



Fishery and biology of *Sepia pharaonis* Ehrenberg, 1831 off Mumbai, northwest coast of India

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Received: 21 Aug 2013, Accepted: 05 Jul 2014, Published: 12 Nov 2014

Original Article

Abstract

Fishery of *Sepia pharaonis* by trawlers at New Ferry Wharf (NFW) during 2000 - 2011 in Mumbai waters is described. The landings ranged from 438 t (2004) to 1,763 t (2005) and the catch rate ranged from 0.17 kg/hr (2003) to 1.04 kg/hr (2005). The relationship between dorsal mantle length (DML) and total body weight (TBW) for males, $TBW = 0.0008414 * DML^{2.57989}$ and for females, $TBW = 0.0009723 * DML^{2.55201}$. Fish formed the major food item in both the sexes (87.1% in males and 86% in females) followed by prawns. Females were dominant in the catch with a sex-ratio of 1:1.24. Maximum numbers of males were mature (43.6%) while maximum numbers of females (37.2%) were spawning. The size at 50% maturity for females was estimated as 153 mm. The major peak spawning season for the species is during February to May.

Keywords: Cuttle fish, *Sepia pharaonis*, fishery, biology, Maharashtra.

Introduction

Sepia pharaonis Ehrenberg, 1831 commonly called as Pharaoh cuttlefish is a coastal Indo-West Pacific species and is the largest cuttlefish in the Indian seas. There has been a steady increase in the production of this species in recent years due to rising demand in export markets. Almost the entire catch is obtained by trawlers along the Indian coasts,

while a small portion comes in targeted fishing (hand-jigging) (Nair, 1985). Much of the previous research on the species has been on the resource characteristics, fishery, export and stock assessment along the Indian coast (Silas *et al.*, 1982 and Nair *et al.*, 1985, 1993; Philip and Ali, 1989; Abdussamad *et al.*, 2004; Mohamed *et al.*, 2009) and Sasikumar *et al.* (2013). Nabhitabhata (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. There has been only limited work on the cephalopod fishery and biology off Maharashtra waters (Sundaram and Sarang, 2004 and Sundaram, 2009, 2011), therefore an attempt has been made to study the biology of *S. pharaonis* from Mumbai northwest coast of India, based on the trawl catches at New Ferry Wharf (NFW), Mumbai.

Material and methods

NFW situated in Mumbai, is one of the major fish landing centers of Maharashtra and since Mumbai accounts for 60% of the total fish landings in Maharashtra (Annam and Sindhu, 2005), the catch statistics from Mumbai can be considered as representative for the state. The trawlers operating from NFW operate 70-80 km off northwest coast of Mumbai at a depth of 40-60 m. The data on landings of cuttlefish by the

trawlers were collected by observing 10-20% of the boats randomly once a week during January 2000 to December 2011. The total number of boats and the total fish landings were obtained from the database maintained at Mumbai Research Centre of Central Marine Fisheries Research Institute. The catch recorded from the observed number of boats was raised to the total number of boats landed in a day, which in turn was raised to the month by taking into consideration the number of fishing days in a month and the monthly estimated number of boats.

Samples of *S. pharaonis* were collected from NFW, during January 2007 to December 2011. The dorsal mantle length (DML) was measured using digital calipers and total body weight (TBW) by an electronic balance (+ 0.01 g). The measurements were taken as described in CMFRI manual (CMFRI, 1995). Juveniles of *S. pharaonis* where sex determination was not possible were termed as 'indeterminates'. A total of 496 specimens were analysed which included 77 specimens of indeterminates (DML- 62 to 85 mm with TBW - 23 to 86 g), 204 males (DML - 104 to 332 mm with TBW - 161 to 2,600 g) and 215 females (DML - 86 to 290 mm with TBW - 82 to 2,100 g), were studied for length-weight relationship, gut content, maturity condition and fecundity.

