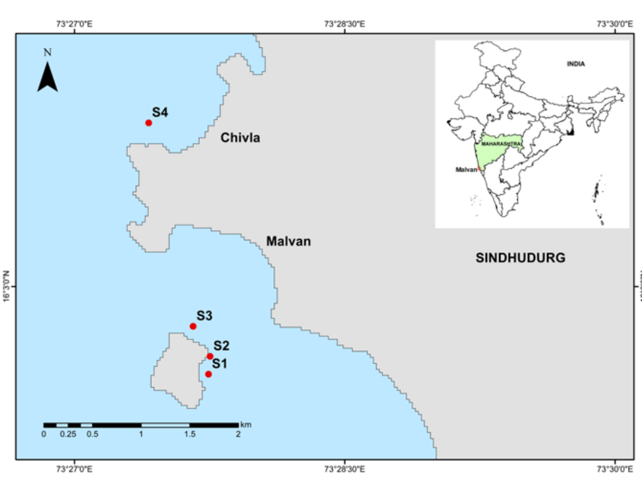
Tourism has great potential and opportunities for sustainable development and the Maharashtra government is promoting coastal and marine tourism (CMT) with diverse strategies to harness the benefits for economic growth and development of the local population. Sindhudurg District in southern Maharashtra has been widely promoted for CMT with the district declared as "tourism district" in 1997. Malvan (Sindhudurg district) is one of the popular CMT and aqua sports destinations in Maharashtra and one of the nearest getaway locations from the Metro city Mumbai. The affordable aqua sports experience (para-sailing, snorkelling, diving, speed boats, jet-ski, banana and bumper boats, kayaks) and dolphin watch cruises attract a lot of people. Fishing vessels and tourism boats navigate and operate in the same waters and the coastal communities interchangeably work in both sectors. Diving snorkelling and homestays were some of the demand-driven developments in the region. Several small-scale diving enterprises and adventure sports activities developed in the region are mostly concentrated in Malvan and are well established and publicity through social media has often created a rush of tourists to Malvan.



Observation sites in Malvan, Maharashtra

Submerged underwater rocks and reefs provide potential sites for diving which have been identified and accessed by these dive enterprises to enable tourists to undertake the affordable (400-3500 ₹/per dive). Poorly managed CMT-related is risky and unsustainable and awareness on sustainable CMT practices is required (De *et al*., 2020). The Swadesh Darshan program of Govt. of India, in which a coastal circuit belt connecting the potential tourism villages in Sindhudurg such as Vijaydurg, Mithbhav, Devgad, Tarkarli, Tondavali, Nivati fort, Shiroda, Sagareshwar, and Mochemad has been planned, may reduce the current tourism pressure on Malvan. There is an urgent need to manage coastal pollution and evaluate the ecosystem carrying capacity for sustainable coastal tourism development in the region.

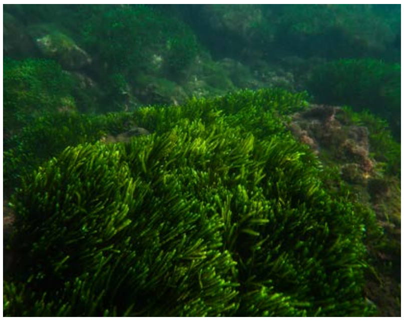
In December 2021, an underwater visual census was conducted during recreational diving. Observations were conducted at 4 crowded, high-intensity diving and snorkeling points for 10-20 minutes each at depths of 4-7 m. The number and fish species observed were recorded. Sites 1-3 are in the core zone of the designated Malvan marine sanctuary (MMS) and 4 in the buffer zone of MMS. Dive sites have patches of corals *Porites* spp., *Turbinaria* spp., *Siderastrea* spp. and stations 1 and 2 have good seaweed patches (*Sargassum* spp., *Caulerpa* spp., *Chaetomorpha* spp, *Dictyota* spp., *Ulva* sp., *Porphyra* spp., and *Padina* spp.). Most of the fishes observed at sites are reef-associated fishes (Table 1). A total of 27 fish species were observed from all dive sites, belonging to 13 families and 23 genera. Though a high number of fish species (108) were reported from the Malvan marine sanctuary (Barman *et al*., 2007), the fish diversity and abundance at current dive sites were very poor (average 13 species) during the observation. The highest diversity in terms of the number of species observed was at Station 1 and the most dominant fish group in numerical abundance was Pomacentridae. The

Single-use plastics trapped in a seaweed patch in the core zone of Malvan marine sanctuary

Beached pollutants in the core zone of Malvan marine sanctuary

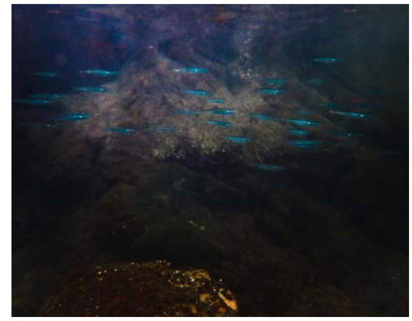
Table 1. Fishes observed in the high-intensity dive sites in Malvan

Family	Genus/Species	Station 1	Station 2	Station 3	Station 4	Occurrence status
Epinephelidae	*Cephalopholis formosa*	*			*	Rare
	Epinephelus malabaricus		*			Rare
Lutjanidae	*Lutjanus argentimaculatus*	*	*			Rare
	Lutjanus rivulatus	*				Rare
	Caesio sp.				*	Rare
Pempheridae	*Pempheris* sp.		*			Rare
Sparidae	*Acanthopagrus berda*	*		*	*	Occasional
Chaetodontidae	*Chaetodon collare*		*	*		Occasional
	Chaetodon decussatus			*		Rare
	Heniochus acuminatus	*	*			Rare
Pomacanthidae	*Pomacanthus annularis*	*			*	Rare
Mugilidae	*Ellochelon vaigiensis*	*	*			Rare
	Chelon spp.			*		Frequent
Pomacentridae	*Abudefduf vaigiensis*				*	Occasional
	Abudefduf bengalensis	*	*	*	*	Common
	Abudefduf sordidus	*	*			Rare
	Chrysiptera unimaculata			*		Rare
	Dascyllus trimaculatus	*	*	*	*	Rare
	Neopomacentrus cyanomos	*	*	*	*	Common
	Neopomacentrus sindensis	*	*	*	*	Common
	Pomacentrus sp.	*	*	*	*	Common
Scatophagidae	*Scatophagus argus*	*	*			Rare
Acanthuridae	*Acanthurus gahhm*	*				Rare
Monodactylidae	*Monodactylus argenteus*		*	*		Occasional
Scaridae	*Scarus ghobban*	*				Rare
Labridae	*Labroides dimidiatus*		*		*	Rare
	Halichoeres cf. *nigrescens*			*		Rare



Seaweed, *Caulerpa* spp. patches at Station 1

Corals at Station 1



Squids at Station 1

Seaweed, *Sargassum* spp. patches at Station 2

Reef fishes and bleached corals at Station 4

current observations during a single observation dive has limitations and the seasonal and long-term variation of marine life in high anthropogenic impact coastal regions needs to be documented.

