MORPHOMETRY, LENGTH-WEIGHT RELATIONSHIP AND BIOLOGY OF *SEPIA ACULEATA* (d' ORBIGNY, 1848) FROM MUMBAI COAST, INDIA

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ABSTRACT

Seventeen morphometric characters of *Sepia aculeata* of Mumbai coast have been studied and the relationships of morphometric characters with dorsal mantle length (DML) were established. The characters compared showed a fair to high degree of correlation ('r' 0.63-0.99). Number of arm suckers and shell rings were related with DML. The shell rings also showed high degree of correlation with DML ('r' 0.79-0.95). However, the relationship between arm suckers and DML was not so good ('r' 0.1-0.4). The length-weight relationship is described as $W= 0.1821336\ L^{2.801102}$. Food and feeding analysis confirm the carnivorous feeding behaviour of the species. Mature females found in all months indicate that it has prolonged spawning season with two peaks, September and March-April. Absolute Fecundity ranged from 214 to 4143 eggs.

Keywords: *Sepia aculeata*, morphometry, length-weight relationship, fecundity

INTRODUCTION

Cephalopods include squid, cuttlefish and octopus, which are commercially exploited all along the Indian coast. *Sepia pharaonis, Sepia aculeata* and *Sepiella inermis* are three species of cuttlefish, which occur widely in India (Bal and Rao, 1984). Cephalopods (as top level predators) feed on a large range of prey, particularly fishes, crustaceans and molluscs. The annual production of cephalopods during 2004 was 1.13 lakh tonnes (4.35%) of total marine landings (Anon, 2004), while the average annual production from 1994 to 2003 is 1.08 lakh tonnes. The average estimated annual catch of *Sepia aculeata* in Maharashtra during the period of 1995-2003 is 2504 tonnes, of which Mumbai alone contributes an average of 1526 tonnes (61%) (Anon, 1995-2003). Oommen (1977a and b) studied the structure of the alimentary canal, digestive enzymes and food and feeding habits of this species from the Southwest coast of India. The length-

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weight relationship and reproductive biology of *S. aculeata* were determined by Chotiyaputta (1980) from Gulf of Thailand and Rao (1997) from Mangalore coast. Menon (1988) conducted a brief study on the morphometric characters of *S. aculeata* from Mumbai waters. In the present paper an attempt has been made to define characteristic of *S. aculeata* of Mumbai region through morphometry, length-weight relationship and biology.

MATERIAL AND METHODS

A total of 250 specimens of *Sepia aculeata* ranging from 25 to 184 mm were collected from landing centres (New Ferry Wharf, Sassoon Docks and Versova) and were brought to laboratory for the study of morphometric characters and biology. However, length-weight relationship comprised of 45 males, 31 females and 393 indeterminates. The length of males, females and indeterminate ranged from 48-137, 36-146 and 32-176 mm and weight 11-311, 8-264 and 5-500 g respectively.

Relationships between the various body measurements to the dorsal mantle length have been calculated and range, mode, standard deviations, mean, correlation of coefficient (r) were established for the characters under study. The above relationship between the characters was worked out by the formula of linear regression: $Y = a + b X$.

The cubic relationship between length (L) and weight (W) was calculated by the formula: $W = aL^b$ in the usual notations. The same can be written in logarithmic form treated by the method of least square using the equation of Le Cren (1951) given as: $\text{Log}W = \log a + b \log l$.

Length-weight relationship was worked out separately for males, females and also for the pooled data. ANCOVA was conducted to test the significant difference in 'b' values between male and female. For studying the feeding intensity, the degree of fullness of stomachs were classified as 'empty', 'trace', quarter full, half full, three quarter and full. The food items in the gut contents were identified. Since the individual food items have negligible volume it was difficult to determine their volumes and hence index of preponderance could not be calculated. The food composition was determined only on the basis of eye estimation as the percentage occurrence of the different food items. For determination of fecundity only mature and ripe ovary were taken into consideration. Twenty mature and ripe ovaries were examined for fecundity studies. The absolute fecundity (AF) was calculated as follows;

$$AF = \frac{n * V}{v}$$; in the usual notations

Seven ovaries were selected for ova diameter studies to study the spawning periodicity. A sub sample of ova was taken from the middle region and spread uniformly over a slide as suggested by

James (1967). The diameter of ova was measured using a compound microscope fitted with an ocular micrometer (one m.d. = 0.019 mm).

