VOL.66 NO.02 JULY-DECEMNER 2024 • PRINT ISSN 0025-3146 • ONLINE ISSN 2321-7898

JMBAI

JOURNAL OF THE MARINE BIOLOGICAL ASSOCIATION OF INDIA

ESTD.1958

MBAI

Marine Biological Association of India

सी एम एफ आर आइ

CMFRI

Available online at: www.mbai.org.in
doi:10.6024/jmbai.2024.66.2.2493-12

Historical and contemporary records of sunfish landings in Indian waters: Insights from archives, literature, and fisher networks

Rekha J. Nair, A. Gopalakrishnan and K. T. S. Sunil
ICAR-Central Marine Fisheries Research Institute, Kochi- 682018, Kerala, India.

*Correspondence e-mail: rekhacmfri@gmail.com
ORCiD: https://orcid.org/0000-0001-6835-0240

Received: 17 June 2024 Revised: 14 Oct 2024
Accepted: 14 Oct 2024 Published: 19 Dec 2024

Short communication

Abstract

The occurrence of five species of sunfish along the Indian coastline is reviewed for the period 1953-2022 based on published records for the period 1953-2021 and discussions with fishermen during the period 2017-2022. Four species of sunfish with 40 records have been documented belonging to three genera. Of the eighteen fishes of *Masturus lanceolatus* landed, 11 were on the east coast and 7 on the west coast; of the total thirteen numbers of *Mola mola* reported landed in Indian waters, six were from the east coast and seven from the west coast. The paper attempts to compile information on the landings of these giant slime eaters and to correlate it with the occurrence of blooms.

Keywords: *Sunfish, India, landings, jellyfish*

Introduction

One of the historic ironies faced in marine science is the lacunae in the knowledge of many iconic and charismatic species (Pope *et al.*, 2010). Ocean sunfish (Tetrodontiformes: Molidae), the heaviest bony fish, is still a mysteriously understood fish. Though an important resource from the biodiversity point of view, the gaps in the understanding of these species are a pointer to either a lack of commercial interest (Sims *et al.*, 2009) or inherent difficulties in gathering data from remote locations when animals are present in seemingly low abundances (Nelson *et al.*, 1997; Doyle *et al.*, 2008). Although IUCN has categorised the sunfish as data deficient (Rijnsdorp and Papakonstantinou, 2015) and vulnerable (Liu *et al.*, 2015), very little information has gone into the research of these iconic species. Ocean sunfish are present around the globe in warm and temperate waters and subject to bycatch by long lines, drift gillnets and midwater trawls in numerous fisheries (Pope *et al.*, 2010). Liu *et al.* (2015) suspect that this species is declining globally by at least 10% per decade, and recommend further monitoring. Ocean sunfishes are very important from the marine food web point of view since the large ocean sunfish primarily consume gelatinous zooplankton and are the largest gelativores in the world oceans (Cardona *et al.*, 2012; Harrod *et al.*, 2013; Nakamura and Sato, 2014). *Masturus lanceolatus*, *Mola alexandrini* and *Mola tecta,* reportedly dominate the tropical, subtropical, warm-temperate and cold-temperate waters, while *Mola mola* reportedly has two clades Pacific and Atlantic and are rarer in the South Pacific areas (Nyegard *et al.*, 2018a). Despite its worldwide occurrence in temperate and tropical seas, very little information has been gathered in India on these fishes except its occasional landing occurrences.

Sunfishes are identified by the character caudal fin replaced by a leathery, rudder-like lobe known as a pseudocaudal fin or clavus (supported mostly by fin-ray elements originally belonging to dorsal and anal fins; small eyes; small mouth placed terminal with teeth united and beak-like in each jaw without a median suture (Matsuura, 2015). Distributed circumglobally, extending through temperate and warm areas of all the ocean except polar regions, these fishes occur at a depth of 30 – 480 m (Allen and Erdmann, 2012; Liu *et al.*, 2015) and constitute five valid species *viz*. *M. lanceolatus* (Liénard, 1840); *M. ramsayi* (Giglioli, 1883); *M. mola* (Linnaeus, 1758); *M. tecta* Nyegaard, Sawai, Gemmell, Gillum, Loneragan, Yamanoue and Stewart, 2017 and *Ranzania laevis* (Pennant, 1776) in three genera. These fishes are laterally compressed deep and short-bodied, almost elliptical with modified scales which form denticles or spines (Nyegaard *et al*., 2018b); a small gill opening placed before the pectoral fin and a very high conical-shaped dorsal and anal fin is positioned opposite to each other. In the daytime, they spend mostly at a depth of 50-200 m; at night, they dive up to 100-250 m depth. They are dynamic swimmers, adept at independent movement in ocean currents (Cartamil and Lowe, 2004).

Sunfish reportedly feed on jellyfish, molluscs, zooplanktons, brittle stars and fishes (Clemens and Wilby, 1961; Scott and Scott, 1988) with juveniles (when they're under one metre in length), having a mixed diet of jellyfish and other species that live on the seafloor, like crustaceans, molluscs, and even some fish. Our knowledge about the natural history of *M. lanceolatus* in Indian waters is very sparse. *M. lanceolatus* does not form part of any targeted catch in Indian waters probably due to its tetrodotoxic character (Halstead and Vinci, 1988) and the first poisoning caused by *M. lanceolatus* was reported by Huang *et al.* (2011). The fish is listed as data deficient in IUCN (Leis *et al*., 2015). Sunfishes are mostly landed as bycatch in longlines, gillnets, shore-seine, purse seine and trawlers (Khan, 1975; Ram Bhaskar *et al*., 1988: Manojkumar *et al*., 1998; Silvani *et al.,* 1999; Cartamil and Lowe 2004; Chellappa *et al*., 2006; Fulling *et al*., 2007; Peterson and McDonell, 2007; Nair *et al*., 2013; Dube *et al*., 2013) with few reports of shore strandings by storm or after collision with fishing vessels (Lyons, 2019). Except for *M. tecta*, all other four species of sunfish have been reported from the east and west coasts of India. The rising number of sunfish landings in India seems to follow a pattern as is highlighted by the increase in recent publications, which warrants a thorough compilation of the literature on the landing pattern in India with the available input on the biology and ecology of this species. A summary of current landing observations is presented, and possible conclusions to the occasional series capture issues and methods for addressing fundamental gaps in our knowledge.

Material and methods

Detailed records were compiled from archive sources, published information (newspaper reports, popular and scientific reviews and papers) and discussions with fishermen for the period 1953-2022. The published literature was tabulated to get an account of the landings reported from different coasts. Besides a personal communication link with fishermen was maintained to request them to inform of possible landings of sunfish at any possible harbours. Species identification of sunfishes on the field was done using basic field guides. The marine fish landings data used in this study/publication are research data of ICAR-CMFRI collected through diachronic primary surveys following a stratified multi-stage random sampling design across the coastline of mainland India.

Results

A collation of the published information and review showed the presence of five species of sunfish being landed along the coasts of India since 1956, with 40 records documented so far (Fig. 1). The five species reported from Indian waters are *M. lanceolatus,* (which includes the *Masturus oxyuropterus* which has now been synonymised with *M. lanceolatus), M. mola, M. ramsayi,* (including the *Mola alexandrine* which has now been synonymised with *Mola ramsayi), R. laevis* (including the *Ranzania truncate* which has been synonymised as *R. laevis).* Dominance in the landing is seen on the east coast compared to the west coast over the years (Fig. 1) with the total length ranging from 529 mm to 1830 mm on the east coast and 525 mm to 1240 mm on the west coast.

Mola lanceolatus (Liénard, 1840)

The original type and paratype of *M. lanceolatus* was reported from Port Louis, Maurice on 24 May 1836 (4 feet long and weighed 107 pounds) and 7 February 1839 (7 feet 10 inches long) and weighed 675 pounds. However, the counts vary greatly with that of the latter publications; no information on the sex of the fish is available.