When sightings were pooled for all stations, rare (<5 numbers), occasional (5-10), frequent (10-20), and common (>20)

Brief Communications

Record of mated Little Indian squid *Loliolus hardwickei* (Cephalopoda: Loliginidae) from the southwest coast of India

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Cephalopods display some of the most complex behavioural adaptations amongst marine invertebrates, particularly concerning their mating behaviour. The reproductive features of the squids are unique. Sperm transfer is a complex process, with males transferring intricate spermatophores to females during copulation and the spermatophores everts as spermatangium by spermatophoric reaction. This in turn gets attached to the female body through distinct mechanisms. The squid spawning grounds of cephalopods, are generally identified based on the presence of egg masses and mated individuals. The Little Indian squid, *Loliolus hardwickei* (Gray, 1849) is known to inhabit estuarine and coastal waters to a maximum recorded depth of 30 m. They have a short life span of < 6 months. Nothing is known about the mating season of little Indian squid *L. hardwickei* and presumably the first record of a mated *L. hardwickei* from the southwest coast of India is reported below.

Eight specimens of Little Indian squid *L. hardwickei* (26 to 62 mm dorsal mantle length DML) were caught from off Kochi (10° 06′ 16″ N; 76° 15′ 07″E) in a trawl net operated at a depth of 20 m, on 28 October 2021. The trawl net with 20 kg sinkers and rigged to bottom operated on a substratum that was sandy/muddy. The bottom temperature and salinity of the area was recorded as 27.2°C and 34 psu respectively. All the sampled individuals were mature. To examine females for any signs of mating activity, the buccal membrane was initially inspected for the presence of spermatophores or spermatangia. Among the two males and six females, a single female *L. hardwickei* had evidence of mating, with attached spermatangia on the buccal membrane (Fig.1).

The particular specimen had a DML of 62 mm and bodyweight of 18 g with 109 spermatangia attached around the buccal region. In fresh condition, it appeared as a bright white mass amid the translucent skin in the ventral buccal region. All spermatangia were stained with malachite green for better visibility and under magnification they appeared as small tear drop-like projections 0.57 mm to 0.73 mm (mean=0.65 mm) long and 0.2-0.3 mm (mean=0.24 mm) width at base (Fig.2 A-C).

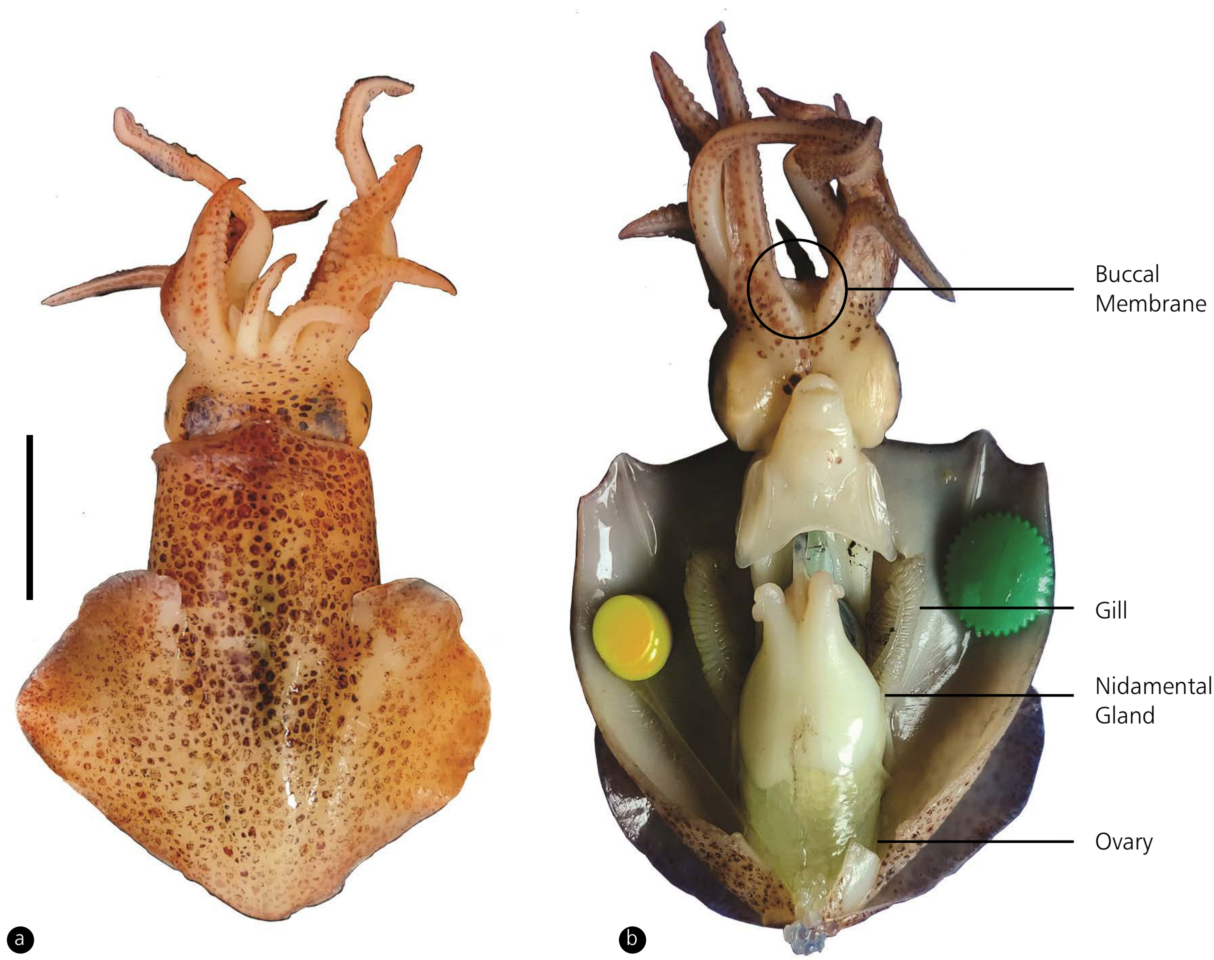

Fig.1. Dorsal (a) and ventral (b) view of mated female *Loliolus hardwickei* from the southwest coast of India (Scale bar=2 cm)

