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Taxonomical and morphometric studies on *Sepia pharaonis* Ehrenberg, 1831(Cephalopoda: Sepioidea) from the Suez Gulf (Red Sea), Egypt.

Rafik Riad[1]; Manal Atta[2]; Youssef Halim[2] and Noha Elebiary[1]
1- National Institute of Oceanography and Fisheries, Alexandria branch, Egypt.
2- Faculty of Science, Alexandria University, Egypt.

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ABSTRACT

Morphometric characters of male and female *Sepia pharaonis* were investigated for samples obtained from commercial trawling vessels of Suez Gulf, Egypt. Samples were collected (850 individuals) between winter 2014 to autumn 2014.Measurements for the smallest and largest male and female specimens, mean and number of parts showed negative allometric growth (slope less than 1). Generally, the coefficient of determination R for MW, HL, HW, FL, FW, FU.L, FU.W, AL and TL (0.9766, 0.9551, 0.9767, 0.9965, 0.9453, 0.9779, 0.9712, 0.9580, 0.9685), respectively, were high for most measurements.

The present study reported some additional characters for this species that were not recorded before from other previous descriptions

1. INTRODUCTION

Cephalopods are characterized by their activity, intelligent carnivorous creatures with highly advanced visual and nervous system (Boyle and Rodhouse, 2005) .They are soft-bodied bilaterally symmetrical animals with a well-developed head and body that consists of the muscular undivided mantle, mantle cavity houses the internal organs and also houses the external fins when present. The head bears an anterior circumoral crown of mobile appendages surrounding the mouth which are the arms and contractile tentacles (FAO, 2005). It is worth to note that cephalopods are the most complex individuals among the whole invertebrate phyla. They are exclusively marine that live in all oceans and seas except Black Sea from continental shelves and slopes throughout most of the world's oceans (FAO, 2005).All cephalopods are carnivores, and most exhibit a preference for live natural foods (Iglesias *et al*., 2014).

Cephalopods are considered important economic seafood item in human diet as they contribute 14% of the world fisheries, according to the FAO (2004). Class Cephalopoda comprises cuttlefishes, squids, octopuses and nutili. It embraces about 1000 known valid species and constitutes about 2.07% of phylum Mollusca (Hassan, 1974). Cephalopods represent a significant worldwide fishery resource.

* Corresponding author: e-mail, rafik_riad67@yahoo.com
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According to Roper *et al*. (1984**)** the world total catch of cephalopods consists of 71.8% squids, 13.6% cuttlefish and 14.6% octopuses.

Riad (1993) stated that in the Egyptian Mediterranean waters the cephalopods constitute 9.8% of the total fish catch of which 61% are cuttlefishes, 3.5% octopuses and 0.21% squids. On the other hand, in the Red Sea Egyptian waters cuttlefishes constitute about 0.69% from the total fish catch (Riad and Abdelhafez , 2008).

Cephalopod fisheries in Egypt are economically important because of its high commercial value in the national markets (Mehanna *et al.,* 2014). Mehanna *et al.*(2009) stated that the high protein content of cephalopods and their low fat content make them an important and healthy valid food element in human diet either as fresh food or processed products. Samiee *et al.* (2013) indicated that the dominant fatty acids in *Sepia pharanois* muscle tissues are Docosahexaenoic acid (DHA) (32.89%) and Eicosapentaenoic acid (EPA) (27.68%). They added that DHA and EPA are Omega-3 essential fatty acids and advocated that Palmitic acid is the dominant fatty acid in the liver tissues of *Sepia pharaonis*.

The aim of the present study is to focus on the characteristic features that differentiate *Sepia pharaonis* that dwelling Suez Canal, Egyptian waters. The present study reported some additional characters that were not recorded before from other previous descriptions.

2. MATERIALS AND METHODS

Sepia pharaonis specimens were seasonally collected during the period from winter 2014 to autumn 2014. A total of 850 individuals were collected from commercial trawling vessels of Suez Gulf, Egypt. Samples were frozen in the deep freezer and stored for investigation. After thawing at room temperature, the sex was determined by checking the presence of the left IV hectocotylized arm (modified arm) in males (Richard, 1967).

