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Reproductive Biology of the Pharaoh Cuttle *Sepia pharaonis* in the Persian Gulf

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Abstract: The Pharaoh Cuttle *Sepia Pharaonis* is known as one of the economically important species in the classes Cephalopoda. In Iranian waters, *S. pharaonis* is the dominant cephalopod species. Samples of *S. pharaonis* were collected monthly from the Bahrakan Coasts in the Persian Gulf from March 2007 to February 2008. This study was conducted to determine its some Reproductive characteristics. The data shows that 70 % of population was males and 30 % was females and the spawning period of *S. pharaonis* covers the whole months of sampling, with two maximum peaks in May and June.

Key words: *Sepia pharaonis* % Reproductive Biology % Persian Gulf % Bahrakan

INTRODUCTION

The Pharaoh Cuttle *Sepia Pharaonis* [1] is a broadly distributed species found from east Africa to southern Japan [2]. It is a neritic demersal species which occurs down to 130 m in Iranian waters, *S. pharaonis* is the dominant cephalopod species and the fishing activity occurs during the spawning season, when adults migrate from deeper waters to shallower waters in the littoral zone [3]. It is caught by bottom trawlers in oman Sea and by traps in the Persian Gulf and is one of the most important cuttlefish species fished in both areas [3].

Despite the clear economic importance of this species, relatively little is known about the biology of *S. pharaonis* [4, 5].

Gabr *et al*. [6] described four maturity stages of *S. pharaonis* for males and females in the Suez Canal based on macroscopic and microscopic of the gonads. Information on maturation and spawning of this species will contribute to knowledge of their population dynamics and management of the stocks. This study represents maturity scales for males and females are described morphologically. The data represent spawning season, variation in maturation in both sexes.

MATERIALS AND METHODS

Samples of *Sepia pharaonis* were collected monthly from Bahrakan, the fishing port in the Persian Gulf (Fig. 1), from March 2007 to February 2008. The samples were caught by local fishermen using trawlers and cuttle-traps and *S. pharaonis* was not found in all monthly samples; it started to appear in the catch in November and disappeared after June. In total, 101 females and 209 males were collected and frozen. After thawing at room temperature, total body wet weight (BW) to nearest 5 g and dorsal mantle length (ML) to nearest 1 mm were measured and recorded. Specimens were dissected to determine sex and maturity stage. Maturity stages for each sex were determined by using of the scale proposed for *Sepia pharaonis* by Gabr *et al*. [6]: for females, I ± immature, II ± mature, III ± pre-spawning and IV ± spawning; for males, I ± immature, II ± mature, III ± fully mature and IV ± spawning. The following reproductive tract measurements were made while the organs were intact within the body cavity: Males, testis weight TEW, spermatophoric complex weight SCW (Needham's sac. spermatophoric complex. penis); Females, ovary weight OW, oviducal complex weight OVW (oviduct. oviducal

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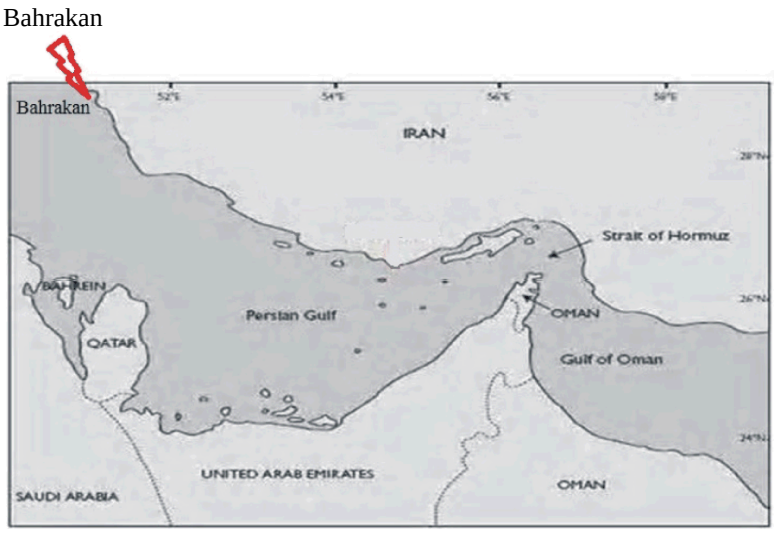