Gonado somatic index (% GNSI) was calculated using the following formula;

$GNSI = \frac{W_{gonad}}{W_{fish}} * 100$; in the usual notation.

In order to determine the size at first maturity, the data on percentage of females in mature and ripe stages were collected, pooled and their cumulative percentage frequencies were plotted against the length. Studies on the ratio of males to females were also worked out month- wise for the period from September 2004 to April 2005.

RESULTS AND DISCUSSIONS

In the present study the coefficient of correlation (r) for various morphometric characters against dorsal mantle length ranged from 0.63-0.99 indicating high degree of relationship among the characters compared (Table1).

The comparison of shell rings against DML also showed high degree of correlation while the arm suckers and DML did not indicate good degree of correlation (Table 2). The statistical analysis of various morphometric characters are given in the Table 3.

The high values of correlation coefficient obtained for various morphometric characters compared with dorsal mantle length indicate high

Table 1 : Regression values for various morphometric characteristics (y) as function of dorsal mantle length (x)

Morphometric characters	Range of 'X' (mm)	Range of 'Y' (mm)	Intercept 'a'	Slope 'b'	'r'
*DML and Mantle Breadth	36-137	26-87	6.5211	0.5868	0.9086
DML and Ven. Mantle Length	3.4-13.7	2.6-10.8	-0.1682	0.8269	0.9890
DML and Total Length-including Tentacles	36-120	92-380	18.368	2.9849	0.9514
DML and Head Length	3.4-14.8	1-3.5	0.4110	0.2228	0.9482
DML and Head Width	4-14.9	1-4	0.7996	0.2196	0.8743
DML and Eye Diameter	3.4-14.6	0.3-1.3	0.0821	0.0767	0.8254
DML and Spine Length	3.4-14.6	0.2-1	0.2447	0.0394	0.6328
DML and Fin Length	4-14.1	3.1-13	-0.7515	0.9799	0.9969
DML and Fin Width	4-14.1	0.4-1.6	0.0270	0.1019	0.9726
DML and Shell Width	3.4-13.8	1.4-4.4	0.5982	0.3107	0.9461
DML and Shell Weight	3.4-13.8	0.3-10.4	-4.7716	1.1683	0.9435
DML and Length of I Arm	4-13	1.9-10.6	-1.4402	0.8212	0.8279
DML and Length of II Arm	4-14.6	1.5-9	-0.5123	0.6836	0.8319
DML and Length of III Arm	4-14.6	1.2-9.3	-0.6547	0.6590	0.8514
DML and Length of IVArm	4-14.6	1.4-10.5	-1.0312	0.8063	0.8534
DML and Tentacle Length	4-14.6	3.5-22.5	2.4255	1.6326	0.8008

* DML = Dorsal Mantle Length

Table 2 : Regression values for number of suckers of arms and shell rings as function of dorsal mantle length.

Morphometric characters	Range of 'X' (mm)	Range of 'Y' (no.)	Intercept 'a'	Slope 'b'	'r'
DML and Suckers of I Arm	6.3-12	5-95	11.8302	5.8196	0.4452
DML and Suckers of II Arm	6.3-12	47-102	45.2492	3.1319	0.3383
DML and Suckers of III Arm	6.3-12	62-115	50.2275	3.6111	0.3248
DML and Suckers of IV Arm	6.3-12	59-172	57.9324	2.9850	0.1774
DML and inner rings of shell	37-140	28-110	8.6871	0.5949	0.7941
DML and Outer rings of shell	37-140	29-112	5.2031	0.7214	0.9517