2.1 Taxonomical studies were based on:

2.1.1 Morphological characters.

The external morphology of some *Sepia pharaonis* specimens were investigated according to Roper *et al*. (1984) and Nesis (1987). The investigation included the external morphology, tentacular club, hectocotylized arm, tentacular club sucker ring, normal arm, normal arm sucker ring, radula, radula lateral and marginal teeth, gill, shell and funnel (siphon).

2.1.2 Morphometric characters.

The body measurements were taken according to Emam (1983); Riad (1993); Gabr and Riad (2008); Emam *et al.* (2014).

The total body wet weight (To. wt) of each specimen was weighed to the nearest 0.1 gm using digital balance. The dorsal mantle length (ML) to the nearest 1mm were measured using ruler. For the body measurement the regression equation of different measurements (Mantle width (Mw), Head length (Hl), Head width (Hw), Fin length (Fl) , Fin width (F w), Funnel length (Fl), Funnel width (Fu w)) plotted against Mantle length. Body morphometric measurements included:

Total length, distance from the left foremost tip of the mantle to the end of tentacle. A to B (Total L) (Fig .1).

Dorsal mantle length, length of the mantle from the posterior tip to the anterior tip measured on the dorsal side, C to D (ML) (Fig. 1).

Head length, Distance between the origin of mantle to origin of tentacle, E to F (HL) (Fig. 1).

Tentacle length, distance along tentacle from the point of emergence from webbing between arms III and IV to the tip of the tentacle, G to H (TL) (Fig.1).

Arm length, the distance from upper margin of the head to the tip of the longest arm, I to J (AL) (Fig .1).

Fin length, the distance from the posterior tip of the mantle to the anterior most tip of the fin, K to L (FL) (Fig. 1).

Mantle width, the largest width of mantle, measured across the shell, M to N (MW) (Fig.1).
Head width, the width of the head measured across the anterior edge of the eyes, O to P (HW) (Fig.1).
Fin width, the width of the fins when fully stretched and measured at the greatest width arm length, Q to R (FW) (Fig. 1).
Funnel (siphon) length, S to T (Fu. L) (Fig. 2)
Funnel (siphon) width, U to V (Fu. W) (Fig.2)
Shell length, distance between the anterior tip to the posterior tip of the shell, W to X (Sh.L) (Fig. 3). **Shell width**, greatest width of the shell, Y to Z (Sh.W) (Fig. 3).

3. RESULTS AND DISCUSSION

3.1 Taxonomical study

Class: Cephalopoda Cuvier, 1798
Subclass: Coleoidea Bather, 1888
Order: Sepioidea Naef, 1916
Family: Sepiidae Keferstein, 1866
Genus: *Sepia* Linnaeus, 1758
Species*: Sepia pharaonis* Ehrenberg, 1831

3.1.1 Synonymies:

Sepia torosa Ortmann, 1888, *Sepia rouxii* d'Orbigny, 1839–1842; *Sepia formosana* Berry, 1912a; *Crumenasepia hulliana* Iredale, 1926, *Crumenasepia ursulae* Cotton, 1929; *Sepia rouxi* d'Orbigny, 1841, *Sepia formosana* Sasaki, 1929; *Sepia tigris* Sasaki, 1929. (Jerb and Roper 2005) ; *Acanthosepion rouxi* Rochebrune, 1884; *Sepia singhalensis* Robson, 1927 (Adam, 1960).

3.1.2 Local name: Sobbet**,** Sobia and habbar.

3.1.3 Geographical Distribution:

The pharaoh cuttlefish *Sepia pharaonis* is widely distributed in the Indo-West Pacific region ranging from the Red Sea to Japan and Australia and forms a dominant species in the commercial fisheries (Roper *et al*., 1984, Nesis, 1987 and FAO, 2005), Suez Gulf and Egyptian Red Sea (Riad, 2008) This cuttlefish is the primary cephalopod fishery product in the Suez Canal and the most valuable commercial cephalopods in the northern Indian Ocean.

3.1.4 General Description obtained from the specimens of the present study:

The body consists of 2 parts head and mantle (Fig.4). The body is characterized by transverse zebra pattern (Fig.5); strongly obvious in skin of head, arms and dorsal mantle. This pattern is mostly observed in males than females. It is worth to note that the animal color is pale brownish to grayish.