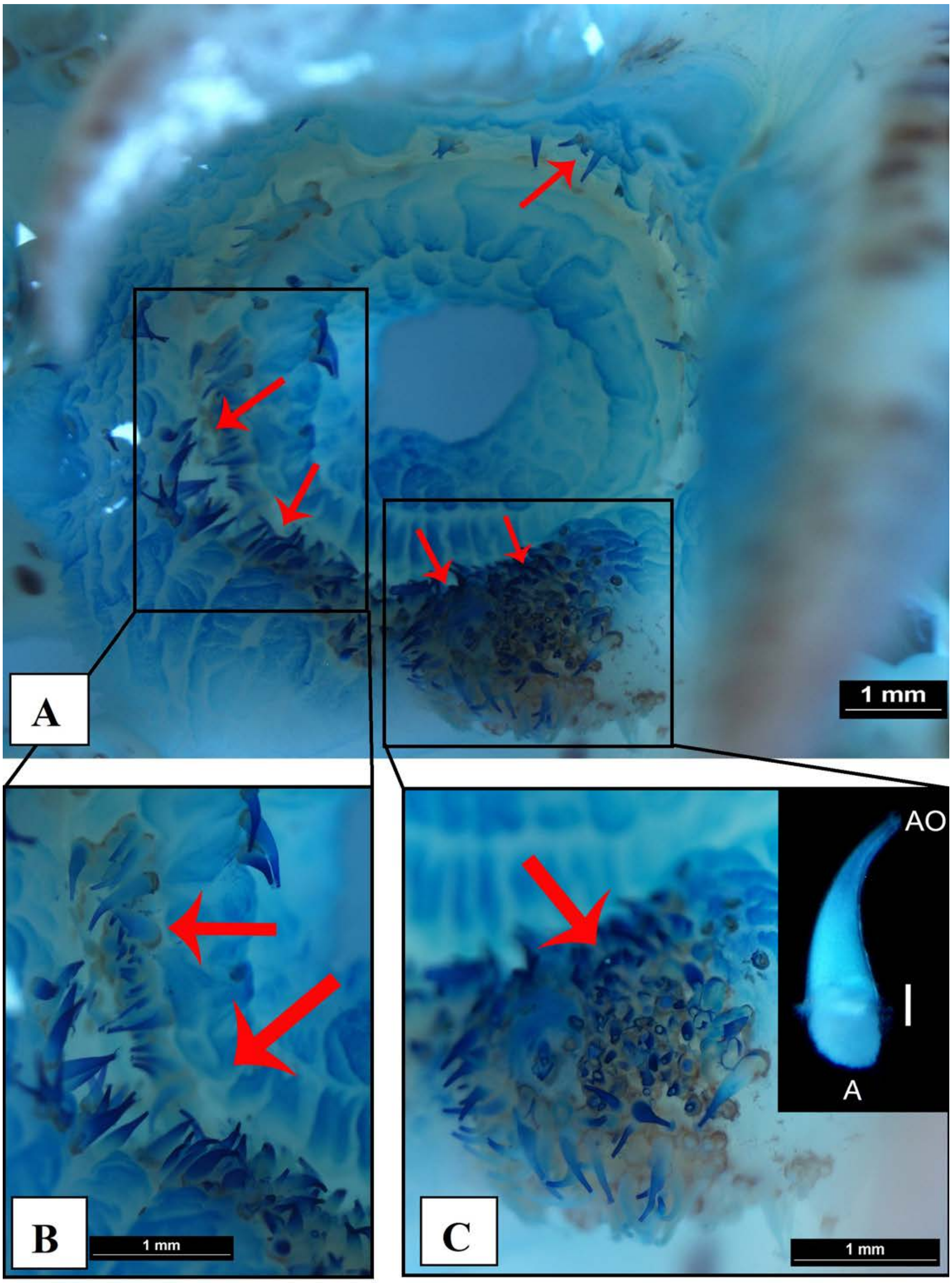

Fig. 2. Buccal region of mated female *Loliolus hardwickei* from the southwest coast of India; A) top view of buccal region, B & C = enlarged view of spermatangium attachment (inset: enlarged view of single spermatangia, A=attachment area, AO= aboral opening). Arrow marks indicate the location of spermatangium attachment.

The individual had a total of 824 oocytes in the ovary. The gonadosomatic index (GSI) of the individual was 25.1 % of the body weight. The size of the ova ranged from 0.59 mm to 1.8 mm (mean= 1.29 mm). The multi-modes in the egg size frequencies at 1.2 to 1.3 and 1.6 to 1.7 mm indicated the species may be intermittent spawner. The present observation indicated that the species may be spawning in nearshore waters of the southwest coast of India and post-monsoon (October) might be a spawning period of the species.

Brief Communications

Fish swim-bladder trade in India

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Processed fish air bladder or swim bladder are highly priced for edible purposes as well as medicinal value in many countries of Southeast Asia. In addition, they are widely used for preparing isinglass which finds application in industrial processes such as wine and beer breweries and preparation of cosmetics. Over the last few decades, global demand for swim bladders has increased exponentially which are sourced from countries with a fairly good production of fishes that are most sought-after for their swim bladders. Croakers are the most preferred and highly priced groups in the swim bladder trade, while several other fishes have also been added to the list in recent years.

In India, fish swim-bladder trade is historically well documented with earliest mentions dating back to the 1800s and reportedly spanned across the coastal regions of the country. The northern Arabian Sea region, including Mumbai, is famous in the global fish swim bladder trade but is poorly known in the domestic sector mostly due to its restricted /closed trade network. The dried fish air bladders, also called "fish maw" and locally known as "*Bhot*" in Maharashtra, are collected and prepared from croakers (Family: Sciaenidae), threadfins (Family: Polynemidae), eels (Family: Congridae & Muraenesocidae), sea bass (Family: Latidae), groupers (Family: Epinephelidae) and catfishes (Family: Ariidae) (Table 1). However, the latter three fish families are less preferred and low-valued. Large-sized croakers are often called "gold" by fishers due to the attractive price they fetch. The region off Gujarat and Maharashtra, from where these fishes are caught along with other high-value fishes like pomfrets and seer fish, is locally called as "*golden belt*" by the local fishers. Often violent conflicts at sea due to fishing access issues and mixed craft gear combination operations for these fishery resources are reported.

Fig. 1. Drying of catfish airbladders in raised platforms in closed rooms of aggregators/exporter

The fishes used in the swim bladder trade are mostly bycatch in diverse fisheries operating various gears in Maharashtra such as purse seine, gillnets, bag nets, trawls and hook and lines, with seasonal targeted fishery for eels observed in certain areas. While aggregations of large-sized croakers are recorded, there is limited information on the biological reasons of aggregation (spawning/migration/feeding/habitat suitability etc). Large-sized croakers like Blackspotted croaker, *Protonibea diacanthus*, Bengal corvina *Daysciaena albida,* Soldier croaker *Nibea soldado* and Bronze croaker *Otolithoides biauritus* are in high demand for air-bladders along with eels (*Muraenesox* spp., *Congresox* spp.). Air-bladders from medium to small sized eels and medium-sized croakers and polynemids are also collected and traded. The price varies according to the species, count per kg, texture, quality, size/thickness of the air-bladder and increases with size and sex of the fish; the price is higher for air bladders from male fish (Fig. 2, Table 1). Kolkata,

Table 1. Some fish groups/species observed in swim bladder trade in Maharashtra and their price (1$ = 72₹)