* DML = Dorsal Mantle Length

Table 3 : Statistical estimates for various morphometric characteristics

Morphometric characters	Range (cm)	Standard Deviation	Standard Error	Coefficient of Variation	Average
Dorsal Mantle Length	3.6-13.7	2.418	0.079	0.285	8.496
Mantle Breadth	2.6-8.7	1.170	0.115	0.194	6.043
Ventral Mantle Length	2.6-10.8	2.202	0.232	0.326	6.755
Total Length including Tentacles	9.2- 38.0	7.627	1.001	0.280	27.218
Head Length	1-3.5	0.723	0.127	0.410	1.765
Head Width	1-4	1.000	0.02	0.394	2.541
Eye Diameter	0.3-1.3	0.150	0.021	0.200	0.751
Spine Length	0.2-1	0.116	0.016	0.198	0.591
Fin Length	3.1-13	3.960	1.194	0.536	7.381
Fin Width	0.4-1.6	0.422	0.127	0.484	0.872
Shell Width	1.4-4.4	0.832	0.086	0.263	3.162
Shell Weight	0.3-10.4	2.984	0.275	0.594	5.021
Length of I Arm	1.9-10.6	1.855	0.270	0.317	5.853
Length of II Arm	1.5-9	1.727	0.2467	0.305	5.669
Length of III Arm	1.2-9.3	1.617	0.238	0.307	5.263
Length of IV Arm	1.4-10.5	1.894	0.276	0.307	6.174
Tentacle Length	3.5-22.5	4.070	0.719	0.237	17.159
Inner rings of shell	28-110	16.530	2.338	0.379	43.653
Outer rings of shell	29-112	16.729	2.365	0.347	48.240
No. of Suckers of I Arm	5-95	18.074	3.356	0.279	64.896
No. of Suckers of II Arm	47-102	18.492	3.433	0.255	72.517
No. of Suckers of III Arm	62-115	21.385	3.971	0.262	81.758
No. of Suckers of IV Arm	59-172	23.268	4.320	0.279	83.482

degree of interdependence of these compared characters. The 'r' value between DML and fin length was 0.99, showing highest correlation. However, the correlation coefficient for number of suckers of four arms against DML was poor 0.4, 0.3, 0.3 and 0.1. Maximum slope (b=2.9) was obtained for total length including tentacles on DML indicating highest growth rate. Regression of tentacle length on DML gave a slope of 1.6, shell weight on DML of 1.1 and fin length on DML of 0.9 while minimum slope was obtained

for the regression of spine length on DML (0.03) indicating very slow growth rate. These findings are in agreement to that of Menon (1988).

The length-weight relationship is obtained as: $W= 0.121551409\ L^{2.98579}$ (male), $W= 0.260105778\ L^{2.651735}$ (female) and $W= 0.1821336\ L^{2.801102}$ (combined) (Fig.1). Analysis of covariance (ANCOVA) was performed on 'b' values of males and females revealed no significant difference between the sexes.