The head is slightly narrower compared to mantle with well-developed eye on each side and covered with transparent membrane. The mouth is surrounded by crown of 10 anterior mobile appendages. These mobile appendages are 8 arms (4 on each side) and 2 long tentacles (one on each side), these tentacles are contractile into 2 lateral pocket on each side. The normal arm (Fig.6, a) with 4 suckers in transverse rows (Fig. 6, b); the sucker ring is characterized by presence of about 20 blunt teeth (Fig. 6, c). Regarding the modified arm (Fig.7) in male (hectocotyli's arm), it is present 4th on the left animal side; this specialized arm in males of *Sepia pharaonis* is characterized by median shallow muscular channel through which the spermatophore passes to the female during mating. hectocotyli's arm (Fig. 7) with 10-12 quadriserial rows of normal suckers at the base, followed by 18 longitudinal rows with ventral suckers (in 2 rows). The suckers of hectocotyli's arm are normal but minute and separated by a fleshy transversely groove. The tentacular club (Fig.8, a) is well differentiated and there are no suckers on the stem. The middle part of the tentacular club have 8 transverse rows of suckers, 5 or 6 suckers much enlarged in the middle of the tentacular club, while 3 or 4 from these suckers are greatly enlarged . It has five surface flattened longitudinal rows of suckers with short stalks. Sucker ring of tentacular club (Fig. 8, b) is a clear circle with no teeth or projection. The swimming membrane of the tentacular club is well developed but does not extend to the stem. Protective membranes do not meet at the base. The mouth of *Sepia pharaonis* from

outside to inside composed of 2 highly chitinized beaks (Figures 9, 10, 11) and radula. The radula (Fig. 12) is composed of central tooth supported by two laterals and marginal teeth (Xiao-dong and Ru-cai, 2002). The radula is composed of 8 longitudinal rows of chitinous teeth as shown in Figure 12 (a, b).

Regarding the mantle of *Sepia pharaonis* (Fig. 13), it's nearly oval in shape. The body is bilaterally symmetrical, with fleshy mantle that surrounds the viscera and defines a ventral mantle cavity in which the gills are suspended. One pair of gills is present (Fig. 14), white to grayish in colour and each gill with about 40 gill lamellae. Fins (Fig. 15) extend along mantle and actually its length is nearly equal to mantle length. Also, fins are characterized by white band that extend along its length from the dorsal side. The cuttlebone outline is oval in shape (Fig.16), anteriorly round and blunt while posteriorly it possesses sharp short rostrum in the form of a spine, somewhat dorsally curved. The dorsal surface of the cuttlebone is convex and smooth in texture. Its striation forms inverted u shape. On the other hand, the ventral surface of the bone is concave in shape and the striation forms inverted V-shape pattern that gradually fades to a more or less transverse striations. The inner limbs (Fig. 17) extend from anterior to posterior of the ventral surface and connect posteriorly to a thick bulbous bulge.

The sulcus (Fig. 17) is deep, wide and extends along the entire length of the cuttlebone. The sulcus is flanked by rounded ribs.

3. 2 Morphometric study

The field of morphometrics is concerned with methods for the description and statistical analysis of shape variation within and among samples of organisms (Boletzky and Nege, 1997). Morphometric investigations of an animal species revealed the inter relation between the various bodily parameters like length, weight, fecundity ,etc (Rahim,1982).

The body measurements of males and females in the present study are given in Table (1). Measurements for the smallest and largest male and female specimens, mean and number of parts showed negative allometric growth (slope less than 1).

Table 1: The relative growth of the body dimensions in *Sepia pharaonis.*

Variables	A	B	R	NO	MAX	MIN
ML/MW	0.6626	0.5882	0.9766	850	14.6	2
ML/HL	0.4273	0.2074	0.9551	850	6	0.9
ML/HW	0.5406	0.3258	0.9767	850	8.7	1.3
ML/FL	-0.6384	0.9879	0.9965	850	24	2.6
ML/FW	0.0785	0.1248	0.9453	850	4.1	0.3
ML/FU.L	0.4425	0.3189	0.9779	850	7.8	1.3
ML/FU.W	0.3976	0.2992	0.9712	850	8.5	0.9
ML/AL	-0.6077	0.9119	0.9580	850	25.4	2
ML/TL	1.8998	2.2621	0.9685	850	8.9	61.8

