



# Species diversity and basic biology of Cuttlefishes from Maharashtra waters, northwest coast of India

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## Manuscript details:

Received : 11.06.2018  
Accepted : 18.09.2018  
Published : 30.09.2018

**Editor: Dr. Arvind Chavhan**

### Cite this article as:

Sundaram Sujit and Mane Sushant (2018) Species diversity and basic biology of Cuttlefishes from Maharashtra waters, northwest coast of India, *Int. J. of Life Sciences*, Volume 6(3): 799-806.

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Available online on  
<http://www.ijlsci.in>  
ISSN: 2320-964X (Online)  
ISSN: 2320-7817 (Print)

## ABSTRACT

Cuttlefish diversity was studied from Maharashtra waters during the period January 2000 - December 2017. Eight species were identified and they are *Sepia pharaonis* Ehrenberg, 1831, *Sepia aculeata* Orbigny, 1848, *Sepia elliptica* Hoyle, 1885, *Sepiella inermis* Orbigny, 1848, *Sepia prashadi* Winckworth, 1936, *Sepia (Doratosepion) kobsiensis* Hoyle, 1885, *Sepia omani* Adam and Rees, 1966 and *Euprymna berryi* Sasaki, 1929. The estimated annual catch of cuttlefishes by trawlers (all species combined) for the period 2000-2017 from New Ferry Wharf landing centre showed a cyclic trend and the landings ranged from 1360.4 t (2002) to a peak of 3,704.1 t (2012) and the corresponding catch rate ranged from 0.985 kg/hr (2002) to 1.599 kg/hr (2012).

**Key words:** Cuttlefishes, biodiversity, Maharashtra, Northwest coast of India

## INTRODUCTION

Cuttlefishes are locally called as '*Goti makul*' in Maharashtra. Cuttlefishes are primarily demersal inhabitants of nearshore and continental shelf zones in warm and temperate waters (Roper *et al.*, 1984). There are about 80 species of cephalopods of commercial and scientific interest distributed in the Indian Seas (Silas, 1968). Almost the entire catch of cuttlefishes is obtained as by-catch in trawl fishing all along the Indian coasts (continental shelf and oceanic region), while a small portion such as *Sepia pharaonis* comes in targeted fishing (hand-jigging) restricted to Vizhinjam-Colachel area on the southwest coast of India (Nair, 1985) and *Sepiella inermis* is observed in *dol* nets along the northwest coast (Sundaram and Khan, 2011).

A lot of work has been carried out on cuttlefishes along the Indian waters and some of the major works carried out on cuttlefishes are by Nair *et al.* (1993), Rao *et al.* (1993), Silas *et al.* (1985a) and Silas *et al.* (1985b).

Mohamed *et al.* (2009) gave an account on the exploitation of juvenile cephalopods from the Arabian Sea and Bay of Bengal including cuttlefishes, to name a few. Sundaram (2009) also gave an account on the various uses of cephalopods including cuttlefishes.

Various authors have mentioned about the cuttlefish fishery from Maharashtra, the recent ones being Sundaram (2011c), Ramkumar *et al.* (2013) and Sugumar *et al.* (2015). From the review of literature it seems there is no study on the diversity of cuttlefishes from Maharashtra waters and therefore an attempt has been made to present the same. The major fish landing centres of Maharashtra such as New Ferry Wharf (NFW), Sasoon Docks and Versova are situated in Mumbai and they account for nearly 60% of Maharashtra's fish landings (Annam and Sindhu, 2005), hence the species from these centres can be considered as representative of Maharashtra state.

## MATERIAL AND METHODS

During the period January 2000 - December 2017, weekly visits were carried out to NFW and monthly visits were made to Sasoon Docks and Versova landing centre. The specimens collected from these centres were brought to the laboratory for species identification based on the identification characters as described in Roper *et al.* (1984) and Silas *et al.* (1985c). Further biological analysis were also carried out and dorsal mantle length (DML) was measured using digital calipers and total body weight (TBW) by an electronic balance ( $\pm 0.01$  g) after the specimens were dried on blotting paper. The measurements were taken as described in CMFRI manual (1995). As mechanised trawling was suspended from 10<sup>th</sup> June to 15<sup>th</sup> August, due to southwest monsoon and restrictions imposed by the government of Maharashtra, observations could not be collected for the month of July.