Fig. 1: Bahrakan, the fishing port in the Persain Gulf

gland), nidamental gland weight NGW. Gonads of both the sexes were preserved in 70% Ethanol for detailed study. Fecundity was defined as the total number of maturing ova (with striation) and mature ova (large smooth ova) in the ovary and the number of ova in the oviducal glands (proximal and distal glands) Gabr *et al*. [6]. Fecundity was studied in females that were in stage IV (spawning), it was estimated using the total count of maturing and mature ova from fresh specimens. For mature males, the spermatophoric complex was dissected and stored in70% Ethanol. Later, spermatophores were separated and counted. Indices of reproductive status for males and females were calculated (after Durward *et al*. [7, 8-11] as follows:

For Males: Gonadosomatic index GSI.100 TEW/BW, Spermatophoric complex index SCI.100 SCW/ BW where BW is the body weight, TEW the testis weight and SCW the Spermatophoric complex weight.

For Females: Gonad somatic index GSI.100 OW/BW, Nidamental gland index NGI.100 NGW/BW, where OW is the ovary weight, NGW the nidamental gland weight.

Length-Weight Relationship: Equations of the form $BW = aML^b$, where a and b are constants of the regression, were fitted by transforming the data into $\log_{10}$ and deriving the regression line by the least squares method. Correlation was expressed by the coefficient r^2 and comparisons between males and females were made by ANCOVA.

RESULTS

In this study, 310 specimen of *Sepia pharaonis* collected (101 females and 209 males) which represents a sex ratio of 2:1 (Table 1).

Mantle length (ML) values were between 96 and 300 mm in 101females and 133 and 360 mm in 209 males. Mean value of ML in females was 233.31 mm and in males it was 269.33 mm. The graph was made according to the distribution of mean ML of both sexes, monthly, it shows that larger females and males appear in the peak of spawning (May and June) (Figure 2).

Body weight (BW) values were between 130 and 2060 mm in females and 270 and 3370 mm in males. Mean value of ML in females was 1102.28 mm and in males it was 1615.36 mm. The graph was made according to the distribution of mean ML of both sexes, monthly (Figure 3).

Length-Weight Relationship: The length-weight relationship for *Sepia pharaonis* is described by the equation: $W=0.0011ML^{2.4797}$, $r^2=0.92$, for females (Fig. 4) and $W=0.0015ML^{2.5403}$, $r^2=0.93$, (Fig. 5). The elevation and slopes from the regression equations for females and males did not differ significantly, thus indicating that females have approximately the same weight as males at the same mantle length and that both sexes increase similarly in weight per unit gain in mantle length.

Maturity Stages: There was no female in stages II and III and 93.06% of females and 79.90% of males were in the fourth stage. There was no male in the second stage (Table 2).

Table 1: Sex ratio of *Sepia pharaonis* population in this study

Month	Sex ratio	P^2
March	3.33	7.53
April	2.05	7.23
May	1.51	3.88
June	0.50	3.00
December	7.30	28.88
January	4.50	8.90
February	2.10	3.90
Total	2.06	37.62

x^2 >3.4: p<0.05

Table 2: Frequency and percentage of *S. pharaonis* in different maturity stages

Maturity stages	Frequency of males	Frequency of females	Percentage of males	Percentage of females
I	7	7	3.35	6.93
II	—	—	—	—
III	35	—	16.74	—
IV	167	94	79.90	93.06