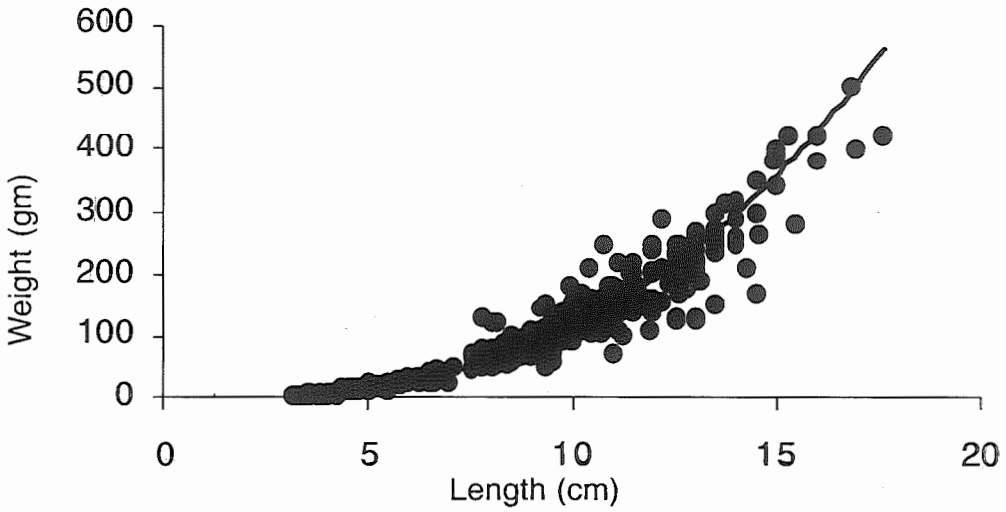

Fig.1: Length-Weight relationship of S.aculeata

Rao (1997) calculated 'b' from Mangalore coast as 2.38 and 2.50 for male and female respectively. Similarly, Chotiyaputta (1980) found 2.50 for male and 2.59 for female from Gulf of Thailand. Menon (1988) established the length-weight relationship for combined sexes of the species from Mumbai coast, where regression coefficient 'b' was 2.47. The present findings deviate slightly from the earlier works. In general, cephalopods report allometric growth *i.e.* values of 'b' different from 3. Present study shows that the 'b' values 2.98, 2.65 and 2.80 for males, females and combined respectively.

In cuttlefishes, the stomach contents were usually found in well-macerated condition as the food is being bitten into very small particles by beaks before swallowing which makes identification very difficult therefore analysis of food content is done by grouping them. Most of the stomachs were having mixed type of food items such as fish, crustaceans or cephalopods parts. During study period 26.42% of the stomachs were found empty, 19.81% had traces of food,11.32% quarter full, 9.43% half full, 7.55% three quarters full and

25.47% completely full (Fig 2). Oommen (1977a and b) studied the structure of the alimentary canal, digestive enzymes and food and feeding habits of this species from the Southwest coast of India and he also reported the well-macerated condition of food.

Though mature females were recorded in all the month, the maximum numbers of mature females were recorded in the month of February to April that could be one peak spawning season. However, high GNSI (Fig. 3) indicated two spawning season, one is September and other one is March-April. Chotiyaputta (1980) found mature ovaries all year round with two peaks of spawning season first from March to April and second one from July to September from Gulf of