Cuttlefishes are observed in trawl and *dol* catches in Maharashtra. The trawlers at NFW operate 70-80 km off northwest coast of Mumbai at a depth of 30-60 m. At Sasoon Docks the fishing area extends up to Ratnagiri and the depth of operation extends from 20-90 m, but generally they carry out trawling in waters beyond 40 m. At Versova the trawlers operate in 20-40 m depth, parallel to coastline from Vasai in the north and Murud-Janjeera in the south. The *dol* nets are operated along Mumbai harbor at the depths of 5-10 m (Mane and Sundaram, 2011). Catch and effort data for cuttlefishes

from trawlers were obtained from the data files maintained by the Fishery Resources Assessment Division of Mumbai Research Centre of Central Marine Fisheries Research Institute.

Four hundred specimens of *S. pharaonis*, 50 - *S. aculeata*, 25 - *S. elliptica*, 500 - *S. inermis*, 25 - *S. prashadi*, 25 - *S. (D.) kabiensis*, 25 - *S. omani* and 25-*E. berryi* were analysed. The length-weight relationship was obtained by the method of 'least squares' based on individual measurements. The relationship of DML and TBW was expressed as parabolic equation of the form,  $W = a * L^b$ . The stomach condition was analysed following Kore and Joshi (1975). The food items were in well-crushed and macerated condition, therefore it was possible to categorise up to the level of groups only (such as fish). The Index of Preponderance was estimated as suggested by Natarajan and Jhingran (1961). The maturity studies and the relative length of arms i.e. the arm formula was estimated following Silas (1985a). The size at first maturity was estimated by King's (1995) method. To estimate the fecundity, ovaries were removed from the fresh specimens and a few drops of formalin (4%) were added and teased to facilitate easy separation. Ova diameter measurements were made according to Prabhu (1956).

## RESULTS AND DISCUSSION

With the increased exploitation and expansion of fishing grounds, new records of cephalopods are reported from various places all along the Indian coast. The estimated annual cuttlefish catch by trawl for the period 2000-2017 from NFW showed a cyclic trend with the catch increasing almost every four to five years. Overall the catch of cuttlefishes showed a cyclic trend with a dip in every fourth year. The catch ranged from 1360.4 t (2002) to 3704.1 t (2012) and the corresponding catch rate ranged from 0.985 kg/hr (2002) to 1.599 kg/hr (2012) (Fig 1). The minimum catch was 1360.4 kg (2002) and the maximum catch was 3704.1 kg (2012). The minimum catch rate was 0.486 kg/hr (2003) and the maximum catch rate was 2.1 kg/hr (2005). According to Nair *et al.* (1992), the seasons recognized for the cephalopod fishery are the premonsoon (February-May), the monsoon (June-August) and the post monsoon (September-January). The monthly abundance suggests that cuttlefish fishery is very high during post monsoon seasons in Maharashtra i.e. during October-December with the peak in December. Generally in Mumbai waters the abundance of cuttlefishes is during

post monsoon period (Kuber, 1987). Cuttlefishes contribute 47% towards the total cephalopod catch in Maharashtra (CMFRI, 2012) and three species namely *S. pharaonis* (20.1%), *S. aculeata* (18.5%) and *S. inermis* (8.1%) dominates the cuttlefish fishery in Mumbai waters. The cuttlefish species available in Maharashtra waters are listed below according to their abundance.

### *Sepia pharaonis* Ehrenberg, 1831

*S. pharaonis* is commonly known as 'Pharaoh Cuttlefish', locally they are also known as 'Waghya makul'. The mantle of *S. pharaonis* is broad, robust and muscular with wide fins. Tentacular clubs moderately long with eight suckers in transverse rows. The spine is short. A vivid transverse tiger-strip pattern on dorsal mantle. Body colour is grayish black. *S. pharaonis* is distributed along Indo-Pacific: Red Sea, Arabian Sea to South China Sea and northern and northwestern Australia. A neritic and demersal species occurring from coast line to about 110 m depth, but more abundant in the upper 40 m (Roper *et al.*, 1984).