A = slope , B = intercept , R = the coefficient of determination, NO = number of samples , Max = maximum measurement and MIN = minimum measurement

Generally, the coefficient of determination R for MW , HL, HW, FL, FW, FU.L, FU.W, AL and TL were 0.9766, 0.9551, 0.9767, 0.9965, 0.9453, 0.9779, 0.9712, 0.9580, 0.9685, respectively . The coefficients were high for most measurements. This coefficient must be not less than 0.7 to say that this relation is strong and significant (R^2< 0.5).

For the body measurement the regression equation is describing the dependence of the relative growth of mantle width, head length, head width, fin length, fin width, funnel length, funnel width on mantle length and the results are given in Table (1) and illustrated in Figs. (18 to 26).

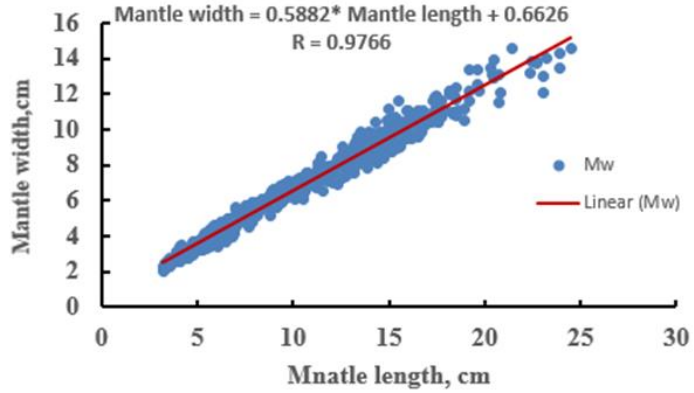

Fig. 18: Relationship between mantel length and mantel width.

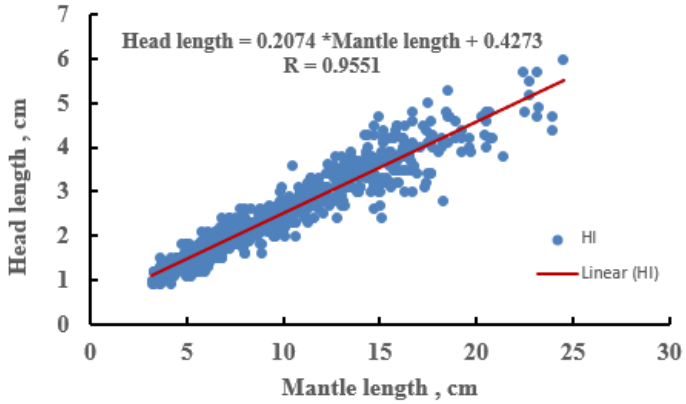

Fig. 19: Relationship between mantel length and head length.

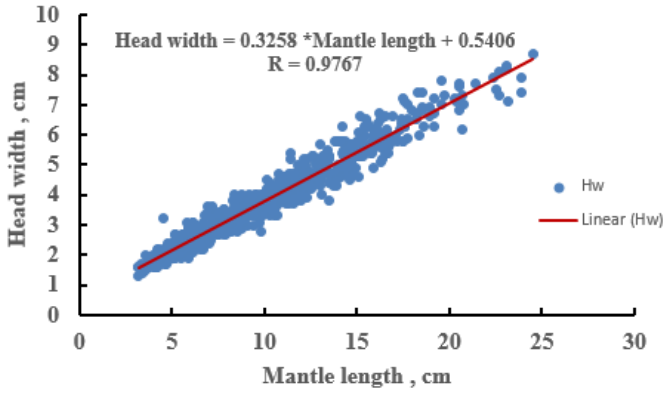

Fig. 20: Relationship between mantel length and head width.