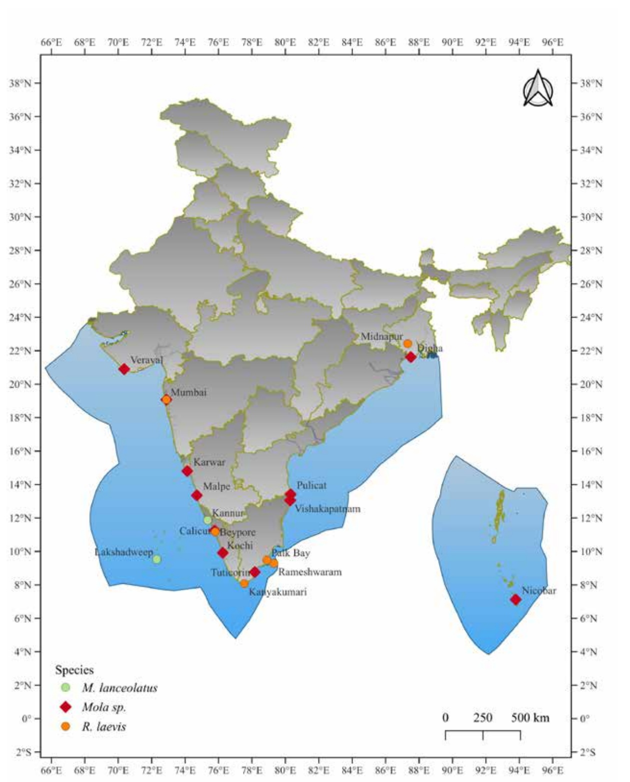

Fig. 1. Coastwise distribution of landings of sunfishes

The first report of a small sunfish landing in India was by Day (1889) in the Fauna of British India (p. 809); however, there are no further descriptions of this fish since it was destroyed in a fire at the Colombo Museum. Day mentions that the species deposited could either be the widely ranging *Orthagoriscus mola (ie, M. mola*) which was already reported by Klunzinger from the Red Sea, or it may be *Orthagoriscus oxyuropterus,* described by Bleeker (1873) from Amboina which was later synonymised as *M. lanceolatus* or possibly a nondescript. However, no clear identity has been placed on that specimen. From the west coast of India, Kulkarni (1953) reported the first record of the landing of *M. lanceolatus* (Table 1). The fish weighed 9 kg and measured 939.8 mm and was preserved for display in a school. Later, Devaraj *et al.* (1976) reported the details of a sunfish of total length (TL) 88 cm which he called *Masturus oxyuropterus* which has now been synonymised with *M. lanceolatus.* (Fig. 1). In August 1993 (Arumugam *et al*., 1994) recorded the landing of a large sunfish with a total length of 1535 mm and body depth of 815 mm which was caught from a depth of 60-90 m in the drift gill net (Paruvakad) operated off Tuticorin on the southeast coast of India. Following this, a still larger specimen (1830 mm) of the same species was recorded (Badrudeen, 1995) for a second time from Periyapattinam, Gulf of Mannar the same locality. After a gap of 17 years, a juvenile of 529 mm was reported by Senthil Kumar (2001). In July 2001, Chellappa *et al.* (2006) recorded an adult male *M. lanceolatus* of length 1150 mm off Tuticorin, Tamil Nadu along with a *M. mola*. The fish was caught by a deep-sea trawler at a depth of 200 m off Tuticorin. In 2007, a juvenile fish of 840 mm was reported by Ramamoorthy *et al.* (2007) at Ervadi, Gulf of Mannar biosphere. The fish was found to drift ashore in the Sadaimuniyam Valasai area. After a gap of four years, Das *et al.* (2012) detailed a male sunfish of TL 1270 mm and weight 70 kg which was caught in a drift gill net operated 20 km away from Parangipettai, south-east coast of India. (Fig 1). The following year, Nair *et al.* (2013) recorded the accidental catch of an adult *M. lanceolatus* of TL 1705 mm in a drift gillnet at Kochi which was the second-largest record from Indian waters. The same year, Das *et al.* (2014) reported the first occurrence of fish from the Lakshadweep Islands, which had a total length of 1470 mm and a weight of 100 kg. In 2013, a fish 132 cm long (TL) and aged 13-14 years (Prakash *et al*., 2016) was recorded from Cuddalore waters. Naranji *et al.* (2016) detailed a fish of length 1390 mm landed at Visakhapatnam harbour which was the first record from the area. The same year Babu *et al.* (2019) reported the landing of an *M. lanceolatus* in Kasimedu fish landing of a total length of 1200 mm and weight of approximately 44 kg caught accidentally in a gill net from a depth of 180–220 m from Chennai. A larger *M. lanceolatus* of total length 1800 mm and weight 70 kg caught at a depth of 150 m in a drift gill net during a multiday fishing operation for 4-5 days about 40 km from shore was landed at Tharuvaikulam landing centre in July 2016 (Kannan *et al*., 2017). This was the largest recorded sunfish after the 1994 landing of 1830 mm at Periyapatnam on the SE coast. In April 2017, 762 mm *M. lanceolatus* was accidentally caught by fishermen and landed at Crawford Harbour, Mumbai by fishermen who could not sell this fish according to Ganesh B Nakhawa, Chairman, of Maharashtra Purse Seine fishermen. Subsequently, in August and October 2017, two sunfishes of *M. lanceolatus* with TL 700 mm and 1705 mm were landed at Calicut and Azhicode in Kannur respectively (Rekha, pers. comm). Based on the above-said literature, it is evident that the current reporting of the sunfish is the 17th record (Table 1) in India and most frequently landed along the Indian coast followed by *M. mola*, *R. laevis* and *M. alexandrine.* The length range of the *M. lanceolatus* landed ranged from 880 to 1830 mm, with a weight of 15 to 100 kg.

Mola mola (Linnaeus, 1758)

Hora reported that the landing of *M. mola* by Japanese divers in the Nicobar Islands in 1929-30 was the first report from Indian waters. The first formal report of a landing of *M. mola* was by Khan (1975) of a fish of length 1240 mm caught from Satpati, 96 km north of Mumbai waters in 1973. In May 1986, a fish of TL 912 mm was caught in a hook and line from a depth of 200 m off Visakhapatnam (Ram Bhaskar *et al*., 1988). After a gap of 10 years, four male sunfishes in the length range 870-1030 mm and weight 40–49 kg were caught by trawl nets operating at 25-50 m in the coastal waters off Veraval. (Manojkumar *et al*., 1998). In June and July 2001, two sunfishes *M. mola* measuring 630 and 650 mm in total length and weighing 11.5 and 12 kg were landed at Keel Vaipar, a hamlet situated 30 km north of Tuticorin (Chellappa *et al*., 2006). After a gap of three years in 2005 four numbers of *M. mola* were caught in a large drift gill net locally called "Paruvali" from a depth of 60-100 m, while the gear was operated for large pelagic fishes along the Tuticorin Coast in Gulf of Mannar, of which three numbers landed at Thiruvaikulam, a fishing hamlet 15 km north of Tuticorin, and one sunfish was landed at Kayalpatnam, another fishing village 40 km south of Tuticorin. (Chellappa *et al*., 2002). From the west coast of India, in January 2006 from Malpe Fisheries Harbour (Thomas *et al*., 2006) and in March 2006, a juvenile *M. mola* of TL 70 cm (Manojkumar and Pavitran, 2007) was reportedly caught in a trawl net operating at a depth of 70 m at Beypore, Calicut. In August 2013, after 7 years, another juvenile *M. mola* of TL 95 cm and weight 50 kg was reported landed at Karwar (Dube *et al*., 2013). After a gap of 5 years, four *M. mola* fish juveniles were landed in the Cochin Fisheries Harbour caught in drift gill nets. In 2016 a fish of 1800 mm total length (TL) was landed at Tharuvaikulam landing centre, Gulf of Mannar. (Kannan *et al*., 2017). Later in