Group/family/Species	IUCN Red List status, Maximum size	Sex	Wet/Dry	Count/kg	Rate (₹)
Croaker, Sciaenidae			Wet	50	1,500-2,000
Otolithoides biauritus	Data Deficient, 160 cm TL		Wet	40	1,750-2,500
			Wet	30	4,500-5,500
			Wet	20	8,000-11,000
			Wet	10	12,000-17,500
			Wet	5	18,000-21,000
			Wet	3	22,000-25,000
Croaker, Sciaenidae					
Protonibea diacanthus	Near Threatened, 120 cm TL	Male	Wet	10	25,000-27000
		female	Wet	10	17,000-21,000
		Male	Wet	5	140,000-165,000
		female	Wet	5	75,000-95,000
		Male	Wet	2	5,55,000-6,50,000
		female	Wet	2	4,00,000-5,00,000
		Male	Wet	1 kg or above	7,00,000-9,00,000
		female	Wet	2 kg or above	5,50,000-7,00,000
Eels, Congridae & Muraenesocidae			Wet	10	10,000-13,000
Conger cinereus	Least Concern, 140 cm TL		Wet	5	15,000-20,000
Congresox talabonoides	Not Assessed, 250 cm TL		Wet	3	22,000-28,000
Muraenesox bagio	Not Assessed, 200 cm TL				
Muraenesox cinereus	Least Concern, 220 cm TL				
Threadfins, Polynemidae			Dry	50	13,000-15,000
Eleutheronema tetradactylum	Not Assessed, 200 cm TL		Dry	25	20,000-23,000
Leptomelanosoma indicum	Not Assessed, 142 cm TL				
Catfish, Ariidae			Dry	50	800-1,000

*Highly variable with local and international trends. Information collected from stakeholders.

Mumbai, Veraval and Chennai are the major collection and export centres of fish maws in India, with aggregators/agents from distant landing centres across the country sending the air bladders to exporters based in these hubs. There are multiple channels involved with several collection agents, in addition to individual suppliers and networks, in place for the exporters. The fresh fish is normally auctioned through competitive bidding, where the highest bidder collects the fish and the air bladder is extracted by an experienced person without damaging the fish or the bladder, after which the fish is mostly resold (@150-250 for eel/*O. biauritus* to 400-600 ₹/kg for large threadfins and *P. diacanthus*). The fresh air bladder is cleared of vessels, tissues and blood, washed and sun-dried or dried in closed areas. Processed fish maws are sorted by size, weight and quality and packed according to value, importer demand and destinations.

Although India is one of the major suppliers of fish maws globally, the domestic and international trade, supply chains and demand drivers are not well documented. In addition to their swim bladders, there is also a high export demand for frozen/chilled croakers and eels to China, Vietnam, Korea, Japan, Middle East and EU countries. The meat of

Fig. 2. Fishmaws of (a) Catfish (b) Eel (c) Conger Eels (d) Male *P. diacanthus* (e) Female *P. diacanthus* (f) Seabass

polynemids and seabass meat are of high demand in local markets for domestic consumption. The price of fish, fish maws and the first sale price has increased considerably in the last decade .India is one of the top five countries that contributes to 50% of the global swim bladder trade in volume and 70% in value (Sadovy de Mitcheson *et al*., 2019). Similar to other high-priced luxury dried seafood items like sea cucumbers and shark fins (trade of which is presently illegal in India), the major export destinations for fish air bladders from India are countries like Hong Kong, China, Singapore and Thailand while very small quantities are also exported to UAE, US, UK and Canada. India's fish maw trade to Hong Kong as declared in the Hong Kong Harmonised System (HKHS) Code (0305210, for dried fish maws) ranged from 278 t in 2015 to 154 t in 2021, showing a decreasing trend in overall export contribution since 2015 (https://tradeidds.censtatd.gov.hk).

The Government of India has specialized rules for ensuring the quality of exported dried air bladders and categories for different types of fish maws and size grades (count) per kilogram traded viz; Export of Dried Fish Maws (Quality Control and Inspection) Rules, 2002. Exporters are supposed to use the ITC HS code 03057200 from 01.01.2012 for "Fish heads, tails and maws". Prior to this, exporters dealing with swim bladders exported mixed-species products and often provided broad HS codes, with or without mentioning the product details. This is likely to have resulted in misreporting or under-reporting the quantity of export. The export and trade data accuracy has improved considerably in recent years and recognising the complexity in classification and coding of marine products in trade, we recommend further standardization using taxon-specific and distinct codes for marine products for certain species/groups in export to avoid data deficiency and scientific uncertainty in management guidance. Several destination countries are also demanding taxon-based information for import in the recent years and imports are also being checked by rapid DNA-based technologies for taxon identification. The trade and export data can be assessed as a proxy in relation to the capture production trends. Underreported/ misreported catch or landings trend data often doesn't reflect the actual status of exploited groups and trade dynamics. The fish maw demand and trade is expected to grow, as many export destination countries are moving away from other luxury seafood products like shark fins, the trade of which has been widely regulated or prohibited, globally. Swim bladder trade from India is entirely driven by high economic value due to export demand, while in the domestic market swim bladders have limited market and user demand. The export demand and incomparable price with other seafood products make these fish groups a highly targeted and trade-preferred group, which in turn necessitates monitoring fishery and trade dynamics of the various species exploited for air-bladder trade. The catch of many large-sized croakers often draws public and media attention and with the access to international traders, and price structure through social media, fishers and traders of many regions are well aware of the high value of swim bladders which provides the fishers an upper hand in bargaining for best prices from traders. With support of social media and internet, trade networking expands from local to an international level even in minor ports and often attracts highly competitive bidding. Visibly, the economic benefits of the swim bladder trade have started directly reaching the community. Fishers and fish/fish product exporters of Maharashtra are aware and concerned of the declining catch, often mentioning the rarity and falling catches of many large-sized croakers, especially *P. diacanthus* and *D. albida* which were once common in the coastal waters. Two large-sized species of croakers found in Indian waters *P. diacanthus* and *O. biauritus* are identified as "prioritised species" for mariculture by ICAR-CMFRI (Kizhakudan and Kizhakudan, 2017), whose declining catch trends have been a concern and management options are highly challenging due to complexity of multispecies and multigear fisheries.

Conservation aquaculture and Minimum Size Limits for catches from the wild have been used for reviving declining fish stocks as part of management and conservation measures in certain countries. In Mexico, the Totoaba aquaculture with *Totoaba macdonaldi*, a large sized croaker of 200 cm TL size is expanding whereas earlier it was a depleted fishery. In Maharashtra, a Minimum Legal Size (MLS) of 70 cm total length (TL) has been recommended for commercial trade of *P. diacanthus,* which can also be implemented for better resource management (Chellappan *et al*., 2018). Potential impacts of global demand on marine fisheries of the developing countries are still undocumented, both in the cases of legal trade and illegal trade. So, in the larger interest of conservation and sustainable utilisation, regular stock and population assessments based on species-specific information viz; exports, catch, fishery, exploratory surveys, are urgently needed. Identification of specific aggregation sites in fishing grounds and involvement of fishers and other stakeholders in developing trade regulations to maximize economic returns and ensure sustainability is desirable.