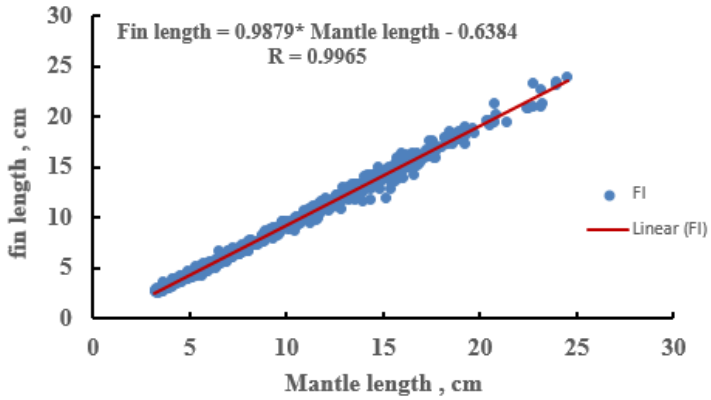

Fig. 21: Relationship between mantle length and fin length.

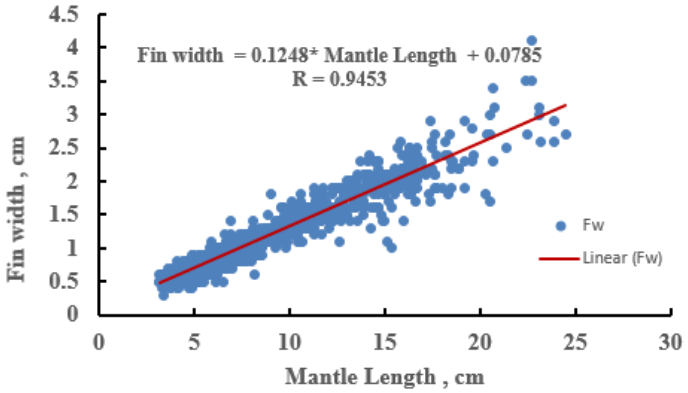

Fig. 22: Relationship between mantel length and fin width.

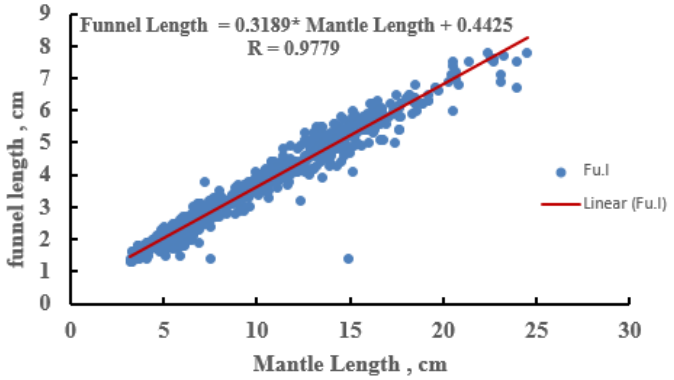

Fig. 23: Relationship between mantel length and funnel length.

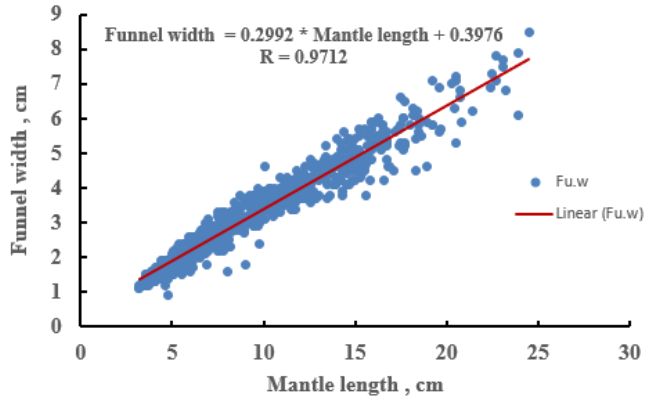

Fig. 24: Relationship between mantel length and funnel width.

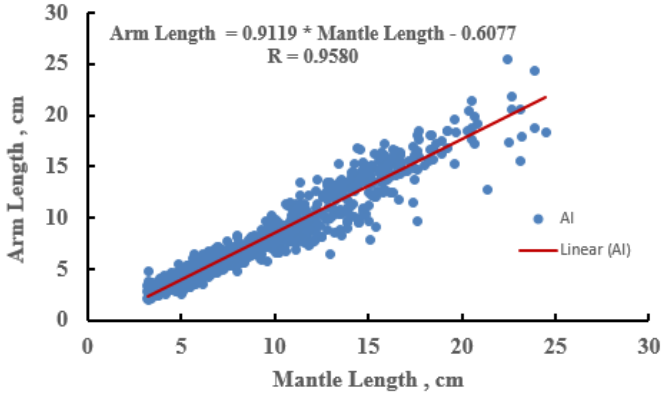

Fig. 25: Relationship between mantel length and arm length.