© Marine Biological Association of India

Table 1. Consolidated records of all sunfish reports from India (1953 -2021)

Species name	Area	Total length (mm)	Type of net	Reference
Masturus lanceolatus	Bombay waters	925	-	Kulkarni, 1953
Ranzania laevis	Malabar coast near Beypore	610	-	Chacko and Mathew, 1964
Ranzania laevis	Sassoon Dock, Bombay city	571	-	Chhapgar, 1964
Mola mola	Off Satpati, Bombay	1240	Gill net	Khan, 1975
Masturus lanceolatus	Gulf of Mannar	880	Shore- seine	Devaraj *et al.*, 1976
Ranzania laevis	Erayumanthurai, Kanyakumari, Tamilnadu	616	Shore- seine	Ebenezer and Joel, 1984
Mola mola	Vishakapatnam, Andhra Pradesh	912	Hook and Line	Ram Bhaskar *et al.* 1988
Mola mola	Porbandar 30 -40 km SE, 47 fathoms	1040, 750 mm width	Gill net	CMFRI
Masturus lanceolatus	Off Tuticorin, Gulf of Mannar	1535	Drift gill net (Paruvalai)	Arumugam *et al.*, 1994
Masturus lanceolatus	Periapattinam, Gulf of Mannar	1830	-	Badrudeen, 1995
Mola mola	Bhidia Fish Landing Centre, Off Veraval, Gujrat	1000, 870, 1030, 900	Trawl net	Manojkumar *et al.*, 1998
Ranzania laevis	Mandapam, Palk Bay	660	Shore- seine	Victor *et al.*, 1998
Ranzania laevis	Midnapur, West Bengal	494 SL	Trawl net	Kar and Chakraborty, 2000
Masturus lanceolatus	Cuddalore, Tamilnadu	529	-	Senthil Kumar, 2001
Mola mola	Off Keel Vaipaar, Tuticorin, Tamilnadu	630 & 650	Drift gill net (Paruvalai)	Chellappa *et al.*, 2002
Masturus lanceolatus	Off Tuticorin, Tamilnadu	1150	Trawl net	Chellappa *et al.*, 2002
Mola mola	Tuticorin, Tamil Nadu	-	Drift gill net (Paruvalai)	Chellappa *et al.*, 2006
Ranzania laevis	Rameswaram, Gulf of Mannar	620	Shore- seine	Sukumaran and Kasinathan, 2006
Mola mola	Calicut	700	Trawl net	Manojkumar and Pavitran, 2007
Mola alexandrini	Chennai, Tamil Nadu	835	Trawl net	Mohan *et al.*, 2006
Mola mola	Malpe Fisheries Harbour	-	Multiday trawl	Thomas *et al.*, 2006
Masturus lanceolatus	Ervadi, Gulf of Mannar	840	-	Ramamoorthy *et al.*, 2007
Masturus lanceolatus	Parangipettai, Tamilnadu	1270	Drift gill net	Bandana *et al.*, 2012
Ranzania laevis	Pamban, Tamilnadu	550	Kalamkattivalai (similar to gill net)	Ramamoorthy *et al.*, 2007
Ranzania laevis	Arabian Sea, Off Vasai, Mumbai	525	Multiday dol net	Purushottama *et al.*, 2014
Mola mola	Karwar	950	Purse seine	Dube *et al.*, 2013
M. lanceolatus	Kochi, Kerala	1705	drift gill net	Nair *et al.*, 2013
M. lanceolatus	Lakshadweep Island	1470		Das *et al.*, 2014
M. lanceolatus	Cuddalore, Tamil Nadu	1350		Prakash *et al.*, 2016
M. lanceolatus	Visakhapatnam, Andhra Pradesh	1390	Trawl net	Naranji *et al.*, 2016
M. lanceolatus	Kasimedu, Chennai, Tamil Nadu	1200	Gill net	Babu *et al.*, 2019
M. lanceolatus	Tharivaikulam landing Centre, Gulf of Mannar	1800	Drift Gill net	Kannan *et al.*, 2017
M. lanceolatus	Mumbai Crawford	762		Newspaper report (Ganesh Nakhawa,) 2017
M. lanceolatus	Calicut	700		Rekha, (Pers comm, 2017)
M. lanceolatus	Azhicode (Kannur)	1705		Rekha (Pers comm, 2017)
Mola mola	Cochin Fisheries Harbour, Kerala			Newspaper, 2018
Mola mola	Digha Mohona, (21°37.843'N,87°32.827'E) West Bengal	780, 685 mm	Trawl net	Ray *et al.*, 2019
Mola mola	Pulicat, Tamil Nadu	1000		Muthaiyah (Pers, Comm) 2019

2019, two specimens of TL 685 and 780-mm were collected from Digha Mohona (21°37.843'N, 87°32.827'E) by using trawl nets (Ray *et al.*, 2019). In 2019, a huge *M. mola* of TL 1 m was caught from the Pulicat Lake, (Muthiia *pers. comm*), Tamil Nadu which was the first of type report from that area. The type of *M. mola* was first described as *Tetraodon mola* by Linnaeus from the Mediterranean Sea; however, only pectoral fin counts of the fish are available.

Ranzania laevis (Pennant, 1776)

The first record of landing of this species in India was that of a female fish in February 1956 in a shore seine at Beypore, (Chacko and Mathew, 1964) seven miles south of Calicut. The female specimen of *Ranzania truncata* measured 61 cm in length and 30 cm in width. Following this, in 1964, Chapghar (1964) recorded another specimen of *R. truncata* with a total length of 571 mm and a weight of 6.5 kg. (Table 1). The next landing reported was that of a male fish after 20 years in 1984 in a shore seine on the southeast coast at Erayumanthurai, Kanyakumari, Tamil Nadu (Fig. 4). The fish had a total length of 616 mm, weighed 8 kg and was fully mature; it was caught in a shore seine operated at a distance of 1 km from the shore, at a depth of 22 m. Victor *et al.* (1998) reported the landing of a fish measuring 660 mm in total length in March 1998 at Palk Bay on the southeast coast, in a shore seine operation near Mandapam in Palk Bay. The northernmost record of the fish was the landing of a fish 494 mm SL in a trawl net in November 1998, from Midnapur, West Bengal (Kar and Chakraborty, 2000). Eight years later, in 2006, a fish of TL 620 mm weighing 7 kg was caught in the shore seine from the Gulf of Mannar near Rameswaram (Sukumaran and Kasinathan, 2006). The next report was in November 2011 when a fish of a total length of 550 mm was landed at Chinnapalam fish landing at Pamban on the southeast coast of India in *kalamkatti valai* (gillnet). The last official record was in 2013 (Purushottama *et al.*, 2014) from a multiday dolnet operated 150 km away from Pachu Bandar Vasai Fort, Mumbai, Maharashtra when an *R. laevis* of 525 mm and weight of 3.8 kg was landed. However, there have been reports from the Sri Lankan side of the capture of this fish (65 kg) brought to the Ottamavadi fish market on 30. 7. 2010 (https://www.flickr.com/photos/arne/9406027797/in/photostream/). The fish has been reported from Bangladesh waters also.

Mola alexandrini (Ranzani, 1839) (previously reported as M. ramsayi)

M. ramsayi is characterized by 16 fin rays on the clavus region, of which 8 bear ossicles. It closely resembles *M. mola* but differs in the number of fin rays on the clavus and the rougher nature of the skin (Bass *et al.*, 2005). Occurrences of *M. ramsayi* in Indian waters are very rare; the first record was from the east coast by Mohan *et al.* (2006) wherein a male specimen measuring 835 mm and mass of 10.5 kg was landed at Chennai Harbour by a mechanised trawl netter. (Table 1). The next report of landing was at Munambam Fisheries Harbour, Kochi, southwest, Kerala on the eastern Arabian Sea in 2013; the fish had a total length of 1110 mm and weighed 50 kg. The fish was caught by trawlers at a depth of 50 m off Quilon (80 58' 487 N and 760 05' 381 E) while operating for threadfin breams along the Kerala coast. (Kishore *et al.*, 2014). The most recent record of *M. alexandrini* was again on the northwest coast (Raje, *pers comm.*) Sassoon Dock, Mumbai in October 2021.