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Brief Communications

Valorization of fish wastes using Green bottle fly pupae, *Lucilia sericata*

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Globally, most fish processing industries are discarding huge quantities of fish trimmings which consist of head, viscera, flesh and bone. Fish trimmings accounts for nearly 20-30% of the total fish yield and is species specific. Often the disposal of these wastes create lot of environmental issues and commonly are sun dried or processed as fishmeal for the poultry feed industry. However, these products did not find a place in aquafeed industry as the protein content of the fishmeal made from fish trimmings is very low (25-35% of DM) compared to regular fishmeal

(60-70% of DM) and the ash content is also very high (30-35% of DM) according to the composition of the trimmings. In this context, the unutilized fish waste/trimmings can be utilized for insect meal production. The insect production system is one where insects can valorize the waste food and convert them into biomass rich in protein and lipids. The nutrient profile of insect pupae grossly depends on the nutrient composition of the waste fed to them. In general, the omega-3 fatty acid composition of insect meal is significantly lower than the fishmeal as the insects do not convert the 18C:2 n-3 fatty acids into Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA). But, it can bio-accumulate the available EPA and DHA from the feed source and hence food wastes with comparatively lower nutritive profile can also be blended with fish trimmings to enhance the nutritive composition of insect pupae as well as utilization of low quality food wastes.

An attempt to produce insect meal from unutilized fish trimmings using green bottle fly, *Lucilia sericata* larvae as the bioconversion agent is described below. A simple low cost device to produce insect pupae in a protected condition and self-harvesting mode of insect pupae collection was designed (Fig. 1). The device consists of a 20l capacity polyethylene terephthalate (PET) carboy as decomposing bin, fly entry point and two numbers of pupae collection bins which are connected to the decomposing bin through 1" diameter PVC pipe. The device is intended to prevent the escape of the pupae. The fish trimmings maintained in the decomposing bin attracts adult green bottle fly, *L. sericata* and the female fly lays eggs on the same day. The eggs hatched at about 9 hours and pass three larval instars in 4 days at ambient temperature (28-30 °C). Thereafter they attain pupae stage and crawl onto soil/sawdust kept in the collection bin which usually lasts from 6 to 8 days in the prevailing (28-30 °C) temperature. At this stage the pupae were harvested from the collection bin. The yield of green bottle fly larvae was about 20% of original fish biomass used for decomposition. After harvesting the green bottle fly pupae (GFP) were washed with freshwater and dried in hot air oven for 6 h at 80 °C. The dried pupae were ground and the nutritive profile of GFP was assessed (Table 1). As the nutritive profile of GFP grown on the fish waste indicates higher level of EPA and DHA, the insect oil can also be extracted from the GFP meal and can be used to replace fish oil. Further, it can also be used as a good feed attractant in carnivorous marine food fish diets. The nutritive profile of greenbottle fly pupae meal (GFPM) clearly indicated that it is a potential alternative ingredient in replacing fishmeal in the diet of marine ornamental and food fish fishes.

Table 1. Nutritive profile of green bottle fly pupae

Proximate composition	(%)
Moisture	4.3
Crude protein	49.65
Crude fibre	8.38
Ether extract	26.77-29.89
Total ash	4.46
Gross energy(Kcal/g)	6.098
Fatty acid profile	
Myristic acid	4.03
Palmitic acid	29.55
Stearic acid	3.85
Oleic acid	24.34
Linolenic acid	0.79
Linoleic acid	0.41
Arachidic acid	1.83
Behenic acid	4.04
Eicosapentanoic acid (EPA)	8.75
Docosahexaenoic acid (DHA)	10.64
Palmitoleic acid	11.72

Fig. 1. The unit fabricated for insect culture

Development of diagnostic clones against an emerging marine fish virus disease: A methodological improvisation in the field of Red Sea Bream Iridovirus disease surveillance

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Red sea bream iridovirus (RSIV) is an OIE-listed viral disease that causes extensive mortality in marine fishes. The first outbreak of this economically significant disease in India was reported during 2018, followed by the second report from ICAR-CMFRI during 2020. Both of these outbreaks occurred in Asian Seabass (*Lates calcarifer*) cultured in open estuarine cages along the west coast of India and caused around 50 to 90% mortality rate in this economically important food fish species. RSIV is now considered an emerging disease in Indian aquaculture systems, and proper control strategies are necessary to prevent the spread of disease and consequent economic loss to the fish farmers. Further, as RSIV has a broad host range and has been isolated from fishes in open water cages, the risk of spreading to wild fish stock is very high. Thus, it becomes pertinent to do both active and passive surveillance of this disease using PCR techniques among diverse marine animals. The rapid and sensitive PCR-based assay can detect RSIV infection at a phase sufficiently early to be an aid in fish disease management. Thus, PCR-based viral disease diagnosis is potentially a fast and reliable method; however, it has certain drawbacks like the possibility of false-negative or -positive results. Standardized positive and negative controls are necessary for PCR-based diagnostic assays to overcome this problem, PCR false-negative results usually occur due to PCR inhibitors and suboptimal reaction conditions. Accordingly, the establishment of recombinant bacterial clones containing antigenic portions having the diagnostic significance of the important pathogens is necessary for diagnostic labs. Keeping the fact, recombinant bacterial clones containing antigenic portions of RSIV was established in the marine biotechnology division of ICAR-CMFRI, as a methodological improvisation in the field of RSIV disease diagnosis. The protocols followed had the approval from Institute Biosafety Committee of ICAR-CMFRI (No.2/IBSC/CMFRI dated 18/11/2021).

As the first step, total DNA was extracted from the brain tissue of the infected cage farmed Asian Seabass (collected and preserved during 2020 disease outbreak), through the phenol-chloroform method, so that the total DNA of 675.7 ng/μl concentration was obtained, having OD 260/280 nm ratio of 1.94. Then PCR was performed using the total DNA and the specific primer sets that can amplify a fragment 568 bp in length from RSIV (RSIV-For: 5’- CGGGGGCAATGACGACTACA-3’, RSIV Rev: 5’-CCGCCTGTGCCTTTTCTGGA- 3’), so that an amplicon

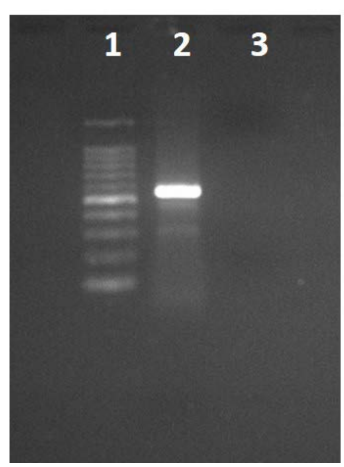

Fig. 1. PCR amplification the diagnostic fragment of RSIV

Lane 1: 100bp DNA ladder (Takara), Lane 2: PCR product, Lane 2: Negative control of 568 bp was obtained (Fig. 1). The PCR product was then sequenced to confirm the specific amplification, and the obtained sequence was submitted in NCBI GenBank under the accession number MZ224281. The confirmed PCR product was then purified and ligated into pMD20-T vector plasmid using the Mighty TA cloning kit. Finally, the ligated plasmid was transformed into competent *E. coli DH5*αcells, the *E. coli* strain which

Fig. 2. Plate after transformation showing blue and white colonies

lacks virulence properties. After transformation, the cells were allowed to grow in the media containing ampicillin, X-gal (colorless analog of lactose), and IPTG (isopropylº-D-1-thiogalactopyranoside), so that the white recombinant colonies could be observed after overnight incubation(Fig. 2). The white colonies were picked and screened by colony PCR using the gene-specific primers (RSIV for and RSIV rev). After confirmation by colony PCR, the positive clones were inoculated to LB Broth containing ampicillin. The glycerol stocks were made from overnight incubated cultures, and stored at -80°C. The prepared diagnostic clones were confirmed through the isolation of plasmid DNA followed by PCR using the target gene-specific primers, and further DNA sequencing.