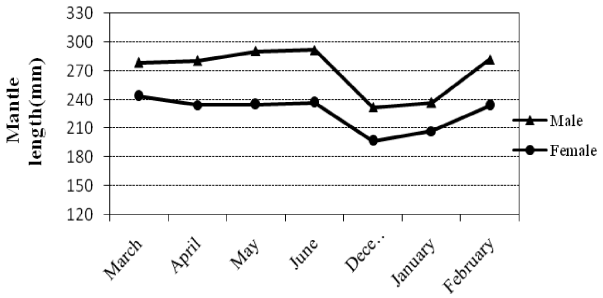


Fig. 2: Distribution of mean mantle lengths of females and males monthly

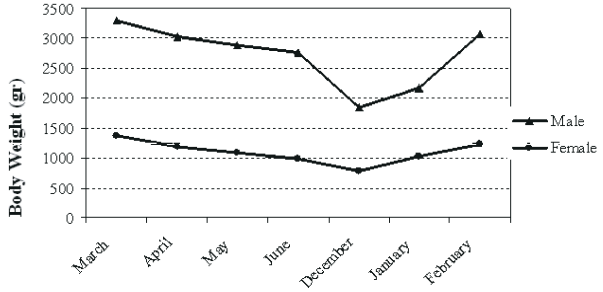


Fig. 3: Distribution of mean body weight of females and males monthly

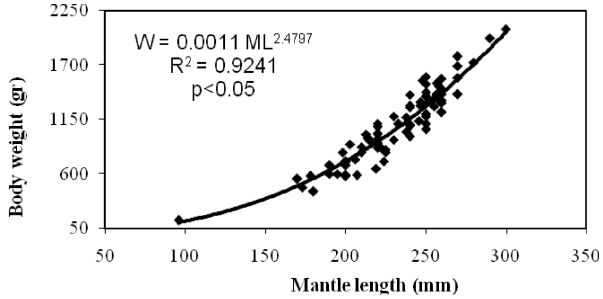


Fig. 4: Relation between mantle length and body weight of females

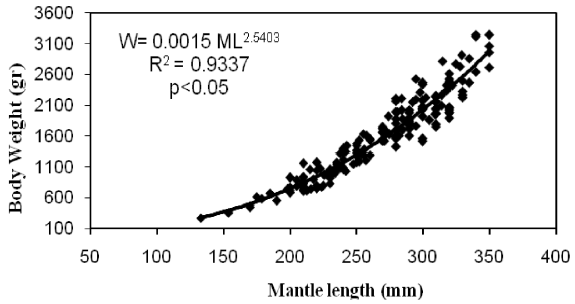


Fig. 5: Relation between mantle length and body weight of *Sepia pharaonis* males

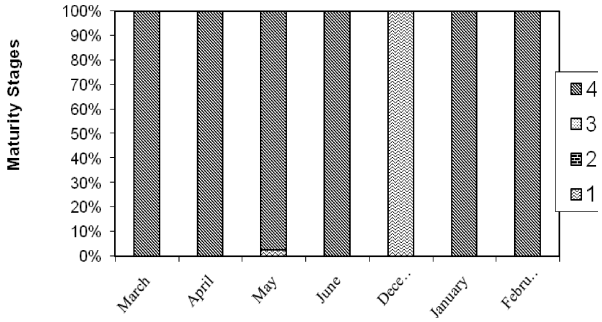


Fig. 6: Monthly frequency distribution of female *S. pharaonis* at different maturity stages

Monthly Variation in Maturity Stages: To determine the spawning season, the occurrence of mature females and males throughout the period of study was examined. Figs. 6 & 7 illustrate the monthly percentage composition of the maturity stages of both the sexes of *Sepia pharaonis*. The occurrence of mature females and males throughout the sampling period indicates that *S. pharaonis* migrate from deeper waters to shallower waters of this area in Persian Gulf.

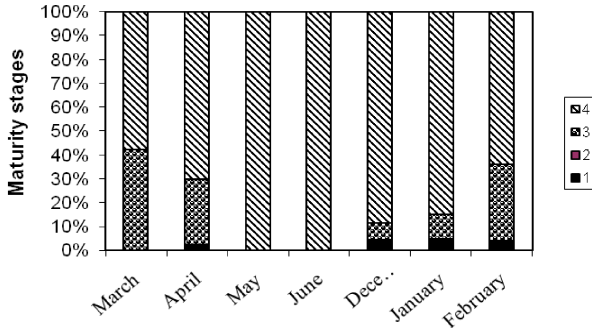


Fig. 7: Monthly frequency distribution of male *S. pharaonis* at different maturity stages