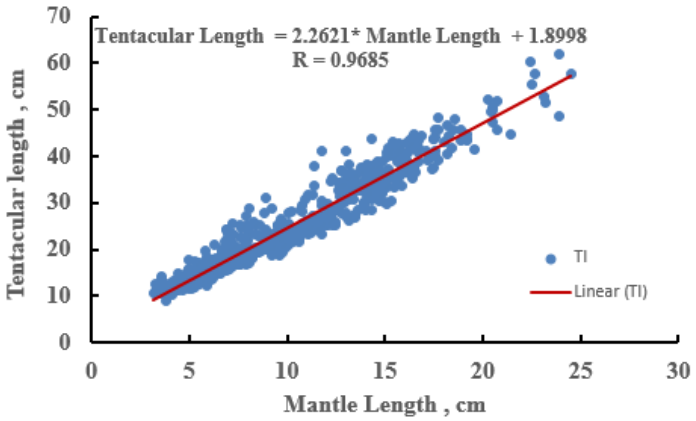

Fig. 26: Relationship between mantel length and tentacular width.

Each Figures from (18 to 26) illustrates the relation between body measurements (MW, HL, HW, FL, FW, FU.L, FU.W, AL and TL) against mantle length and these relations were strong and straight line and the regression equation for each is as follow : Mantle width = 0.5882*Mantle length + 0.6626 (R= 0.9766); Head length = 0.2074* Mantle length + 0.4273 (R= 0.9551); Head width = 0.3258 *Mantle length + 0.5406 (R= 0.9767); Fin length = 0.9879 *Mantle length – 0.6384 (R= 0.9965) ; Fin width = 0.1248 * Mantle length + 0.0785 (R = 0.9453).

Funnel length = 0.3189 *Mantle length + 0.4425 (R = 0.9779); Funnel width = 0.2992 *Mantle length + 0.3976 (R = 0.9712); Tentacular length = 2.2621 *Mantle length + 1.8998 (R= 0.9580) ; Arm length = 0.9119 * Mantle length – 0.6077 (R = 0.9685).

The present work provides the first comprehensive study on the taxonomy of the cuttlefish *Sepia pharaonis* recorded in the Suez Gulf, Red Sea waters, Egypt.

The present study revealed that *Sepia pharaonis* description is in good agreement with that given by Adam (1959, 1960) to specimens collected from the Gulf of Suez and Gulf of Aqaba, also with that previously described by Roper *et al*. (1984) and Nesis (1987), and with that previously given by FAO (2005). Description given by Riad (2008) for samples of the same species collected from the Suez Gulf and Red Sea also accords well with that of the present work.

The present study reported some additional characters that were not recorded before from other previous descriptions, these characters are:

1) The presence of 8 longitudinal rows of chitinous teeth in radula recoded in this study, does not match with that of Xiao-dong and Ru-cai (2002) who recorded that the number of the rows is 7, this change may be due to Environmental variation.
2) The presence of about 20 blunt teeth in arm sucker ring
3) Tentacular sucker ring without teeth or projections
4) The number of gill lamellae is about 40

It is worth to note that morphometric studies help in understanding the systematic and phylogenic status of a group from a taxonomical point of view. Systematic knowledge of species population is essential when investigating the biology, ecology, behavior and fisheries of different species forms (Roper and Voss, 1983). Morphometric analysis helps to understand the relationship between body parts (Carpenter, 1996). This type of measurement analysis scheme is important to document the direction of size of variation (Bookstain, 1991).

In the present study, the external morphometric characters (MW, HL, HW, FL, FW, FU.L, FU.W , AL and TL) are

increased with increasing in the mantle length. The regression equations for the body measurements revealed the dependence of different body parts growth on mantle length as shown in Figures (18 to 26). Tehranifard and Dastan (2011) studied morphometric characters on the same species but from Iranian waters and concluded that sexual dimorphism is not distinct.