In conclusion, the establishment of recombinant bacterial clones containing antigenic portions of an emerging fish viral pathogen namely, RSIV was done through the present study, as a methodological improvisation in the field of RSIV disease surveillance. The clones can be used as the positive control in RSIV diagnostic and molecular surveillance protocols of the national fish disease surveillance program, to ensure 100% accurate results in the PCR protocol. Now, future investigations on RSIV circulating in the country through extensive active and passive surveillance programs in both healthy and diseased fish are warranted, to have specific stringent control measures against this emerging viral pathogen in the marine aquaculture industry.

Brief Communications

Sporadic occurrence of Epizootic ulcerative syndrome outbreaks under post flood conditions in Kerala

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Epizootic ulcerative syndrome (EUS) is considered to be an infection with an oomycete known as *Aphanomyces invadans,* commonly known as water molds causing heavy mortalities in wild and in farm fish. Large-scale fish mortality waters especially in the flood-affected fish farms in Kerala, following heavy rainfall and flood in

August 2018 were reported. Subsequently, several fish disease cases were reported to ICAR-CMFRI by farmers, with characteristics of the invasive, tissue-destructive stages of EUS (Fig.1). In such cases reported, several species tested positive for EUS including *Channa bleheri,* and *C. diplogramma.* The affected fishes showed clinical symptoms like lethargy and lateral recumbency in rearing facilities. In some fish, the caudal peduncle, caudal fin or dorsal fins were severely eroded, and deep ulcers exposing the underlying musculature were also observed.

The infected fishes were transported to ICAR-CMFRI and routine disease investigation procedures were carried out in microbiology laboratory. The submitted fish were observed for gross pathological changes. The systematic evaluation of the infected fishes showed different pathological features like haemorrhages on the operculum, head, ventral abdomen, vent and posterior to pelvic fin and base of fins. Further, they showed loss

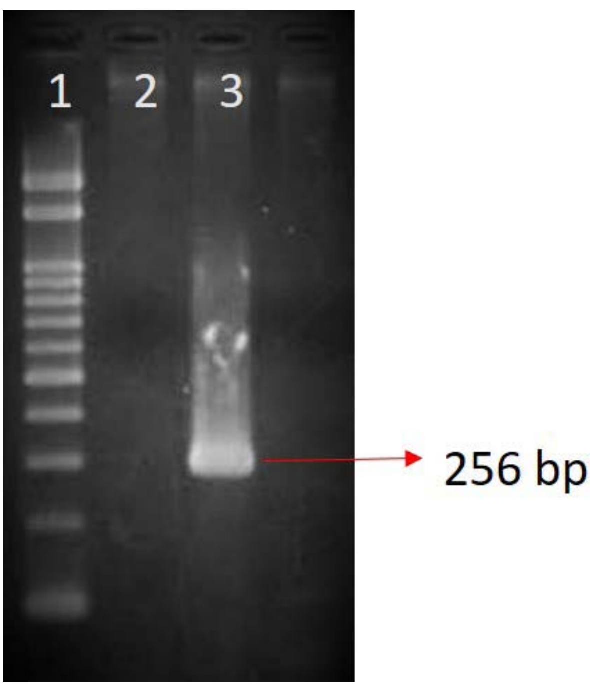

Fig. 1. Agarose gel electrophoresis profile of PCR-amplified for EUS: Lane 1: 1kb DNA ladder; Lane 2: Lane 2: Negative control Lane 3: Infected fish sample. A special band about of 256 bp showed the positive results

of body scales, blackish discolouration at the tip of gills, empty gut, white cotton like fungal growth on ulcers and the left posterior side of the head *etc*. In severely affected fish, large, deep red-colored ulcers were observed. Blood, liver, kidney, brain and spleen samples were collected aseptically and screened for fish pathogens. Further, the fungal growth seen on the ulcers of affected fish was directly taken for molecular identification. The direct microscopical examination of the squash preparations from affected tissues shown the presence of clusters of encysted primary zoospores on non-septate hyphae of *Aphanomyces invadans*. Confirmatory diagnosis was done through PCR using extracts from affected tissues. Molecular confirmation indicated amplicons of the desired size (ITS region, amplicon size 256 bp) (Fig. 2), which were consistent in all suspected samples from affected hosts. Although viral screening were negative, bacteriological investigation of blood and other internal organs discovered the co- infection with bacteria like *Sphingomonas paucimobilis.*

A number of predisposing factors and postulates were attributed to such expansion of hosts susceptible to EUS. However, previous reports worldwide manifests that temperatures drop are suspected to have played a critical role in increasing susceptibility of fish to infection by *A. invadans*. Lower water temperatures on post flood conditions may resulted in a retarded immune response in fish. Heavy rainfall and soils which are either naturally acidic or disturbed by agriculture or residential development may lead to a lowering of water pH, which might have caused skin trauma, providing a portal of entry for infective zoospores. Further, sudden changes in hydrographic parameters of estuarine water next to heavy freshwater influx after flood might have created stressful conditions for brackish-water fishes, paving the way for the spread of EUS, and concomitant bacterial infections.

The sporadic outbreaks of EUS post flood season and report of this destructive pathogen associated mortalities in closed and isolated facilities like ornamental facilities and negatively certified imported fishes suggests enzootic occurrence of this pathogen post flood seasons. Further, the expansion of hosts and co-infection with new bacterial pathogens should also viewed seriously, considering the 100% mortality in case of EUS outbreaks. In this context, the invasive nature of EUS and its apparent pathogenicity to many endemic host fish species endorse that EUS poses a substantial threat to other fishes, especially at the climate driven risks of floods in Indian continent. Surveillance, pathology testing, more vigilant reporting of suspected outbreaks and further investigation upon its spread and impact on wild and cultured fish has to be given priority, and this will assist in the development of comprehensive biosecurity practices against EUS spread in present scenario.

Impact of COVID 19 on marine fish marketing in Andhra Pradesh

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The impact of Covid-19 pandemic on the livelihoods of farmers, fisherfolk through a primary survey of fish supply chain operators in Andhra Pradesh was carried out during July and August 2021. Fifty sample respondents comprising, fishermen (6), retailers (31), wholesalers (11) and distributors (2) were selected from Srikakulam (Bandarivanipeta), Vizianagaram (Chintapalli), Visakhapatnam (Poodimadaka, Visakhapatnam Fisheries Harbour, and Pedda Jalaripeta), East Godavari (Amalapuram, Bhairavapalem, and Kakinada), and Krishna (Gilakaladindi) districts.