Discussion

Total landings of *M. lanceolatus* along the Indian coasts showed a dominant preference for landing on the east coast over the west coast. Of the 18 fishes landed, 11 were on the East Coast and 7 on the West Coast; the length range of the samples ranged from 529 -1800 mm on the East Coast and 700-1705 mm on the West Coast. Of the total 13 numbers of *M. mola* reported landed in Indian waters, six were from the East Coast and seven from the West Coast. Many environmental variables have been linked to species distributions of fishes worldwide. The largest recorded size of *M. lanceolatus* was a male of 337 cm (Tortonese, 1990) while the biggest one recorded from Indian waters was in 1994 of 1830 mm. The maximum recorded length of *M. mola* is 333 cm (Claro, 1994) and the greatest recorded mass is 2·3 t (Roach, 2003). Although far from these gigantic sizes, most of the records of *M. mola* from Indian waters are of relatively small individuals. Of the 13 fish for which the length is available, the total length ranges from 63 to 180 cm and 5 were about 100 cm (Table 1). *R. laevis* commonly called the slender sunfish with a maximum reported length of 100 cm (Claro, 1994) prefers water temperatures between 15 and 28 °C with a mean of 24 °C (Kaschner *et al.*, 2016) and was generally reported from waters at around 20 °C (Robinson, 1975; Solokovskaya and Sokolovskiy, 1975; Castro and Ramos 2002; Wan and Zhang, 2005). Of the seven reports from Indian waters, four are from the southeast *ie* the Gulf of Mannar waters in the cooler season and the other three are from the Northern Arabian Sea. Several authors stated various reasons for the landing of sunfish *viz.* rise in sea surface temperature shark attacks, and accidental entanglement in fishing gear or vessels. However, most of the sunfish landed in Indian waters were in good condition leading to the equation that these fishes were either basking or feeding when entangled in nets. Of the 40 sunfish landings reported from the Indian waters 21 were from the west coast and 19 from the east coast and Palk Bay region. The present compilation points to the presence

© Marine Biological Association of India

of *M. lanceolatus* more in the northeastern waters during the southeastern monsoon period of July–August. (Table 1). *R. laevis* has been recorded from the west coast of India during March and the east coast during the southeast monsoon period of November to January. Studies point to the fact that the Ocean sunfish abundance was positively correlated with sea surface temperature and Chlorophyll *a*, indicating that a combination of both temperature and productivity dictates spatial use (Sims *et al.*, 2009). Babu and Joseph (2002) collated the landing of the Indian sunfishes between February to July to the steady increase in sea surface temperature of the Indian Ocean. Studies by Santosh *et al.* (2002) indicate upwelling in the section at 16°30′ and 18° 30′ N characterized by low temperature, high salinity and low oxygen. There have been reports of upwelling during this period along the east coast (Lafond, 1957, Murthy and Varadachari, 1968). Sasmal (1989) reported that the isotherms of the subsurface layer along l9°N associated with low-temperature water in the southern sector at 50 m level indicated upwelling along the coast. Reports of the movement in the northern hemisphere are northward being performed in late winter-spring and southward being performed in late summer-autumn (Dewar *et al.*, 2010; Potter and Howell, 2011; Thys *et al.*, 2015; Sousa *et al.*, 2016 b). The migration pattern of *M. mola* is mostly associated with warmer sea surface temperatures since these fishes always avoid cooler temperatures (Thys *et al.*, 2015).

Ocean sunfishes are present around the globe in warm and temperate waters and are subject to bycatch by long lines, drift gillnets and midwater trawls in numerous fisheries (Pope *et al.*, 2010). Sunfish landings by storm strandings or vessel strikes are reported to be very rare in India (Purushottama *et al.*, 2014). Accidental entanglement in fishing gear is one of the main threats to molid populations, as bycatch in longlines, (Joung *et al.*, 2005), in surface gillnet fisheries (Mangel *et al.*, 2019) and tuna gillnet fisheries in Pakistan (Moazzam, 2020 a). In Peru, *M. mola* and *M. lanceolatus* have been reported as bycatch in both types of fisheries, which essentially target dolphinfish, *Coryphaena hippurus* Linnaeus, 1758, and different sharks (Alfaro-Shigueto *et al.*, 2010). The main threat faced by this species is the high rates of bycatch as in other parts of the world (Silvani *et al.*, 1999; Fulling *et al.*, 2007). It is also evident that fishery bycatch and discards are increasing with the increase of fishing efforts and enhanced production along the east coast of India as well as the West Bengal coast which not only effect discarded bycatch but also the entire food web continuously (Vivekanandan, 2013). Observing the gradual decline of the species *M. mola*, it is listed as Vulnerable (VU) in the IUCN Red List category (Liu *et al.*, 2015).

Sunfish are known to feed on jellyfish, siphonophores and salpids (Fraser-Brunner 1951) which are now frequently found along the Pakistan coast (Moazzam, 2020 a) and the west coast of India. Major entanglements of sunfishes were reported from the continental margin along the Sindh and Balochistan coast. As jellyfish and gelatinous biomass are the most preferred food for sunfishes (Fraser-Brunner, 1951), Gibbons and Richardson (2009) Pope *et al.* (2010), Nakamura *et al.* (2015), co-relates the relationship between the occurrence of sunfish and blooming pattern of jellyfish. From October 2019 to May 2020, a massive bloom of jellyfish *Crambionella orsini* occupied a major part of the Arabian Sea including Pakistan, Iran, Oman and India. Additionally, blooms of gelatinous biomass including siphonophores and salpids have been frequently reported along the same area (Moazzam, 2020 b). Sunfish entanglement has been high in Pakistan waters. The increase in the number of entanglements from 2016 to 2019 in Pakistani waters was attributed to an increase in the frequency of blooms of jellyfish and other gelatinous material. (Moazzam, 2020 b). Two major blooms were reported in the literature during the period April–July and October 1995–1996 and November 2012 to February 2013 on the east coast. During the post-monsoon of 2013, a bloom of jellyfish occurred and large numbers were washed along the coast of Kerala (The Hindu Newspaper, 2013). Dube *et al.* (2013), Nair *et al.* (2013) and Das *et al.* (2014) recorded two species with three documentations of sunfishes along the coast of Kerala and Lakshadweep Island. (Table 1). Another bloom was sighted in 2017 along the coast of Goa (Times of India Newspaper, 2017), and also the entanglement of sunfish in the trawlers of Kerala (Kishore *et al.*, 2014), which may have been struck in its path during its migration. Breen *et al.* (2017) also noted that the migration pattern of sunfish depends on jellyfish blooming along the northeast Atlantic, where the sunfish was seen moving in the winter months. Because jellyfish prefer warmer water for spawning, greater sea temperatures play a significant role in the blooming of the species. These two findings are closely comparable to that of Thys *et al.* (2015), who found that sunfish migration depends on increased ocean temperatures and the blooming occurrences of jellyfish (Gibbons and Richardson, 2009).