In Maharashtra, the species is observed in trawl netters at NFW, Sasoon Docks and Versova landing centre throughout the year. The peak period of abundance is December. Sundaram (2014) estimated the length-

weight relationship as  $TBW = 0.0008414 * DML^{2.57989}$  for males and  $TBW = 0.0009723 * DML^{2.55201}$  for females. The DML of indeterminants (specimens where sex could not be ascertained) landed by trawlers at NFW ranged from 62 to 165 mm, males ranged from 104 to 339 mm and females from 86 to 290 mm. Sundaram and Sarang (2004a) also observed abundance of indeterminants during April-May in Mumbai. According to Roper *et al.* (1984) the maximum DML for the species is 430 mm for males and 330 mm for females. According to Silas *et al.* (1985a) the maximum size for males is 265 mm (at Waltair) and the maximum size for females is 245 mm (at Madras) and in the west coast they are larger compared to other centers along the Indian coast and they attain 334 mm and 320 mm for males and females respectively (at Vizhinjam). *S. pharaonis* from Mumbai waters are comparatively smaller in size. Fish formed the major constituent of food (86%) for this species followed by prawns (3.3%), cephalopods (1.7%) and digested matter (8.9%). Females were dominant in the catch with a sex-ratio of 1:1.24. The size at 50% maturity for females was estimated at 153 mm. The maximum fecundity was 16,344 in the month of November and the ova diameter ranged from 2 to 8 mm. The peak spawning season is from February to May.

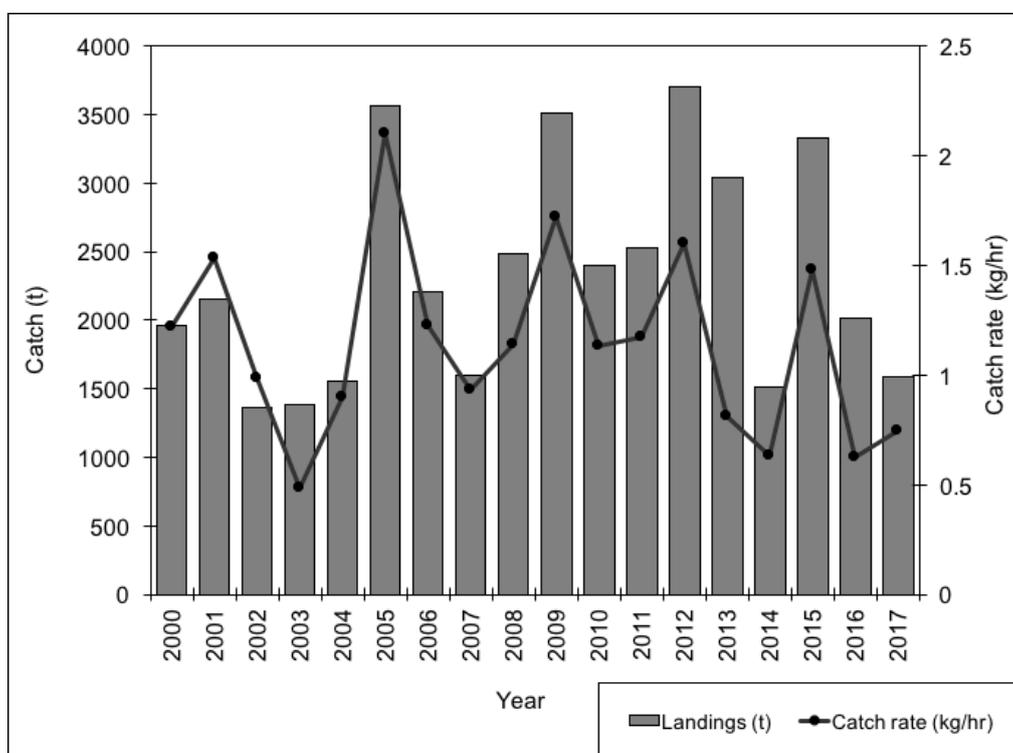


Fig. 1. Catch and catch rate of Cuttlefish by trawlers at New Ferry Wharf, Mumbai

According to Nair *et al.* (1993), Maharashtra accounted for 44% of the all India *S. pharaonis* landings. Off late hand-jigging of this species is carried out in Rantagiri waters, Maharashtra (Sundaram and Deshmukh, 2011) and (Sundaram and Sawant, 2013). Nair *et al.* (1985) made some observations on the hatching and post hatching behavior of *S. pharaonis*. Nabitabhata (1994), Anil *et al.* (2005), Anon (2006) and Sivalingam *et al.* (1993) studied on the hatchery production of the species and on the possibility of *S. pharaonis* as a candidate species for Mariculture. During the reproductive season, the species migrates shoreward and aggregates in shallow waters (Silas *et al.*, 1982). Eggs are laid in clusters and attached to plants, shells and other substrates (Roper *et al.*, 1984).