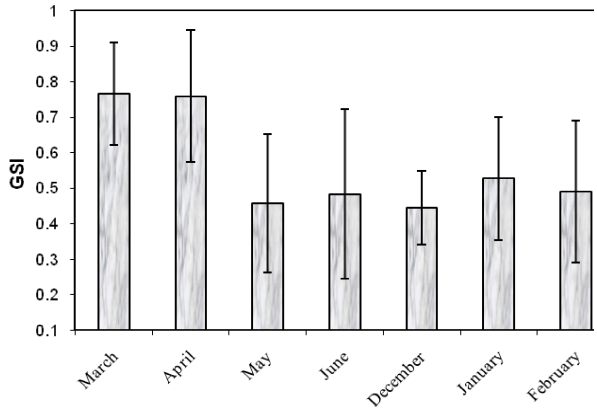


Fig. 8: Variation of gonadosomatic index (GSI) in *Sepia pharaonis* males

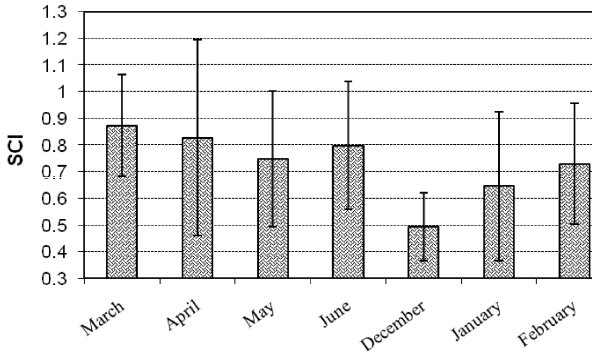


Fig. 9: Variation in monthly means of Spermatophoric complex index (SCI) of *Sepia pharaonis* males

Maturity Indices: For *Sepia pharaonis*, seasonal variation in the indices (GSI, NGI and SCI) was not pronounced for both sexes. GSI is the ratio of gonad weight to body weight. The graph of gonadosomatic index of males (Figure 8) showed low mean values in the months May and December and high mean values in March and April. Maximum values of the SCI (Spermatophoric complex index) were found around March and April and minimum value in December (Fig. 9).

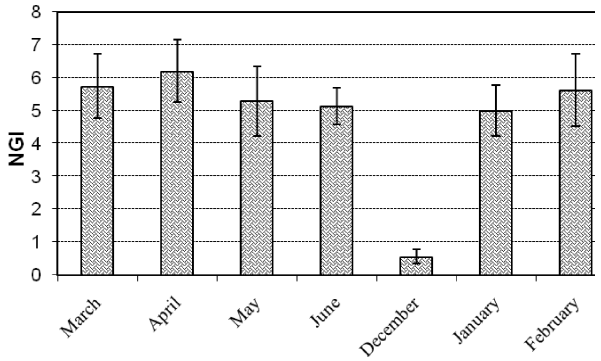
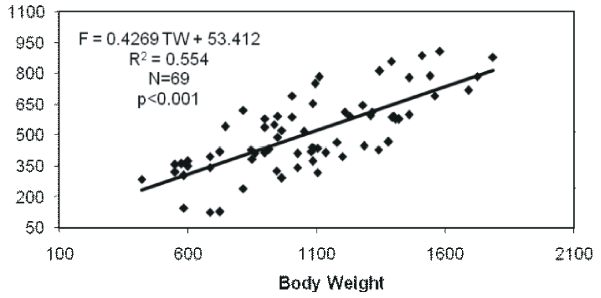


Fig. 10: Variation in monthly means of NGI (Nidamental gland index) of *Sepia pharaonis* females



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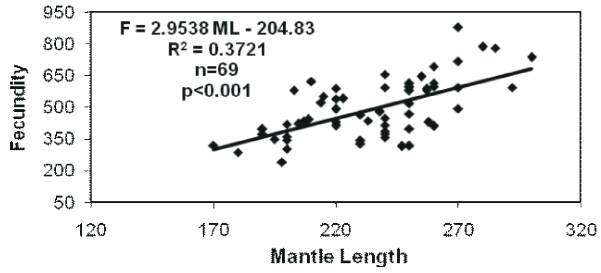