The prevalence of large numbers of jellyfish in coastal waters of the northwestern Bay of Bengal has also influenced plankton ecology (Table 2). The heterotrophic dinoflagellate that is consumed by *M. mola* has a competitive advantage against jellyfish, which could be the reason for the increased frequency of occurrences in Southeast India. Studies by Gremillet *et al.* (2017) on the ocean sunfish as ocean health indicators clearly showed that these organisms are surprisingly abundant in areas that are heavily overfished as well as exposed to ocean warming and high ocean sunfish numbers are suggestive of very high regional jellyfish stocks. Due to their larger size, sunfish are significantly easier to observe compared

Table 2. Jellyfish blooms along the Indian coast

Region (coast)	Latitude-longitude	Period	Species	Nos./remark	Reference
Astaranga (East)	19.95296° N, 86.35975° E	May-16	*Porpita porpita*	> 100000	The Sambad, 2016
Puri (East)	19.79737° N, 85.83531° E	May-18	*Porpita porpita*	> 100	The Sambad, 2018
Dhalabali (East)	19.66156° N, 85.45819° E	Dec-12	——-	80–100	Sahu and Panigrahy, 2013
Rushikulya (East)	19.36819° N, 85.06302° E	November 2012 to Feb-13	*Pelagia noctiluca*	1–7 nos/10 m2	Baliarsingh *et al*., 2020
Gopalpur (East)	19.26228° N, 84.91537° E	Dec-12	——-	——-	Sahu and Panigrahy, 2013
		Apr-14	——-	——-	Baliarsingh *et al*., 2020
Visakhapatnam (East)	17.71295° N, 83.32311° E	Feb-15	*Crambionellastuhlmanni*	500 kg of jellyfish	Deccan Chronicle, 2015
Hamsaladeevi (East)	15.96259° N, 81.12808° E	Sep-15	——-	4 (each 25 kg)	The Hindu, 2015
Chennai (East)	12.98249° N, 80.26901° E	March, 2019	*Porpita porpita*	——-	The Hindu, 2019
Kalpakam (East)	12.52228° N, 80.16547° E	April–July and October 1995–1996	——-	——-	Masilamoni *et al*., 2000
Rameswaram (East)	9.285583° N, 79.33589° E	May-17	——-	——-	DTNEXT, 2017
Thiruvananthapuram (West)	8.488269° N, 76.90127° E	Oct-13	——-	> 100	The Hindu, 2013
Karwar (West)	14.80072° N, 74.11443° E	Oct-18	——-	> 1000	Deccan Herald, 2018
Goa (West)	15.25032° N, 73.92025° E	Jan-19	Purple-striped jellyfish	——-	Times of India, 2019
		Oct-15	*Physalia physalis*	——-	Times of India, 2015
Mumbai (West)	19.10957° N, 72.82336° E	July–August 2018	*Physalia physalis*	——-	The Indian Express, 2018
Jakhau (West)	23.23420° N, 68.56806° E	November–December and April–May	Family: Rhizostomatidae	——-	Cadalmin, 2010
North Malabar. Kerala	12.1510° N, 75.1420° E	November -March	*Acromitus flagellatus, Chrysaora caliparea*		Mongabay, 2021 ((online: news. mongabay.com/2021)
Hare Island, GOMBR	(09°11.779′ N, 079°04.420′ E		*Pelagia noctiluca*	> 100/m2	Ramesh *et al*., 2021
Manali Island, GOMBR	(09°13.15′ N, 079°07.33′ E				

to gelatinous zooplankton. Consequently, research efforts should focus on documenting their spatiotemporal patterns of occurrence. Correlating the landings of the Sharptail mola with available published information on the jellyfish bloom and gelatinous zooplankton forming a major diet of the *M. mola* (Fraser-Brunner, 1951) it is seen that there is a strong correlation with the blooms on the Indian coast. Long-term popup satellite tagging studies of *M. mola* in the north western Pacific (Dewar *et al*., 2010) and three regions of the Atlantic (Sims *et al*., 2009; Potter and Howell, 2011) show no evidence of *M. mola* movements across ocean basins, but rather protracted occupation within hemispheric ocean margins. In these studies, latitudinal movement patterns correlated with seasonal changes in temperature and productivity, indicate favourable thermal and foraging habitats (Sims *et al*., 2009; Dewar *et al*., 2010; Potter and Howell, 2011). The exact relationship between sunfish distribution and SST is not well understood, as sunfish may be able to achieve thermoregulation within the mixed layer when conditions are favourable (Cartamil and Lowe, 2004; Potter and Howell, 2011). Sunfish diving behaviour appears to be very flexible in response to environmental conditions and prey distributions (Hays *et al*., 2008; Sims *et al*., 2009; Sousa *et al*., 2016). The wide distribution of each sunfish species, and the large geographic overlaps between species, may be due to its capacity to balance thermal, oxygen and prey-seeking budgets in variable oceanic conditions. The aggregation of marine pelagic vertebrates in areas dominated by steep thermal gradients such as tidal and shelf-break fronts, upwelling regions, mesoscale eddies and oceanic fronts has also been documented widely. Chlorophyll *a* also influences the distribution and migration of marine predators such as loggerhead turtles albacore tuna (*Thunnus alalunga*) and whale sharks (*Rhincodon typus*). Hence, the importance of these oceanographic phenomena.

Mola mola holds an overall low commercial value globally (Fulling *et al*., 2007) and directed fisheries are largely restricted to Asian waters (Sagara and Ozawa, 2002; Liu *et al*., 2009; Kang *et al*., 2015). Nonetheless, high bycatch rates are reported worldwide and severe localized declines have been documented, leading the International Union for Conservation of Nature (IUCN) to recently categorize this species as 'Vulnerable' (Liu *et al*., 2015). Deep diving behaviour, migration patterns, population structure and ecology of the family are still difficult to understand due to the lack of detailed studies in Indian waters and the rare availability of these species. Further research is needed to fully elucidate the natural history of molids in Indian waters since academic and oceanographic studies are lacking in this area in the Indian context of these species.

Conservation implications

The study points to the presence of five species of sunfish landings across the Indian coast with a predominant area around the southeast coast of India. Of the over 50 numbers that landed in the harbours, 45 numbers were officially recorded scientifically. The species that landed most was *M. lanceolatus* on the southeast coast of India especially in the Gulf of Mannar area. Official landing records are available only up to the year 2017. Though the meat of the fish is not in demand in local markets, the flesh of the ocean sunfish is considered a delicacy in some regions, the largest markets being Taiwan and Japan. All parts of the sunfish are used in cuisine, from the fins to the internal organs. Some parts are used in certain areas of traditional medicine. Though there is no clear linkage between the presence of jellyfish bloom and the sunfish landing, the presence of a migratory pattern of the sunfish along the Indian coast cannot be challenged since there have been reports of sunfish getting caught serially in fishermen's nets along the southwest and southeast coast and getting discarded since they are of no use in trade locally. Given the importance of location and environmental conditions in shaping the stranding and catches of sunfishes in Indian waters, more studies must be focussed on these gentle giants. A citizen science study can help gather information on this vulnerable species which though highly fecund may disappear from our waters forever. Moreover, there is no existing baseline of information on the basic biology, distribution, abundance or fishing-induced mortality of this unique fish. Scientists have no idea how the global population of ocean sunfish is faring. There is no regulation of the fishery or bycatch of ocean sunfish anywhere in the world and any little information available will help protect this gentle slime eater. Stakeholder involvement is a possible mitigation measure which can be adopted for these giants. With the availability of bloom notifications on the coast, advisories for the lookout of this species can be advocated to the stakeholders and fishing vessels to prevent ship strikes and mortality of the species.

Acknowledgements

The authors thank the Indian Council of Agricultural Research for the facilities provided. The authors also wish to thank the numerous fishermen and the numerous friends who contributed data freely.

Author contributions

Conceptualization: RJN; Methodology: RJN; Data collection: RJN, SKTS; Data analysis: RJN, SKTS; Writing Original draft: RJN, AG, SKTS; Writing review and editing: RJN, SKTS; Supervision: RJN, AG

Data availability

The data are available and can be requested from the corresponding author.

Conflict of interests

The authors declare that they have no conflict of financial or nonfinancial interests that could have influenced the outcome or interpretation of the results.

Ethical statement

No ethical approval is required as the study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of sensitive samples/ protected environments.

Funding

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

References

Alfaro-Shigueto, J., J. Mangel, M. Pajuelo, P. H. Dutton, J. A. Seminoff and B. J. Godley. 2010. Where small can have a large impact: Structure and characterization of small-scale fisheries in Peru. *Fish. Res.,* 106: 8-17.