The length-weight relationship (LWR) was obtained by the method of 'least squares' based on individual measurements. The relationship of DML and TBW was expressed as exponential 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, and hence 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) for studying diet composition. Maturity stages were carried out following Silas (1985a). The size at first maturity was estimated by King's (1995) method. Gonado somatic index (GSI) [(weight of the entire ovary/ total weight of the animal) x 100] was also estimated. 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

The estimated annual catch trends in trawl and the catch rate of *S. pharaonis* for the period 2000-2011 from NFW is shown in Fig 1. It was observed that the catch showed a decreasing trend from 2000 up to 2003 and then showed a sudden increase in landings in 2005 which then gradually

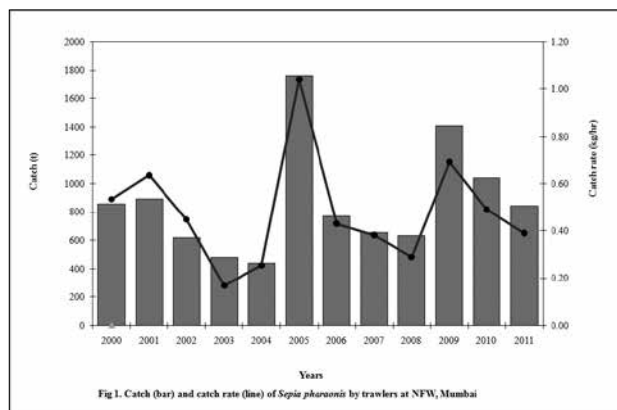


Fig. 1. Catch (bar) and catch rate (line) of *Sepia pharaonis* by trawlers at NFW, Mumbai

decreased up to 2008 and thereafter an increase in 2009 and further a declining trend up to 2011. The landings ranged from 438 t (2004) to 1,763 t (2005) and the catch rate from 0.17 kg/hr (2003) to 1.04 kg/hr (2005). The contribution of *S. pharaonis* towards the cephalopod landing ranged between 0.1% (2002) and 19% (2010) and *S. pharaonis* was the dominant species of cuttlefish contributing about 6.1% to the cephalopod landings (annual landing) in Mumbai during the study period. The cuttlefishes are taken to the processing unit within 4-6 hours, where they are de-skinned and de-gutted and are mainly exported. The month-wise catch rate averaged for the period 2000-2011 showed a peak in December (Fig. 2) indicating seasonal abundance during this period. Small sized specimens (ranging in length from 40 to 80 mm) were mainly observed during April-May and it constitutes about 10% of the total *S. pharaonis* catch during this period. Very large sized specimens measuring more than 300 mm were observed in December. The price of *S. pharaonis* increased from Rs.160/kg in 2000 to Rs.280/kg in 2011 at NFW.

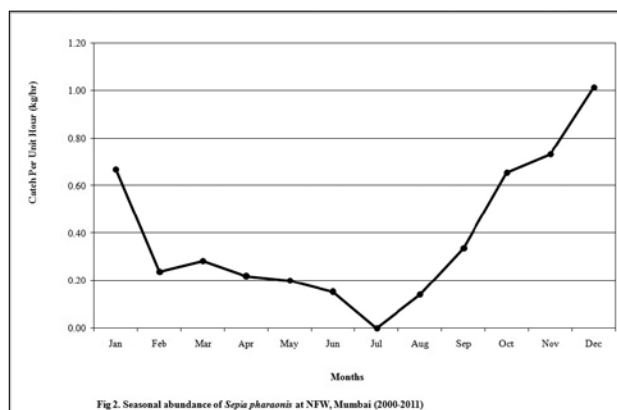


Fig. 2. Seasonal abundance of *Sepia pharaonis* at NFW, Mumbai (2000-2011)

The occurrence of this species in trawl net increases with increasing depth and this cuttlefish is caught mostly from depths beyond 30 m (Nair *et al.*, 1993). The sudden growth of fishery of this species along the northwest indicates demand driven exploitation. According to Nair *et al.* (1993), Maharashtra accounted for 44% of the all India *S. pharaonis* landings and the fourth quarter accounted for as much as 61-72% during different years. Kizhakudan *et al.* (2003) reported very large sized *S. pharaonis* in Gujarat waters during upwelling period. According to Silas *et al.* (1985 c) the juveniles of the species measuring up to 100 mm in size occur in the inshore waters and are caught in shore seines, boat seines and from depths up to 40 m in trawl nets particularly in Waltair, Madras and Mandapam waters. The Juveniles are obtained from January to July in Waltair area and throughout the year with the exception of September in Madras area. Juveniles up to a maximum size of 120 mm are obtained in trawl nets in Cochin area all the year round except in June and December and in Vizhinjam area from January to April and in August. Sundaram and Sarang (2004) also observed abundance of small sized specimens during the same period i.e. April-May from Mumbai waters.