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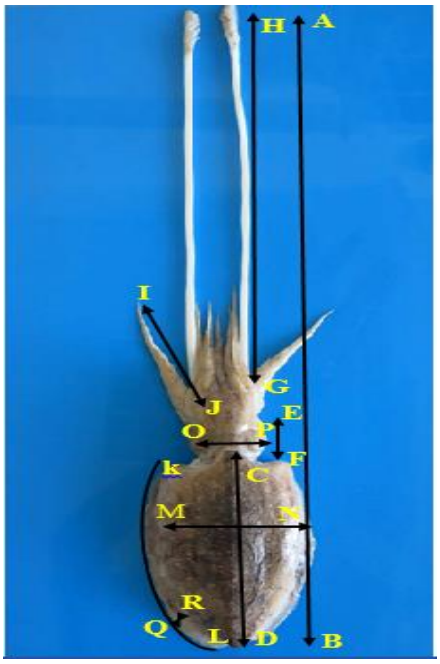

Fig. 1: The different morphometric measurements of *Sepia pharaonis* body on dorsal view.

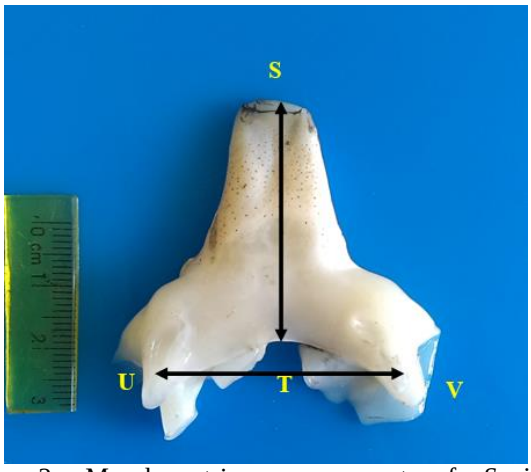

Fig. 2: Morphometric measurement of *Sepia pharaonis* funnel.

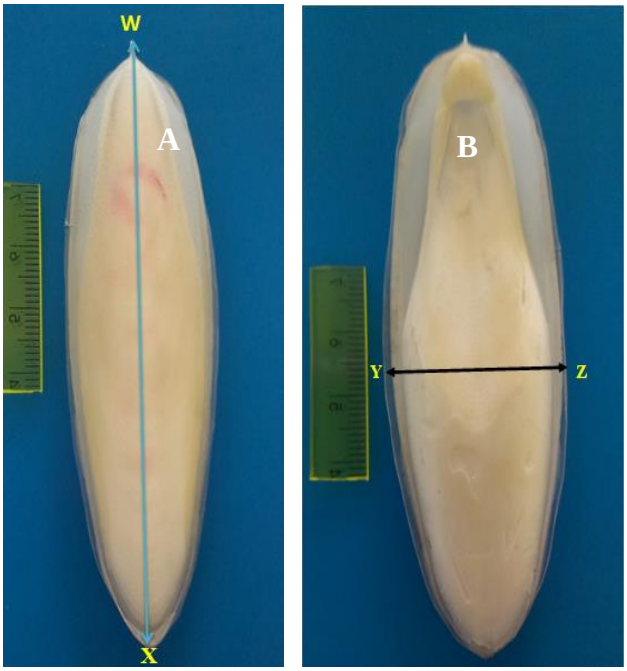

Fig. 3: Different measurements of *Sepia pharaonis* cuttlebone a) dorsal view, b) ventral view.

Fig. 4: The whole animal *Sepia pharaonis* Ehrenberg, 1831 (dorsal view).