#### ***Sepia aculeata* Orbigny, 1848**

*S. aculeata* is commonly known as 'Needle Cuttle fish'. Mantle of *S. aculeata* is about half broad as long and the tentacular club is long and slender. The cuttle bone is elongate oval with granular dorsal surface. Body is greenish grey in colour with pale reflective line along base of fins. *S. aculeata* is distributed along the Indo-Pacific: Southern India to South China Sea, East China Sea north to central Japan. They are demersal, neritic species ranging in depth from the shore down to 60 m (Roper *et al.*, 1984).

In Maharashtra, the species is observed in trawlers netters at NFW, Sasoon Docks and Versova landing centre. The species is observed in the catch throughout the year. The peak period of abundance is October. The mantle length of the species landed at NFW ranged from 20-140 mm which is smaller compared to other centers along the Indian coast. According to Silas *et al.* (1985a) the maximum size for males and females on the east coast are 190 mm and 200 mm respectively (at Mandapam) and on the west coast the maximum sizes for the two sexes are 245 mm and 200 mm (at Bombay). According to Roper *et al.* (1984) the maximum DML for the species is 230 mm. Fish formed the major constituent of food (80%) for the species followed by prawns (15%), and digested matter (5%). The earlier studies on the species from Mumbai waters are by Menon (1988) and Nalwa *et al.* (2005).

#### ***Sepia elliptica* Hoyle, 1885**

*S. elliptica* is commonly known as 'Oval bone cuttlefish'. The mantle of *S. elliptica* is oval with the dorsal anterior margin triangular. The arm lengths are sub-equal and the arm suckers are tetra serial. Club sucker-bearing

surface is flattened, with 10-12 minute suckers in transverse rows. Swimming keel of the club extends well proximal to carpalis. The Cuttlebone is oval and very angular 'V-shaped' anteriorly, bluntly rounded posteriorly, and the dorsal surface is grayish white. *S. elliptica* is often misidentified as *S. aculeata* from Maharashtra waters. *S. elliptica* can be easily identified from *S. aculeata* by its cuttlebone which is distinctly shaped and also by the presence of prominent markings on all the arms. *S. elliptica* is a tropical Indo-Pacific species extending from northern to western Australia, Queensland, Capricorn island group, Gulf of Carpentaria and VietNam and occur mainly in coastal waters at a depth range of 16 m to 142 m (Jereb *et al.* 2005). According to Jereb *et al.* (2005), the occurrence of this species from Indian waters is doubtful. However Silas *et al.* (1985c) has reported the occurrence of this species from Indian waters.

In Maharashtra, the species is observed in trawlers netters at NFW during December-February with peak landings in January (Sundaram and Khan, 2010b). According to Nair *et al.* (1992), *S. elliptica* appears to be occurring in Cochin and Veraval waters almost throughout the year. The mantle length of the species landed at NFW ranged from 87 mm to 118 mm with the corresponding weight ranging from 82.6 gms to 182.4 gms. The maximum DML recorded for this species is 175 mm (Jereb *et al.* 2005). The largest sizes recorded for males and females of *S. elliptica* caught in trawl net in Waltair are 89 mm and 95 mm respectively (Silas *et al.* 1985a) and in Veraval waters it is recorded as 149 mm (Kasim, 1993). Sivasubramanian (1991) has reported the maximum mantle length as 130 mm from the Bay of Bengal. The maximum length recorded during the present observations from Mumbai waters is 118 mm. Prawn formed the major constituent of food (90%) for this species followed by fish (10%). females were observed to be broader than males and overall the dominance of males was observed in the catch from Mumbai.

#### ***Sepiella inermis* Orbigny, 1848**

*S. inermis* is commonly known as 'Spineless cuttlefish'. The mantle of *S. inermis* is oval and a pigmented gland is present at posterior tip of mantle. The cuttlebone is spineless. Males have white spots along base of fins. *S. inermis* is distributed along the Indo-Pacific: Indian Ocean, Southern Red Sea, Gulf of Aden to Andaman Sea and southern south China Sea. They are demersal

shallow-water species occurring to depths of about 40 m (Roper *et al.*, 1984).