From the length measurements taken from NFW it was observed that the species in Mumbai waters had a maximum DML of 369 mm for males and 320 mm for females. The relationship between DML and TBW was exponential. Therefore the values of length and weight were transformed into logarithm to linearise the equation. The equation for males is expressed as $TBW = 0.0008414 * DML^{2.57989}$ ($r^2 = 0.9534$), for females as $TBW = 0.0009723 * DML^{2.55201}$ ($r^2 = 0.9760$) and for indeterminate as $TBW = 0.0004417 * DML^{2.71938}$ ($r^2 = 0.9779$).

Anil *et al.* (2005), reported that *S. pharaonis* they grew to an average size of 168 mm (521 g) by the seventh month of

rearing and according to Anon (2006) they grew to 150 mm in six months. According to Roper *et al.* (1984) the maximum DML for the species is 430 mm for males and 330 mm for females. Kizhakudan *et al.* (2003) reported huge aggregation of large sized cuttlefish off Gujarat coast with DML ranging between 300-350 mm. According to Silas *et al.* (1985 c) the largest recorded size for males and females of this species on the east coast are 265 mm and 245 mm from Waltair and Madras waters respectively and this species grows to a larger size on the west coast (Vizhinjam waters) with 334 mm and 320 mm for males and females respectively. From the earlier literature and the present studies it can be inferred that males grow much larger in size than females.

The Index of preponderance revealed that in males, fish formed the major constituent of food (87.1%) followed by prawns (5.9%), cephalopods (0.2%) and digested matter (6.8%), in females, fish (86%) was followed by prawns (3.3%), cephalopods (1.7%) and digested matter (8.9%) and in indeterminate, fish (56.6%) was followed by prawns (15.1%), cephalopods (5%) and digested matter (23.3%) (Table 1) Traces of crab remnants were also found occasionally in both males and females. In males 23.7% of the guts analysed were empty, 25.9% were $\frac{1}{4}$ full, 26.2% were $\frac{1}{2}$ full, 1.8% were $\frac{3}{4}$ full and 22.2% were gorged. In females 18.7% of the guts analysed were empty, 21.6% were $\frac{1}{4}$ full, 18.5% were $\frac{1}{2}$ full, 19% were $\frac{3}{4}$ full and 21% were gorged. In indeterminate 60.1% of the guts analysed were empty, 13.8% were $\frac{1}{4}$ full, 11.3% were $\frac{1}{2}$ full, 5.6% were $\frac{3}{4}$ full and 8.9% were gorged. There seems to be no difference in the feeding habits between males and females.

S. pharaonis is an active predator, feeding on a variety of fish and crustaceans, and sometimes on other cephalopods and because of their benthic nature, they mostly feed on small fish and crustaceans like prawns and crabs that dwell near the bottom, sometimes on cephalopods also (Silas *et al.*, 1985c). According to Roper *et al.* (1984), the food includes crustaceans, variety of small demersal fishes and cannibalism is not exceptional which is in agreement with the observations in the present study. In the rearing experiments carried out by Anil *et al.* (2005), live feed organisms such as mysids, shrimp post larvae and artemia were primary food items given during first 20 days. Thereafter they feed on mysids, fish larvae, and juveniles of mullets.

Females were dominant in the catch with a sex-ratio of 1:1.24. Of the total, 40.2% males were immature, 43.6% mature and 16.2% in spawning stage. Among females, 32% were immature, 30.6% mature and 37.2% in spawning stage. All females were mature above 260 mm. The size at first maturity for females was estimated at 153 mm DML. In the present

Table 1. Index of Preponderance of *S. pharaonis* (males and females combined)

Month/ Diet	Prawn	Fish	Cephalopods	Crabs	Digested matter
January	0.3	94.9	0.0	0.0	4.8
February	0.6	95.0	3.5	0.0	1.0
March	5.4	90.9	0.3	0.0	3.5
April	33.4	19.1	1.3	0.0	46.2
May	6.1	64.8	4.6	0.0	24.5
June					
July					
August					
September	2.3	81.0	0.5	0.1	16.2
October	4.3	95.1	0.0	0.1	0.5
November	12.5	86.2	1.2	0.0	0.0
December	0.9	98.6	0.1	0.0	0.4
Annual %	7.3	80.6	1.3	0.0	10.8

study the maximum fecundity was 16,344 in November and least was in September with 369 ova. The ova diameter ranged from 2 to 8 mm. The GSI of females increased from September onwards and reached a primary peak in October and thereafter there was decline till December and then it increased to a secondary peak in February and thereafter there was a steep decline up to May (Fig. 3). The observations indicate that the peak spawning season is from February to May and a minor spawning season between October to December.