Most of the respondents (76%) were in the age group between 30-40 and 40-50. Literacy status of the respondents indicated that, 42 % were illiterate, while 26 % have completed higher secondary education (Table 1).

Table 1. Socio-economic characteristics of the respondents

Age distribution (Years)		Educational Status (%)	
Age range	Years	Grade	Frequency
30-40	18 (36)	Illiterate	21 (42)
41-50	20 (40)	Primary	9 (18)
51-60	7 (14)	Secondary	13 (26)
More than 60	5 (10)	Graduate	7 (14)

Note: Figures in parentheses indicate percent to total

The impact of covid-19 on several aspects of business affected by the COVID 19 pandemic were obtained from the respondents. This included information on production, demand, transportation, and trade, among other things. A major drop in fish business as a result of the COVID 19 pandemic was reported by 40% of the respondents. The COVID 19 pandemic, according to 76% of respondents, has resulted in a significant drop in demand for their products. Due to a significant drop in the price of their fish items, 52 % of respondents were affected (Table 2). The major reason for the reduction in demand for fish could be attributed to the initial inertia and fear among the consumers for fish consumption during the initial stages of the spread of the pandemic. More than 70% of respondents believed that due to the COVID 19 pandemic selling their products has become more difficult.

Furthermore, 84% of respondents have temporarily halted their fish business owing to a lack of ice and transportation to neighboring states. Fish trading was permanently closed for 8% of the respondents, 4% of respondents have ceased selling domestically, and 4% have stopped selling overseas as well. Fish trading, particularly export was badly affected due to lack of transportation facilities, difficulties in sending export documents due to non-functioning of postal/ courier services, and difficulties in clearing containers in the ports of importing countries.

During the pandemic, 76 % of respondents felt it is more difficult to market their products, while 24% felt

Table 2. Opinion of respondents on effect of fish business due to COVID 19

Category	Demand for fish	Fish Prices
Large decline	38 (76)	8 (16)
Slight decline	10 (20)	1 (2)
No change	0 (0)	26 (52)
Slight increase	1 (2)	15 (30)
Large increase	1 (2)	0 (0)

Note: Figures in parentheses indicate percent to total

Table 3. Opinions of fishermen regarding regulations implemented by Government as a result of pandemic

Fish processing / distribution (%)			Fish harvest (%)			Support (%)		
More	Less	No	Enhanced	Reduced	No change	Finance	In Kind (or) provisions	No support
16	46	38	20	2	78	0	48	52

it is more difficult to obtain inputs / goods. Despite the obstacles that fish traders face, such as access to markets, ice availability, labour, and transportation, it was discovered that an alternative and non-traditional marketing channel, Whatsapp group-based online marketing, has evolved in the retail sector. Due to the pandemic, 16% of respondents said that laws have been tightened, particularly on Sundays and public holidays. In contrast, 46% of respondents believe COVID has made regulations less restrictive. There has been no change in government restrictions for fish processing or distribution, according to 38 % of respondents. 20% of respondents believe that new government laws will help them harvest more during a pandemic. According to 78 % of respondents, government rules have had little effect on fish production (Table 3).

Regarding the level of government assistance received by respondents as a result of the pandemic. 52% of the respondents said they had received no help from the government. Other than cash assistance, 48% of respondents received mentioned support from state/ central governments in the form of rice and pulses (Table 3).In conclusion the COVID-19 outbreak and subsequent limitations had a negative influence on fish marketing operations in north Andhra Pradesh. Furthermore, skilled workers, migrant workers, and laboures being compelled to stay at home, affected all aspects of the marine fishery sector as well as their lives. Further financial relief to the sector and steps to reduce supply chain disruptions to avoid detrimental impact on the marine fishery sector of Andhra Pradesh is needed.

Brief Communications

On the rare stranding of a lactating sea cow and its calf in the Gulf of Mannar coast

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Two female sea cows (*Dugong dugon*), possibly a dam and her female calf got stranded on 08th September 2021, along the Gulf of Mannar coast at Mandapam (9°16'49.872"N; 79°10'35.583"E), Ramanathapuram district, Tamil Nadu. The morphometric details are given in the Table. Both the animals had relatively robust body with minor skin aberrations. The carcass of calf was comparatively fresh indicating that the mother would have died earlier and the calf later due to starvation. The internal organs of both the animals did not reveal any significant abnormalities towards the cause of death.

The sea cows (Dugongs) are found in Indo-pacific

Fig. 1. Stranded Sea cow (*Dugong dugon*) and its calf

Table 1 Morphometric details of the sea cows stranded at Mandapam, Tamil Nadu

Morphometric parameters		Measurement (cm)	
Tip of snout to fluke notch	:	336	131
Tip of snout to center of anus	:	237	101
Tip of snout to center of genital aperture	:	225	86
Tip of snout to center of umbilicus	:	185	65
Tip of snout to anterior insertion of flipper	:	80	28
Tip of snout to center of eye	:	40	18
Tip of snout to external ear	:	53	24
Center of eye to ear	:	12	6
Distance between centers of eyes	:	34	19
Center of eye to center of nostril (same side)	:	21	8
Flipper length, anterior insertion to tip	:	59	28
Flipper length, axilla to tip	:	43	23
Maximum width of flipper	:	24	12
Length of fluke	:	49	17
Width of fluke	:	69	26
Girth at umbilicus	:	214	101
Girth at axilla	:	161	75
Length, Muzzle (anterio-posterior)	:	26	13
Breadth, Muzzle (lateral)	:	25	11
Length, Chin	:	17	8
Breadth, Chin	:	19	9
Sex	:	Female	Female
Weight (approximate)	:	350 kg	60 kg

region and they are the only member of the order Sirenia. This herbivorous marine mammal mostly relies on bottom vegetation, primarily sea-grasses as their diet. As the sea grass beds are vulnerable to human destruction and disturbances the ultimate survival of this marine mammal would be uncertain. Moreover, there is an urgent need to carry out their population census in India.

A note on Spinetail Devil rays from Indian waters

During a regular fishery survey along the coast of West Bengal, a single specimen of Spinetail Devil ray (*Mobula mobular*) was recorded at Digha Mohana on 31st August 2021. The specimen was identified with the help of "Guide to the Manta and Devil rays of the world" by Stevens *et al*. (2018) and measurements recorded which were compared to similar, earlier published records. The specimen is among the largest sizes recorded for Spinetail Devil ray (Table 1). The key distinguishing features of the species was the presence of caudal spine, white tipped elongated dorsal fin, spiracle under a distinct ridge above the margin of the pectoral fin where it joins body, tail equal to or longer than disc width and white ventral markings wrap up behind and above eyes, just exceeding margin where pectoral fin joins body. The female individual was caught by a multiday trawl operated off Digha, West Bengal. Locally called as 'chill', it has very little demand in nearby markets such as Nandakumar (Purba Medinipur District) and Calcutta. According to fishermen, the species is very rare in landings and, whenever landed, cut into small pieces, salted, and sent to Kerala where there is local. The price at landing centre usually varies between ₹50-70 per kg depending on the demand.