Allen, G. R. and M. V. Erdmann. 2012. Reef fishes of the East Indies. Perth, Australia: Universitiy of Hawai'i Press, Volumes I-III. Tropical Reef Research.

Arumugam, G., T. S. Balasubramaniam and M. Chellapa. 1994. On the largest sunfish ever caught from the Indian seas. *Mar. Fish. Infor. Serv. T & E Ser.*, 128: 16-17.

Babu, C. A. and P. V. Joseph. 2002. Post-monsoon sea surface temperature and convection anomalies over Indian and Pacific Oceans. *Q. J. R. Meteorol. Soc.,* 22(5): 559-567.

Babu, C., K. Silambarasan, A. Anrose and L. Ramalingam. 2019. A new record of a rare species *Masturus lanceolatus* (Point-tail sunfish) from Chennai coastal waters, India. *Indian J. Geo-Mar. Sci.*, 48 (3): 297-301.

Badrudeen, M. 1995. On the largest sunfish Masturus lanceolatus Leonard recorded at Periapattinam, *Gulf of Mannar. Mar. Fish. Infor. Serv. T & E Ser.*, 137: 20.

Baliarsingh, S. K., A. A. Lotliker, S. Srichandan, A. Samanta, K. Nimit and M. B. Nair. 2020. A review of jellyfish aggregations, focusing on India's coastal waters. *Ecol. Process.,* 9: 58.

Bandana, D., A. Gopalkrishnan and A. Saravanakumar. 2012. Rare catch of *Masturus lanceolatus* (Lienard, 1840) Gill, 1885 from Parangipettai coast, Tamilnadu. *Indian J. Geo-Mar.* 41(5): 489-490.

Bass, A. L., H. Dewar, T. Thys, J. Todd Streelman and A. Karl Stephen. 2005. Evolutionary divergence among lineages of the ocean sunfish family, Molidae (Tetraodontiformes). *Mar. Biol.,* 48: 405-414.

Bleeker, P. 1873. Description et figure d'une espèce insulindienne d'*Orthagoriscus*. Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen. Afdeeling Natuurkunde (Ser. 2) v. 7: 151-153.

Breen, P., A. Cañadas, O. A. Cadhla, M. Mackey, M. Scheidat, S. C. Geelhoed and M. Jessopp. 2017. New insights into ocean sunfish (*Mola mola*) abundance and seasonal distribution in the northeast Atlantic. *Sci. Rep.,* 7(1):1-9.

Cardona, L., I. Álvarez de Quevedo, A. Borrell and A. Aguilar. 2012. Massive consumption of gelatinous plankton by Mediterranean apex predators. *PLoS ONE,* 7 (3): e31329.

Castro, J. J. and A. G. Ramos. 2002. The occurrence of *Ranzania laevis* off the Island of Gran Canaria, the Canary Islands, related to sea warming. *J. Fish. Biol.,* 60: 271-273.

Cartamil, D. P. and C. G. Lowe. 2004. Diel movement patterns of ocean sunfish *Mola mola* off southern California. *Zool. J. Linn. Soc.,* 266: 245-253.

Chacko, P. I. and M. J. Mathew. 1964. A record of the sunfish *Ranzania truncate* (Retzius) near Beypore, Malabar coast. *J. Bombay Nat. Hist. Soc.*, 53 (4): 724-725.

Chhapgar, J. 1964. Occurrence of the oblong sunfish in Bombay waters *Ranzania truncate* (Retzius) *J. Bombay Nat. Hist. Soc.*, 61 (2): 453-456.

Chellappa, M., T. S. Balasubramanian and G. Arumugam. 2002. On the occurrence of sunfish off Tuticorin, India. *Mar. Fish. Infor. Serv. T & E Ser.*, 174: 9-10.

Chellappa, M., T. S. Balasubramanian and G. Arumugam. 2006. *Occurrence of Sunfishes along Tuticorin Coast. Mar. Fish. Infor. Serv. T & E Ser.*, 188: 22.

Claro, R. 1994. Características generales de la ictiofauna. In R. Claro (ed.) Ecología de los peces marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo. p. 55-70.

Clemens, W. A. and G. V. Wilby. 1961. Fishes of the Pacific coast of Canada. *Fish. Res. Bd. Canada. Bull.,* 68: 443.

Das, B., A. Gopalakrishnan and A. Saravanakumar. 2012. Rare catch of *Masturus lanceolatus* (Lienard, 1840) from Parangipettai coast, Tamil Nadu. *Indian J. Geo-Mar. Sci.*, 41 (5): 489-490.

Das, P., P. Singh, A. Bhargava, P. Singh and R. Nagpure. 2014. New locality of sharp-tail sunfish (*Masturus lanceolatus*) in Indian waters. *Mar. Biodivers. Rec.,* 7: E75.

Day, F. 1889. The fauna of British India, including Ceylon and Burma. Fishes, London: Taylor and Francis,1, 548 pp; 2, 509 pp.

Devaraj, M., P. Nammalwar and R. Thiagarajan. 1976. Record of the sunfish *Masturus oxyuropterus* (Bleeker) from the Indian coast. *J. Mar. Biol. Assoc. India,* 18 (3): 664-665.

Dewar, H. T., S. L. H. Thys, C. Teo, J. Farwell, T. O'Sullivan, M. Tobayama, T. Soichi, Y. Nakatsubo, Y. Kondo, D. J. Okada, G. C. Lindsay, A. Hays, K. Walli, J. T. Weng, S. Streelman and A. Karl. 2010. Satellite tracking the world's largest jelly predator, the ocean sunfish in the Western Pacific. *J. Exp. Mar. Bio. Ecol.,* 393: 32-42.

Doyle, T. K., J. D. R. Houghton, O'Suilleabha, V. J. Hobson, F. Marnell, J. Davenport and G. C. Hays. 2008. Leatherback turtles satellite tagged in European waters. *Endanger. Species Res.*, 4: 23-31.

Dube, N., S. R. Sharma and K. K. Philipose. 2013. Note on the ocean sunfish, *Mola mola* (Linnaeus, 1758) landed at Karwar, west coast of India. *Mar. Fish. Infor. Serv. T & E Ser.*, (217): 31-32.

Ebenezer, I. P. and J. J. Joel. 1984. On a large sunfish *Ranzania typus* from the Southwest coast. *Indian J. Fish.*, 31 (3): 360-361.

Fraser-Brunner, A. 1951. The Ocean Sunfishes (Family Molidae). *Bull. Nat. Hist. Mus., Zool, Ser.*, 1: 87-121.

Fulling, G. L., F. Dagma, K. Knight and W. Hoggard. 2007. Distribution of Molidae in the northern Gulf of Mexico. *Gulf. Caribb. Res.,* 19: 53-67.

Gibbons, M. J. and A. J. Richardson. 2009. Patterns of jellyfish abundance in the North Atlantic. *Hydrobiologia*, 616: 51-65.

Gremillet, D., C. R. White, M. Authier, G. Doremus, V. Ridoux and E. Pettex. 2017. Ocean sunfish as indicators for the rise of slime. *Curr. Biol.,* 27: R1263eR1264.

Halstead, B. W. and J. M. Vinci. 1988. Biology of poisonous and venomous marine animals, in Tu, A.T. (Ed.) Marine toxins and venoms. *Handbook of Natural Toxins*, 3: 1-30.

Hays, G. C, T. K. Doyle, J. D. R. Houghton, M. K. S. Lilley, J. D. Metcalfe and D. Righton, 2008. Diving behaviour of jellyfish equipped with electronic tags. *J. Plankton Res.,* 30: 325-331.

Harrod, C., J. Syväranta, L. Kubicek, V. Cappanera and J. D. R. Houghton. 2013. Reply to Logan and Dodge: stable isotopes challenge the perception of ocean sunfish *Mola mola* as obligate jellyfish predators. *J. Mar. Biol. Assoc. India*, 82 (1): 10-16.