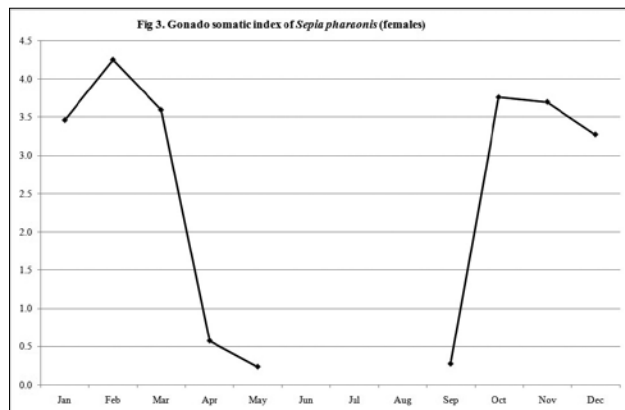


Fig. 3. Gonado-somatic index of *Sepia pharaonis* (females)

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). According to Nair *et al.* (1993) the sex-ratio was 23:77 on the west coast and according to Silas *et al.*, 1985c, females dominated almost throughout the year along Waltair, Madras and Cochin waters. Anon (2006) reported that the species showed mating behavior from 5th month onwards. According to Sivalingam *et al.* (1993) the egg capsules measured 16-20 mm in length. Nair *et al.* (1993) reported that at different centers on the east coast the size at first maturity was in the range of 119-121 mm for males and 120-138 mm for females. On the west coast both the sexes attained maturity at slightly larger sizes than on the east coast with females maturing at 157-160 mm. The above observations were true for the species from Mumbai waters also. According to Silas *et al.* (1985 c) the size at first maturity in Waltair, Madras and Vizhinjam waters was 150 mm, 121 mm, 145 mm for males and 170 mm, 121 mm, 160 mm for females respectively. The size of 100% maturity is 190 mm in both the sexes in Cochin waters (Silas *et al.*, 1985 c). These observations indicated that males attain maturity at slightly smaller size than females on both the coasts and the sizes at first maturity of both sexes are larger on the west coast. According to Nair *et al.* (1993), cuttlefishes of both the sexes with mature gonads were observed in several months at many centers on both the coasts indicating that spawning

is not restricted to any season but extended over a period of time, as in many cephalopods in Indian waters. The spawning season for the species at Vizhinjam extends from September to April Anil *et al.* (2005). Silas *et al.* (1982) observed that spawning occurs from October to December and during March to April in general on both the coasts, sometimes extending up to August (based on the study from Waltair, Vizhinjam and Cochin waters), which is in agreement with the observations made in the present study with the species having a minor spawning season during October to December and a major spawning period during February to May. The recruits observed in the catch ranging in DML from 40-80 mm are from this batch. The DML of the species after 6, 12, 18, 24, 30, 36 months from Cochin waters was estimated for as 101 mm, 165 mm, 204 mm, 229 mm, 244 mm, 254 mm for males and it was 90 mm, 145 mm, 179 mm, 199 mm, 211 mm, 219 mm for females respectively (Nair *et al.*, 1993).

Due to increasing export market, *S. pharaonis* is now very much sought after. Studies on the biology would prove useful to evolve effective fishery management measures for judicious exploitation of the resource. There is an urgent need to estimate the resource position and the maximum sustainable yield of this resource in Maharashtra waters for proper management of exploitation and conservation of the resource.

Acknowledgements

I am thankful to Dr. V. D. Deshmukh, Principal Scientist and Scientist-in-Charge, Mumbai Research Centre of CMFRI and Dr. K. S. Mohamed, Principal Scientist and Head, Molluscan Fisheries Division, Central Marine Fisheries Research Institute, Kochi.

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