In Maharashtra, the species is observed in trawl netters at NFW, Sasoon Docks and Versova landing centre throughout the year. The peak period of abundance is December. The maximum numbers of indeterminants are observed in May-June ranging in length from 5-20 mm (Sundaram and Chavan, 2005). The estimated length-weight relationship for males is  $TW = 0.001507648 * DML^{2.4474}$  and for females is  $TW = 0.000674217 * DML^{2.6808}$ . The DML of males ranged from 17 mm to 70 mm and females ranged between 17 mm to 90 mm. According to Roper *et al.* (1984) the maximum DML for the species is 125 mm. The maximum sizes recorded for males and females on the east coast are 84 mm (Madras) and 94 mm (Portonova) respectively and on the west coast at Cochin the maximum size noticed in the trawl fishery is 124 mm for both the sexes (Silas *et al.*). Month-wise analysis of stomach contents of *S. inermis* revealed that 'crustacean remains' formed the major constituent in all the months with dominance in January. The monthly percentage occurrence of 'fish' exhibited considerable variation. Sex ratio ranged between 1:1.10 (March) to 1:2.36 (June). 50% of the males matured at 48.06 mm and females matured at 55.04 mm. Fecundity ranged between 216 and 354 ova. Ova diameter varied between 0.38 and 3.57 mm. Matured females occurred throughout the year with a primary peak in October followed by three secondary peaks in January, April and July-August, indicating four spawning seasons (Sundaram and Khan, 2011).

Further studies on the species from the northwest coast were carried out by Sundaram and Khan (2009) on the stock assessment and Sundaram and Khan (2010a) on its morphometry. The species is also sundried and sold (Sundaram *et al.*, 2013).

#### ***Sepia prashadi* Winckworth, 1936**

*S. prashadi* is commonly known as 'Hooded cuttlefish'. The body of *S. prashadi* is rather slender, elongate and oval in outline. The arms are sub-equal and well tapering. The tentacles end in short and broad clubs. The suckers are ranged in eight oblique transverse series and three suckers of the third series are enlarged. The cuttle bone of the species is very distinct, with its dorsal surface pink in colour. As the cuttlefish grows and mature it develops transverse stripes. *S. prashadi* is a Western Indian Ocean species distributed from

southern Mozambique to the Gulf of Aden, Red Sea, Arabian Sea, Gulf of Oman, the Gulf between Iran and the Arabian Peninsula, Indian west and east coasts and Sri Lanka. They are demersal and shallow water species ranging in depth to over 40 m (Roper *et al.*, 1984).

In Maharashtra, the species is observed in trawl landings at NFW and Sassoon docks exclusively during September - October and such seasonal occurrence was observed in Mumbai since the year 2000 onwards (Sundaram and Sarang, 2004b) and *S. prashadi* replaces *S. aculeata* during this period (Sundaram *et al.*, 2006). According to Roper *et al.* (1984) the maximum DML for the species is 140 mm. The mantle length of the species landed at NFW ranged between 40 mm to 140 mm. Prawn formed the major constituent of food (90%) followed by fish (10%).

#### ***Sepia (Doratosepion) kobiensis* Hoyle, 1885**

*S. (D.) kobiensis* is commonly known as 'Kobi cuttlefish'. The mantle of *S. kobiensis* is slender and elliptical with the mantle width 45-47% of the mantle length. The arms are tapering to fine points and the arm formula is usually 4:1:2:3. The arms are short, attenuate and subequal. The arm suckers are globular quadriserial with those in the median rows larger than the marginal ones. The tentacular club is short and narrow. The cuttlebone is lanceolate and the spine is long and directed upwards. The cuttlefish is dark brown in colour and prominent small dots are observed along the rim. *S. kobiensis* is known to be distributed worldwide in Western Pacific: South China Sea, East China Sea, and Yellow Sea to southern and central Japan. *S. (D.) kobiensis* is a demersal cuttlefish ranging up to 160 m depth (Roper *et al.*, 1984).

In Maharashtra, the species is observed in trawlers netters at NFW during the period October-December with peak landings during November. The species entered the fishery in Mumbai waters from the year 2001 and the peak landings were observed in 2003 (Sundaram, 2011a). According to Roper *et al.* (1984) the maximum mantle length of *S. (D.) kobiensis* is 90 mm and Okutani (1987) has reported the maximum dorsal length as 70 mm. At NFW the DML of *S. (D.) kobiensis* ranged from 35 - 130 mm and the corresponding body weight ranged from 18.812 - 56.421 g which seems to be larger than those occurring in other coasts. Majority had guts with 'trace' and 'empty' condition and the food was finely macerated. The species seems to mainly feed on 'prawn' (70%) followed by 'fish' (20%) and digested

matter (10%). About 60% of the specimens analysed for the maturity studies were in 'mature condition' followed by 'gravid' (20%) and 'immature' specimens (20%).