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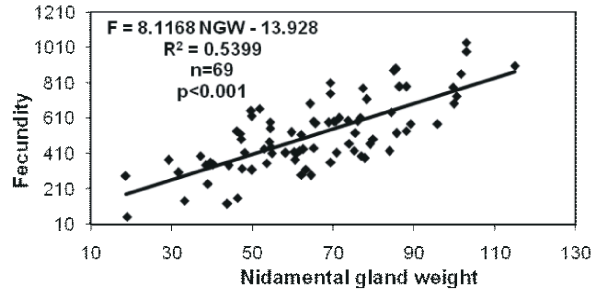
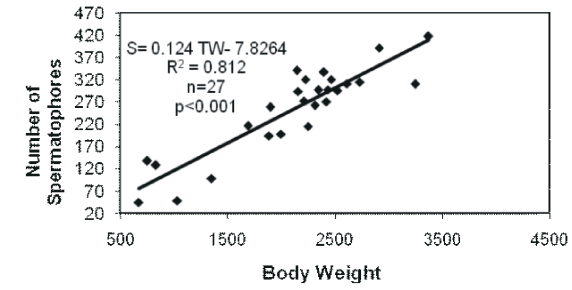


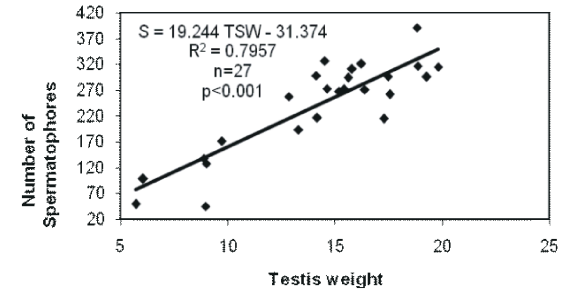
(C)

Fig. 11: The relationship between Fecundity with: A) Body Weight B) Mantle Length C) Nidamental gland weight of *Sepia pharaonis*

The highest levels of NGI (Nidamental gland index) of females were observed in April and minimum NGI value in December when females were immature (Fig. 10).



(A)



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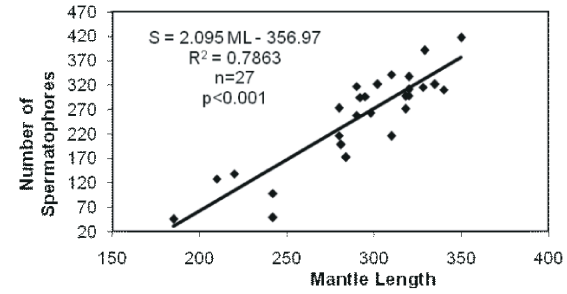

(C)

Fig. 12: The relationship between number of spermatophores with: A) Body Weight B) Testis weight C) Mantle Length of *Sepia pharaonis*

Fecundity: Total number of ova in spawning female *S. Pharaonis* (Stage IV) ranged from 53 in a female 198 mm ML and body weight of 815 g, to 1589 in a female 254 mm ML and body weight of 1660 g. Fecundity was correlated with mantle length, body weight and with weight of the nidamental gland (Fig. 11).

Spermatophores: Maximum and minimum number of spermatophors of *S. pharaonis* was 856 and 45 for males with 300 mm and 185 mm of mantle length and 2465 and 670 g of body weight respectively. The relationship between the number of Spermatophores with body Weight and testis weight and mantle length is shown in Fig. 12. The number of spermatophores with these parameters was well correlated.