Subal Kumar Roul*, Shikha Rahangdale, Sujitha Thomas and Prathibha Rohit | Digha Regional Station of ICAR-Central Marine Fisheries Research Institute

Table 1. Maximum size records of *Mobula mobular* in the world oceans

Maximum length (DW in cm)	Sex	Region/Area	References
455*	Unsexed	Gulf of Cadiz (Spain)	Lozano (1928)
127	F	Mumbai	Setna & Sarangdhar (1949)
470*	Unsexed	Paris Museum	Bigelow & Schroeder (1953)
112	Unsexed	Calicut	Devadoss (1984)
167.4	Unsexed	Gulf of Mannar	Talwar & Kackar (1984)
520**	Unsexed	Off Algeria	di Sciara *et al*. (1987); Pellegrin (1901)
340	F	Northern Tyrrhenian Sea	di Sciara & Serena (1988)
265	F	Gulf of Mannar	Rajapackiam *et al*. (1994)
265	M		
450*	F	Vizhinjam	Pillai (1998)
300	M	Adriatic Sea	Scaccoet *et al.* (2009)
140	F	Mumbai	Raje *et al*. (2009)
130	M		
79	Unsexed	Veraval	Borrell *et al*. (2011)
270	F	Gulf of Antalya	Başusta & Özbek (2017)
272	M		
320	F	Gaza	Abudaya *et al.* (2018)
306	M		
320	Unsexed	-	Stevens *et al*. (2018)
217	F	Gulf of California	Gaskins (2019)
350	Unsexed	Gulf of California	di Sciara *et al*. (2020)
483**	Unsexed	France	di Sciara *et al*. (2020)
270	F	Gulf of California	Serrano-López *et al*. (2021)
270	M		
339	F	Digha Mohana	Present study

Note: *The specimens were currently confirmed as *Mobula birostris* and

**the specimen is currently presumed to be of *M. birostris* (di Sciara *et al*., 2020)

Deformity in *Maculabatis gerrardi*

Worldwide, diverse morphological deformities have been reported in elasmobranchs of which most are from captive sharks and a few from free-swimming specimens. On 10 March 2021 a deformed juvenile ray (Disk Width 15 cm) caught in a hand trawl net operated by the non-motorised boat at 2 km distance from the shore was landed in New Mahe fish landing centre, Puducherry. The species was identified as *Maculabatis gerrardi* due to the characteristic bands on the tail. The ray was found to have rostral deformity due to incomplete fusion of the right and left pectoral fins with the head resulting in a deep cleft between the head and pectoral fins. There was also deformity in the pectoral fin with deep splits in the posterior half of the pectoral fins.

Fig. 1. Deformity in *Maculabatis gerrardi*

Reported by V. Mahesh*, P. Shiju, O. Remisha, Ramya Abhijith, P. K. Asokan and K. Vinod | Calicut Regional Station of ICAR-Central Marine Fisheries Research Institute.

Fishing with Gargoor traps in the Gulf of Mannar

Fish traps often used for the exploitation of demersal reef fishes have low impacts on the habitat. They are passive fishing gears with enclosures to which fishes are lured or guided and escape is made difficult using labyrinths or retarding devices like funnels or similar construction. In the Gulf of Mannar and Palk Bay fish traps made of bamboo or plastic-coated wire mesh, locally known as 'koodu' are extensively used for perch fishery. During field visit, numerous metal wire weaved traps placed in the Mookaiyur fishing harbour were found and further enquiry among the fishermen revealed that a person who worked in Iran has adapted the Gargoor trap technology used to catch fish in the Persian Gulf and Oman Sea. The trap weaved with metal wire (Number 18) in a basket shape (semi-sphere) has three parts: body, bottom and a semi-conical entrance of 1.2 m height, 2 m diameter and 35-60 mm mesh size. Two steel pipes are additionally tied in the bottom to sink the traps. The door of the gargoor (diameter 65-78 cm) functions as a one-way funnel and fishes are unable to get out of the trap due to its design. The traps are placed at 10-30 fathoms in a sandy/clayey bottom for 4-6 days and demersal fishes such as groupers, lethrinids, parrotfish, snappers and surgeonfish mainly constitute the catch in the traps. Normally 4-5 members are involved in this fishing operation. The cost of a trap is ₹2800 which lasts for about 7 months.

Reported by M. Rajkumar*, S. Thirumalaiselvan and R. Vinothkumar | Mandapam Regional Centre of ICAR-Central Marine Fisheries Research Institute

Record size of *Panulirus penicillatus* landed in Sakthikulangara Fisheries Harbour

The spiny lobster *Panulirus penicillatus* that lives on shallow rocky and coral reefs in the tropical Indo-Pacific region. A record size male specimen, *P. penicillatus* was collected from the lobster gillnet fishery at 50-60 m depth. It measured total length (TL): 344mm and weighed 2.04 kg. Measurements recorded were carapace length (CL): 150 mm; carapace width (CW): 110 mm; abdominal length (AL): 130mm; telson: 55mm; abdominal length + Telson: 185mm. Body was entirely brown black in colour. The specimen may be the maximum recorded size of the species on the south west coast of India.

Reported by Rekha Devi Chakraborty*, R. Ratheesh Kumar, K.N. Saleela, Aghana Muralidharan, L. Sreesanth and N. Ragesh | ICAR-Central Marine Fisheries Research Institute, Kochi-682 018, Kerala

Report of *Mola mola* (Linnaeus, 1758) from coastal waters of Maharashtra, Arabian Sea

Molas or Ocean sunfishes of family Molidae (Tetradontiformes) have a flattened and oval truncated body and thick leathery skin. They are targeted fishery in the western Pacific and South Atlantic but mostly bycatch in other fisheries globally. A single specimen of immature female *Mola mola* (810 mm TL, 28 kg) was observed in the Naigav night market, Palghar (Maharashtra) on 12.11.2021, caught by gillnetter operated off Vasai (19'37.621 N, 71'31 278 E), in the Arabian Sea was recorded during survey. There were no takers for the *Mola mola* fish in the Market due to unfamiliarity. The fish was identified following Sawai *et al.* 2017. Fin rays count for pectoral (12), Dorsal (18), Anal (17) and clavus (12) fins were recorded. Other sunfish species recorded in the region are *Ranzania laevis* and *Masturus lanceolatus*.

Table. 1. Morphometric and meristic characteristics of *Mola mola* from Maharashtra

Morphological characters	Measures (mm)
Snout length	128
Head length	270
Head depth	320
Eye diameter	45
Pre-anal fin length	560
Pre-dorsal fin length	505
Pre-clavus band length	660
Depth of the body	600
Total body depth	1365
Dorsal fin height	400
Dorsal fin base width	220
Anal fin height	380
Anal fin base width	310
Pectoral fin length	106
Pectoral fin base length	44

Reported by Thakurdas, Vicky Prajapati, Punam A. Khandagale, Suresh , P. Hrishikesh and K.V. Akhilesh* | Mumbai Regional Station of ICAR- Central Marine Fisheries Research Institute

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