### ***Sepia omani* Adam and Rees, 1966**

*S. omani* is commonly known as 'Oman cuttlefish'. The mantle of *S. omani* is oval with the dorsal anterior margin is triangular. Club sucker bearing surface is flattened, with 3 or 4 suckers in transverse rows and 3 to 5 suckers in middle of third longitudinal row extremely enlarged. The Cuttlebone is acuminate and has a long spine. The dorsal surface of the mantle has dark brown transverse stripes. *S. omani* is distributed in the Northern Indian Ocean: Gulf of Oman, off Pakistan and western India (Jereb *et al.* 2005).

In Maharashtra, the species occurs very rarely in the catch and was observed at NFW in trawl catch during April 2009 (Sundaram, 2011b). The dorsal mantle length of the species landed at New Ferry Wharf ranged from 40 to 75 mm with the corresponding weight ranging from 17.662 to 59.737 g. According to Jereb *et al.* (2005) the maximum mantle length of the species is 100 mm. The species seems to mainly feed on fish (80%) followed by prawn (20%).

### ***Euprymna berryi* Sasaki, 1929**

*E. berryi* is commonly known as 'humming-bird bobtail squid'. *E. berryi* has a short, stout and sac like mantle. The body and head are united by a broad dorsal commissure in the nuchal region and except for this connective commissure the head is free from the mantle opening. The fins are semi-circular in outline and inserted at mid length of the mantle. The arm formula is usually 3:2:1:4. The gladius is absent and light organs or photophores are present placed on lateral lobes of ink sac. The body is transparent when fresh and the mantle is whitish with numerous dark brown chromatophores both on dorsal and ventral sides. *Euprymna berryi* is a pelagic coastal species occurring up to 60 m depth. It is known to be distributed along the coast of China, south to Hong Kong and Japan, Taiwan and possibly Andaman Islands and Sri Lanka (Jereb and Roper, 2005).

In Maharashtra, the species was observed at NFW and Versova landing centre in trawl and hand trawl catches respectively. They are observed in the catch during May and October (Sundaram and Paul, 2008). The DML ranged from 14 to 20 mm in Mumbai waters. Females grow much larger than males and the maximum mantle

length is 30 mm in males and 50 mm in females (Jereb and Roper, 2005). The gut was with digested matter which could not be identified.

These animals live with their body partially buried in the bottom, covered by sand. It swims at night, using the light organ for camouflage when approaching preys, which are normally benthic crustaceans (Young and Vicchione, 1996). This species has been reared successfully in aquaculture experiments by Choe (1966).

Cuttlefishes are known to make seasonal migrations, which are influenced by breeding activity. It seems that in all probability these species observed may have come to nearshore waters for breeding. The price of cuttlefishes ranged between Rs.50-250/kg according to the size and species at the landing centre. Due to the abundant availability of cuttlefish and its high commercial importance, a detailed study on the distribution and population dynamics is essential for this resource from the Northwest coast of India in general and Maharashtra coast in particular. Fig 1 clearly indicates that the catch has increased over the years and eventually it would lead to over-exploitation.

The results by Nabitabhata (1994) confirmed prominent potential of cephalopods for aquaculture *i.e.* high growth rates, short life cycle, high fecundity, high hatching rate, absence of true larval stages etc. Silas (1985b) has given future perspectives and priorities for cephalopods wherein the author mentions about aquaculture of cephalopods. The factors in favour of cephalopods for aquaculture are the availability of spawners and eggs in inshore waters and rapid growth. Further studies on the biology and other aspects would prove useful to evolve effective fishery management measures for judicious exploitation of the resource. Specimens of all the above mentioned species are deposited in the reference collection of Mumbai Research Centre of Central Marine Fisheries Research Institute.

### **Acknowledgement**

The author is thankful to Dr. K. S. Mohamed, Principal Scientist and Head, Molluscan Fisheries Division, Central Marine Fisheries Research Institute, Kochi and Dr. V. D. Deshmukh, Principal Scientist and Scientist-in-Charge, Central Marine Fisheries Research Institute, Mumbai.

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