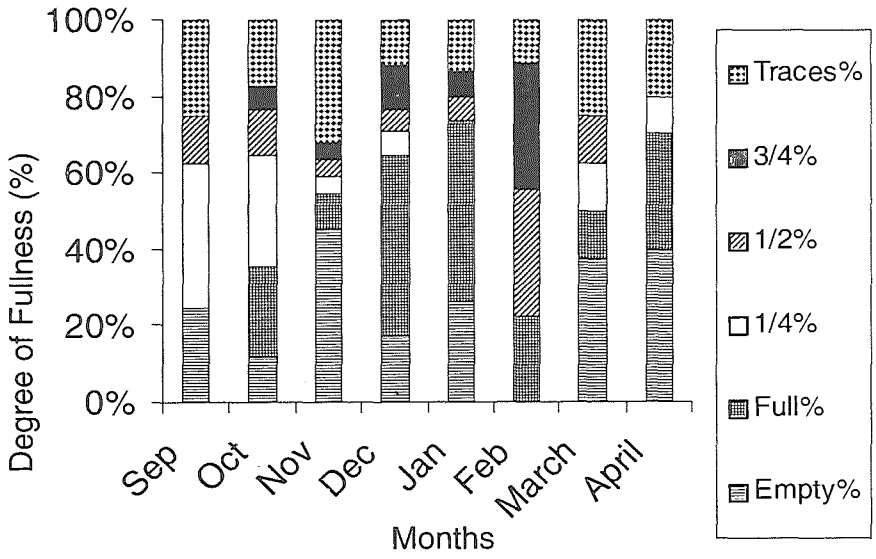

Fig. 2: Monthwise distribution of degree of fullness of stomach

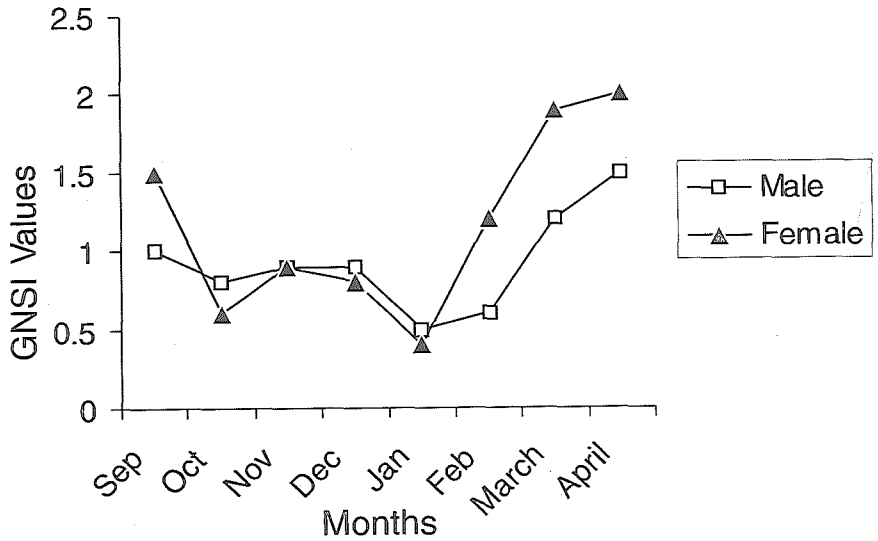

Fig. 3: Monthwise GNSI values in S.aculeata

Thailand. Silas *et al.*, (1986a and b) observed mature and spawning cuttlefish in most of the months at Visakhapatnam, Kakinada, Madras, Porto Novo and Mandapam on the East coast, Cochin and Bombay on the West coast. Absolute fecundity of *S.aculeata* ranged from 214 to 4143 eggs having dorsal mantle length range of 87 mm to 146 mm. Size at first maturity was calculated as 99 mm (Fig. 4). Sex ratio (males: females) indicated