Huang, K. M, S. M. Liu, Y. W. Huang, K. Huang and D. F. Hwang. 2011. Food poisoning caused by sunfish *Masturus lanceolatus* in Taiwan, *J. Food. Drug. Anal.*, 19 (2): 191-196.

Joung, S. J., K. M. Liu, Y. Y. Liao and H. H. Hsu. 2005. Observed bycatch of Taiwanese tuna longline fishery in the South Atlantic Ocean. *J. Taiwan Fish. Res.*, 32: 69-77.

Kang, M. J., H. J. Baek, D. W. Lee and J. H. Choi. 2015. Sexual maturity and spawning of ocean sunfish *Mola mola* in Korean waters. *Korean J. Fish. Aquat. Sci.*, 48:739-44.

Kannan, K., K. Suresh Kumar, P. U. Zacharia and P. P. Manojkumar. 2017. Sharptail Mola landed at Thoothukudi. *Mar. Fish. Infor. Serv. T & E Ser.*, 231: 32.

Kar, S. and R. Chakraborty. 2000. First record of the sunfish *Ranzania laevis* (Pennant) (Pisces: Osteichthyes: Perciformes: Molidae) from the West Bengal coast. *J. Bombay Nat. Hist. Soc.*, 97 (2): 288-289.

Kaschner, K., K. Kesner-Reyes, C. Garilao, J. Rius-Barile, T. Rees and R. Froese. 2016. 811 Aqua Maps: Predicted range maps for aquatic species (Version 08/2016) [Computer 812 software]. www.aquamaps.org

Khan, M. Z. 1975. On the sunfish, *Mola mola* (L) a new record from Indian waters. *Indian J. Fish.,* 22 (1&2): 295-296.

Kishore, T. G., C. A. Shiyas, G. Sivakumar, J. Nair Rekha, S. Dinesh Kumar, P. K. Seetha, K. S. Sobhana, T. M. Najmudeen, V. H. Sajna and P. U. Zacharia. 2014. Giant devil manta rays landed by purse seiner at Cochin fisheries harbour. *Mar. Fish. Infor. Serv. T & E Ser.*, 220: 21-22.

Kulkarni, C. V. 1953. Local and Scientific name of commercial fishes of Bombay. *J. Bombay Nat. Hist. Soc.*, 51 (4): 948-950.

Lafond, E. C. 1957 Oceanographic studies in the Bay of Bengal section. *Proc. Indian Acad. Sci., Sec B* 46: 1-46.

Leis, J. L., K. Matsuura, K. T. Shao, G. Hardy, G. Zapfe, M. Liu, L. Jing, R. Robertson and J. Tyler. 2015. *Masturus lanceolatus. The IUCN Red List of Threatened Species,* 2015: e. T193634A115330232.

Liu, K. M., M. L. Lee, S. J. Joung and Y. C. Chang. 2009. Age and growth estimates of the sharptail mola, *Masturus lanceolatus*, in waters of eastern Taiwan. *Fish. Res.,* 95: 154-160.

Liu, J., G. Zapfe, K. T. Shao, J. L. Leis, K. Matsuura, G. Hardy, M. Liu, R. Robertson and J. Tyler. 2015. *Mola mola* (errata version published in 2016). The IUCN Red List of Threatened Species 2015: e.T190422A97667070. Downloaded on 05 March 2020.

Lyons, K. 2019. Holy mola: huge sunfish washes up in northern waters for the first time in 130 years. https://www.theguardian.com/environment/2019/mar/04/huge-sunfish-washes-up-in-northern-waters-for-first-time-in-130-years

Mangel, J. C., M. Pajuelo, A. Pasara□Polack, G. Vela, E. Segura□Cobeña and J. Alfaro□Shigueto . 2019. The effect of Peruvian small□scale fisheries on sunfishes (Molidae). *J. Fish Biol.,* 94: 77-85.

Manojkumar, B., J. K. Kizhakudan, S. Thomas and A. P. Dineshbabu. 1998. A record of sunfish *Mola mola* from coastal waters at Veraval. *Mar. Fish. Infor. Serv. T & E Ser.,* 157: 21-23.

Manojkumar, P. P. and P. P. Pavithran. 2007. First record of ocean sunfish, Mola mola from Malabar coast. *Mar. Fish. Infor. Serv. T & E Ser.,* 192:15-16.

Matsuura, K. 2015. Taxonomy and systematics of tetraodontiform fishes: a review focusing primarily on progress in the period from 1980 to 2014, *Ichth. Res.,* 62: 72-113.

Masilamoni, J. G., K. S. Jesudoss K. Nandakumar, K. K. Satpathy, K. V. K. Nair and J. Azariah. 2000. Jellyfish ingress: A threat to the smooth operation of coastal power plants. *Curr. Sci.*, 79 (5): 567- 569.

Moazzam, M. 2020a. Jellyfish *Crambionella orsini*: a menace for fishing in the Arabian Sea. *Wildlife and Environment* 26: 15.

Moazzam, M. 2020b. IOTC-2020-WPEB16-24. Distribution and abundance of sunfish (Family Molidae) in the–Northern Arabian Sea based on data collected through the, Indian Ocean Tuna Commission. Victoria, Seychelles. Retrieved from https://coilink.org/20.500.12592/1zv72v on 25 Oct 2024.

Mohan, S., S. Selvanidhi, G. Srinivasan and P. Poovannan. 2006. *Mola ramsayi* (southern sunfish): a new record from Indian waters. *Mar. Fish. Infor. Serv. T & E Ser,* 189: 23-24.

Murty, C. S. and V. V. R. Varadachari. 1968. Upwelling along the east coast of India *Bull. National Inst. Sci. India*, 38: 80-86.

Nakamura, I. and K. Sato. 2014. Ontogenetic shift in the foraging habit of ocean sunfish *Mola mola* from dietary and behavioural studies. *Mar. Biol.,* 161 (6): 1263-1273.

Nakamura, I., Y. Goto and K. Sato. 2015. Ocean sunfish rewarm at the surface after deep excursions to forage for siphonophores. *J. Animal. Eco.*, 84 (3): 590-603.

Nair, R. J., S. Paul and S. Dinesh Kumar. 2013. Record of a rare Sharp-tail sunfish, *Masturus lanceolatus* Liénard, 1840 (Tetraodontiformes: Molidae) landing from the South-west coast of India. *Mar. Fish. Infor. Serv. T & E Ser*, 218: 7-7.

Naranji, M. K., R. Fricke and F. Netto. 2020. New Record and range extension of the Orange Scorpionfish, *Neomerinthe amplisquamiceps* (Scorpaenidae), in the coastal waters of Visakhapatnam, India. *Thalassas* 36: 399-404.

Naranji, M. K., V. G. Rao and D. Venu. 2016. An occurrence of the rare Sharptail Mola *Masturus lanceolatus* (Lienard, 1840) (Tetraodontiformes: Molidae), in the coastal waters of Visakhapatnam, India. *J. Threat. Taxa.,* 8 (13): 9592-9594.

Nelson, D. R., J. N. McKibben, W. R. Jr. Strong, C. G. Lowe, J. A. Sisneros, D. M. Schroeder, and R. J. Lavenberg. 1997. An acoustic tracking of a megamouth shark, *Megachasma pelagios*: a crepuscular vertical migratory. *Envt. Biol. Fish*, 49: 389-399.

Nyegard, M., E. Sawai, N. Gemmell, J. Gillum, N. R. Loneragan, Y. Yamanoue and A. L. Stewart. 2018a. Hiding in broad daylight: molecular and morphological data reveal a new ocean sunfish species (Tetraodontiformes: Molidae) that has eluded recognition. *Zool. J. Linn. Soc.*, 182 (3): 631-658.

Nyegaard, M., N. Loneragan, S. Hall, J. Andrews, E. Sawai and M. Nyegaard. 2018b. Giant jelly eaters on the line: Species distribution and bycatch of three dominant sunfishes in the Southwest Pacific. *Estuar. Coast. Shelf Sci.,* 207: 1-15.