DISCUSSION

In this study the high mean values of SCI (Spermatophoric complex index) and GSI (Gonadosomatic index) for male *S. pharaonis* were observed in March and April and low mean values in the months May and December (Figures 8 and 9). The highest level of NGI (Nidamental gland index) for females were observed in April and minimum NGI value in December when females were immature (Figure 10). The increase in the maturity indices showed that peak of sexual maturition of *S. pharaonis* occurred in these months. Decrease of these indices in May and June showed that spawning of *S. pharaonis* occure in these months. Based upon above mentioned 93.06% of females' and 79.90% of males were in the fourth stage throughout the period of sampling and no spent females were found. Stage IV females may eventually move off the fishing ground, where they may be preyed upon due to a weakened condition, or they might return to spawn again Gabr *et al*. [6]. Aoyama and Nguyen [5] noted that *Sepia pharaonis* in Yemen migrates to deeper water after spawning where most of the females die, while some males were assumed to survive to the following year then die after participating again in reproductive activity. Mortality occurs in many cephalopods after one or several bouts of spawning, Arnold and Williams-Arnold, [12]; Mangold *et al*. [13]. Vallinassab's studies [14] showed two spawning seasons for this species in waters of Sistan and Baluchestan of Iran, First of these were in spring from early of March to the middle of May and the second was in Autumn from middle of September to the end of November, The main spawning season was Spring that simultaneously with the end of southwest monsoon in this region.

Researches on *S. pharaonis* in Indian Ocean showed the spawning was found to take place in Novemberr, December and March, April in West region and October to December and April to June in East region, Silas *et al*. [15]. Based on observation recorded for this species by Ayoama and Nguyan [5] in waters of Yemen, mature species were from May to December but main peak of spawning was from early of October to the end of November. The period of peak reproductive activity for *S. pharaonis* was early spring to summer and spawning occurred from March to June in the Suez Canel, Gabr *et al*. [6]. The differences were seen between spawning season in various areas because of various ecological conditions and effective factors on spawning such as food availability. During maturation, there is a shift of emphasis from somatic growth to gonadal development and

vitellogenesis. Research observations suggest that energy and nutrients for maturation are supplied mainly by diet rather than stored resources: the species does not use protein from muscle tissue for developing and growing its reproductive tissues, Gabr *et al*. [16]. In this study fecundity was estimated by counting the number of maturing and mature ova which varied from 53 in a female 198 mm ML and an body weight of 815 g, to 1589 in a female 254 mm ML and an body weight of 1660 g and mean of fecundity was 566 for *S. pharaonis*. The relationship between the fecundity with body weight and mantle length is shown in Figure 11, the relationship between the two variables was weak (r^2=.0.55 and r^2=.0.37 for body weight and mantle length respectively). Persian and Vallinassab [14] recorded 500-700 ova for this species from waters of Sistan and Baluchestan of Iran. According to Gabr *et al*. [6] the total number of ova in spawning female *S. pharaonis* (Stage IV) ranged from 75 in a female 97 mm ML and an ovary weight of 4.6 g, to 1525 in a female 215 mm ML and an ovary weight of 41.9 g forthis species, there was a tendency for the larger females to be more fecund than the smaller ones, although the relationship was weak (r^2=.0.60). The weak relationship may result from some females of similar size having already laid different numbers of eggs, since all these individuals appeared to be in spawning condition, Gabr *et al.* [16]. Mean of number of spermatophors 255 obtained and maximum of number of spermatophors was 856 of *S. pharaonis* with 300 mm of mantle length and 2465 gr of body weight and this analysis of number of spermatophors showed that relationship between body weight and number of spermatophors was a type of liner equation (S=0.124 TW-7.8264, r^2=.0.81). According to Gabr *et al*. [6] the number of spermatophors in mature male *Sepia pharaonis* ranged from 38 in a small male (43 mm ML) to 530 in a large male (150 mm ML). The wide scatter was expected because some males had already released a proportion of their spermatophors since all these individuals appeared to be in spawning condition. The result of this study showed that sex ratio of *S. pharaonis* was 2:1 and in all months except June, males significantly outnumbered females (x^2-t-test, $p<0.05$). The proportion of males to females were 70:30 in waters of Sistan and Baluchestan [14] and it was 0.46 to 0.54 and 0.61 to 0.39 in waters of Sistan and Baluchestan and bushehr, respectively [17]. Several reason for these differences can be: samples were caught by bottom trawlers from waters of Sistan and Baluchestan in 2000 year, whereas collected samples in 1994 were from coastal waters. Based on observation recorded by Ayoama and Nguyan [5], the sex ratio of *S. pharaonis* with mantle length below 30cm is nearly 1:1, while, all those larger than 30 cm are male and the largest one is about 43 cm, reasons for the absence of large females may possibly be the differences of growth rate and the shorter life span.

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