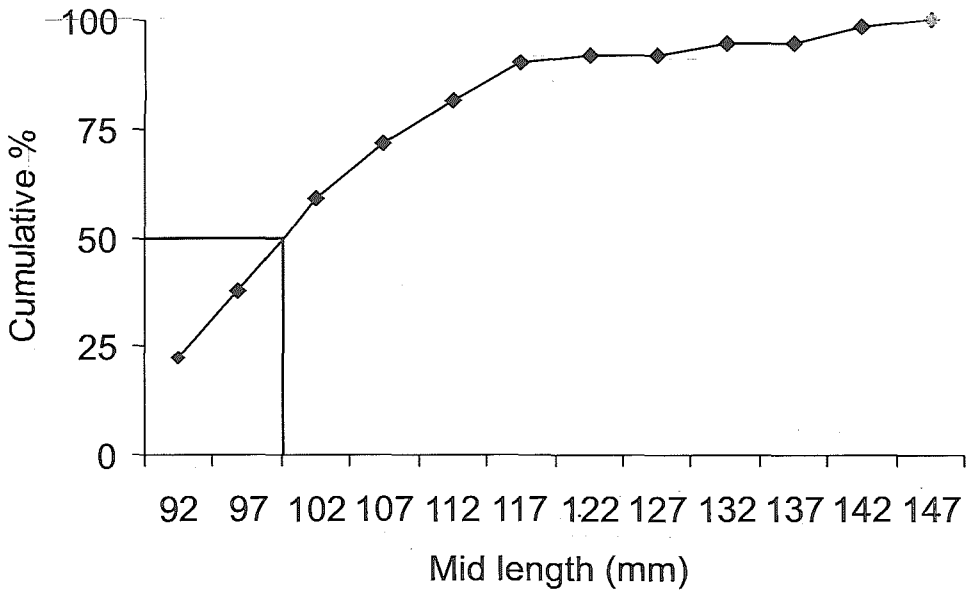

Fig. 4: Length at first maturity of S.aculeata

males were more in numbers as compared to females and the value of sex ratio was more than one in almost all the years. Rao (1997) found the fecundity range from 206-1568 eggs with an average of 587eggs while Chotiyaputta (1980) observed average fecundity of 1644 eggs. These findings are similar to the present.

The length at first maturity varied from place to place in India. Silas *et al.*, (1986 b) estimated it as 77 mm at Visakhapatnam, 100 mm at Madras, and 83 mm at Mandapam and 124 mm at Cochin for males and102 mm at Visakhapatnam, 118 mm at Madras, 110 mm at Mandapam, 130 mm at Cochin and Bombay for female. Rao (1997) estimated it as 86 mm in Mangalore area. But in the present estimation (99 mm for combined sex) is relatively higher as compared to findings of Rao (1997) but lower than that of Silas *et al.*, (1986 b). Silas *et al.*, (1986) also observed that males are more in the population as compared to females. Chakraborty *et al.*, (1997) reported L_∞ of this species as 297 mm whereas in the present study it was found to be 258 mm. This clearly indicates that there is reduction in the mean length and maximum size of the species. This may be one of the reasons for reduction in

the length at first maturity of this species, which is 99 mm as compared to 130 mm recorded by Silas *et al.* (1986). A species, which is under tremendous pressure of being over exploited usually, tries to mature early so that at least some progeny is left behind for its race to sustain (Ricker, 1975). The present study on *Sepia aculeata* indicates that over the years, the fishing pressure has gone up tremendously resulting in sharp decline in catches. Thus, management measures like reduction of efforts, protection of juveniles and spawners is necessary.

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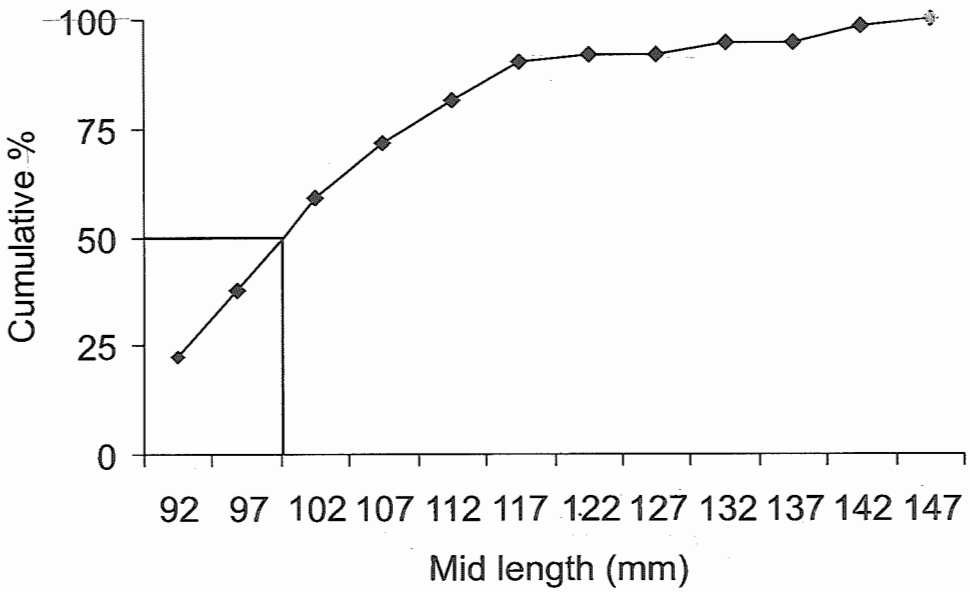

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