Prakash, S., T. T. Ajith Kumar and M. Thangaraj. 2016. DNA barcoding of Sharp Tail Sunfish *Masturus lanceolatus* Lienard, 1840 (Tetraodontiformes: Molidae). *Proc. Zool. Soc. Lond.,* 69: 153-156.

Pradhan, M. 1965. Occurrence of the sunfish *Ranzania truncate* (Retzius) near Veraval along Gujarat coast. *J. Bombay Nat. Hist. Soc.*, 62 (1): 163-164

Peterson, S. and Z. McDonell. 2007. A bycatch assessment of the Cape horse mackerel *Trachurus trachurus capensis* midwater trawl fishery off South Africa. Birdlife WWF Responsible Fisheries Programme Report, 2005, 30 pp.

Potter, I. F. and W. H. Howell. 2011. Vertical movement and behaviour of the ocean sunfish, *Mola mola*, in the northwest Atlantic. *J. Exp. Mar. Bio. Ecol.,* 396: 138-146.

Pope, E. C., G. C. Hays, T. M. Thys, T. K. Doyl, D. W. Sims, N. Queiroz, V. J. Hobson, L. Kubice and J. Houghton. 2010. The biology and ecology of the ocean sunfish *Mola mola*: a review of current knowledge and future research perspectives. *Rev. Fish Biol. Fish.,* *20* (4): 471-487.

Purushottama, G. B., C. Anulekshmi, C. Ramkumar, S. Thakurdas and B. Mhadgut. 2014. A rare occurrence and biology of the slender sunfish, Ranzania laevis (Actinopterygii: Tetraodontiformes: Molidae), in the coastal waters of Mumbai, North-West Coast of India. *Indian J. Geo-marine Sci.,* 43 (8):1554-1559.

Ram Bhaskar, B., D. P. Rao, M. R. Murty, G. Maheswarudu, Y. V. K. Durga Prasad, K. Phani Prakash and J. D. Susheel Kumar. 1988. Rare occurrence of sunfish *Mola mola* (Linnaeus) from the coastal waters off Visakhapatnam (Bay of Bengal). *J. Bombay Nat. Hist. Soc.*, 85: 629-631.

Ramamoorty, N., M. Varghese, A. Raju, C. Kashinath and M. Seeni. 2007. On the sunfish, *Masturus lanceolatus* landed near Ervadi, Gulf of Mannar. *Mar. Fish. Infor. Serv. T & E Ser.,* 192: 14-15.

Ramesh, C. H., S. Koushik, T. Shunmugaraj and M. Ramana. 2021. Occurrence of a Scyphozoan jellyfish, *Pelagia noctiluca* (Forskål, 1775) bloom in the Gulf of Mannar Marine National Park, Southern India. *Indian J. Geo-Marine Sci.,* 50 (02): 161-164.

Ray, D., A. Mohapatra, M. Ghorai, P. Tudu and S. Mishra. 2019. First record of a rare sunfish, *Mola mola* (Linnaeus, 1758) from coastal waters of West Bengal, India. *Rec. Zoo. Sur. India*, 119: 81-84.

Rijnsdorp, A. D. and C. Papakonstantinou. 2015. *Mola mola*. The IUCN Red List of Threatened Species 2015: e.T190422A45141101.

Roach, J. 2003. World's heaviest bony fish discovered? National Geographic. Available at http://news.nationalgeographic.com/news/2003/05/0513_030513_sunfish.html/

Sagara, K. and T. Ozawa. 2002. Landing statistics of molids in four prefectures of Japan. *Mem. Fac. Fish., Kagoshima Univ.*, 51: 27-33.

Sahu, B. K. and R. C. Panigrahy. 2013. Jellyfish bloom along the South Odisha coast, Bay of Bengal. *Curr. Sci.,* 104 (4): 410-411.

Sukumaran, S. and C. Kasinathan. 2006. A note on the landing of a slender sunfish near Rameswaram. *Mar. Fish. Infor. Serv. T & E Ser.,* 187: 18.

Santosh, K. M., H. R. V. Reddy and P. Arun. 2002. Hydrography of the Bay of Bengal during southwest monsoon and its significance on oil sardine fishery. *Bangladesh J. Fish. Res.,* 6 (1): 69-74.

Sasmal, S. K. 1989. Hydrography of the northern Bay of Bengal during the southwest monsoon. *Mahasagar,* 22 (3): 105-112.

Scott, W. B. and M. G. Scott. 1988. Atlantic Fishes of Canada, University of Toronto Press, Toronto. 731 pp.

Senthil Kumar, G. R. 2001. Systematics, biochemical and toxicology of tetradontidfishes (Pisces: Tetradontiformes) of the south-east coast of India. Ph. D. thesis. Annamalai University, India, 136 pp.

Silvani, L., M. Gaz,o and A. Aguilar. 1999. Spanish driftnet fishing and incidental catches in the western Mediterranean. *Biol. Cons.* 90: 79-85.

Sims, D. W., N. Queiroz, T. K. Doyle, J. D. R. Houghton and G. C. Hays. 2009. Satellite tracking of the world's largest bony fish, the ocean sunfish (*Mola mola*) in the north east Atlantic. *J. Exp. Mar. Bio. Ecol.,* 370: 127-133.

Sousa, L., N. Queiroz, G. Mucientes, N. E. Humphries and D. W. Sims. 2016. Environmental influence on the seasonal movements of satellite-tracked ocean sunfish *Mola mola* in the north-east Atlantic. *Anim. Biotelemetry*, 4: 1-19.

Thys, T. M., J. P. Ryan, H. Dewar, C. R. Perle, K. Lyons, J. O'Sullivan and G. Gaxiola-Castro. 2015. Ecology of the ocean sunfish, *Mola mola*, in the Southern California Current System. *J. Exp. Mar. Bio. Ecol.*, 471: 64-76.

Tortonese, E. 1990. Molidae. In: J.C. Quéro, J.C. Hureau, C. Karrer, A. Post and L. Saldanha [eds.]. Check-list of the Fishes of the Eastern Tropical Atlantic (CLOFETA). Vol 2. JNICT, Lisbon, Portugal; SEI, Paris, France; and UNESCO, Paris, France. p. 1077–1079.

Thomas, S., B. Sreedhara and Y. Muniyappa. 2006. Record of sunfish *Mola mola*, landed at Malpe Fisheries Harbour, Karnataka. *Mar. Fish. Infor. Serv. T & E Ser* 189: 26.

Ramamoorthy, N., M. Varghese, A. Raju, C. Kasinathan and M. Seeni. 2007. On the sunfish, *Masturus lanceolatus* landed near Ervadi, Gulf of Mannar. *Mar. Fish. Infor. Serv. T & E Ser.,* 192: 14-15.

Robinson, B. H. 1975. Observations on living specimens of the slender Mola, *Ranzania laevis* (Pisces, Molidae). *Pac. Sci.,* 29: 27-29.

Solokovskaya, T. S. and A. S. Sokolovskiy. 1975. New data on the expansion of the area of reproduction of ocean sunfishes (Pisces, Molidae) in the northwestern part of the Pacific Ocean. *J. Ichth.,* 15: 675-678.

Victor, A. C. C., D. Kandasamy and N. Ramamoorthy. 1998. On the large sunfish landed near Mandapam. *Mar. Fish. Infor. Serv. T & E Ser.*, 157: 26-27.

Vivekanandan, E., V. V. Singh and J. K. Kizhakudan. 2013. Carbon footprint by marine fishing boats of India. *Curr. Sci.*, 105 (3): 361-366.

Wan, R. and R. Zhang. 2005. Spatial distribution and morphological characters of the eggs and larvae of the slender sunfish *Ranzania laevis* from the tropical waters of the western Pacific Ocean. *Curr. Zool.,* 51: 1034-104.