Fig. 5: The zebra pattern that characterized *Sepia pharaonis.*

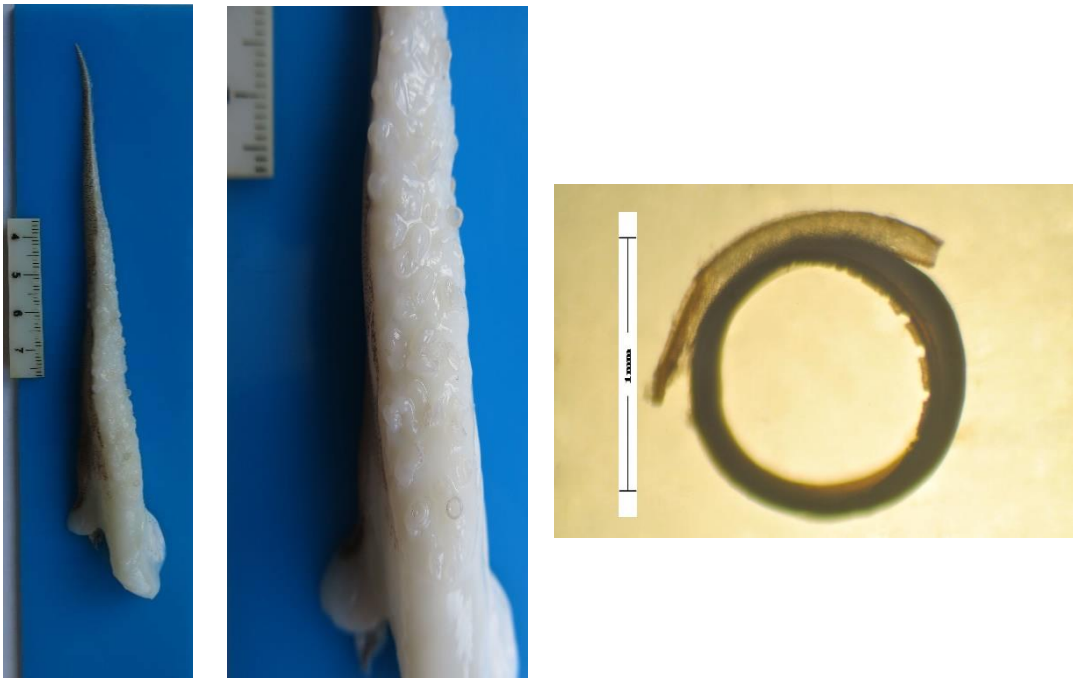

Fig. 6: Normal arm , Enlarged part of normal arm, sucker ring with blunt teeth. of normal arm , sucker ring with blunt teeth. with blunt teeth.

Fig. 7: Hectocotylus arm of male *Sepia pharaonis.*

Fig. 8: Tentacular club of *Sepia pharaonis* , Enlarged sucker ring of tentacular club (clear circle without teeth).

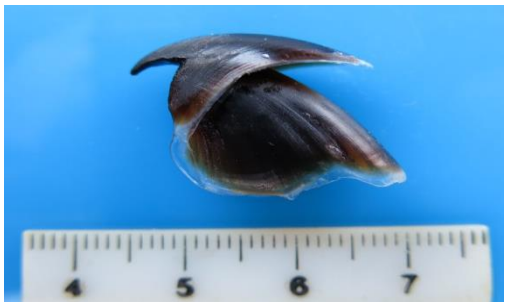

Fig. 9: Upper beak (lateral view) of *Sepia pharaonis*

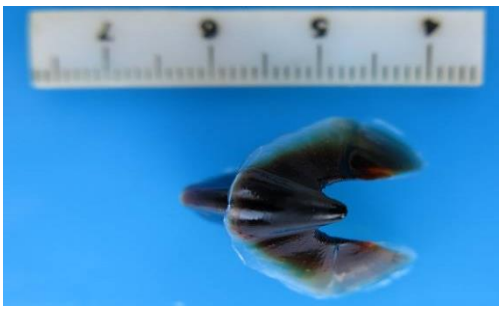

Fig. 10: Lower beak (dorsal view) of *Sepia pharaonis.*

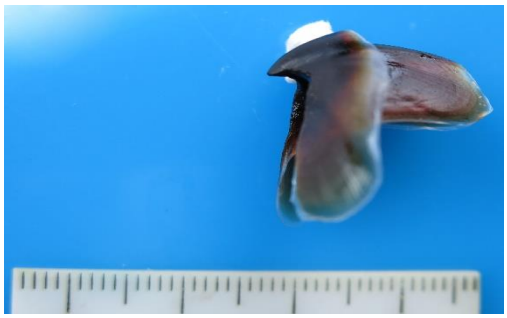

Fig. 11: Lower beak (lateral view) of *Sepia pharaonis*.

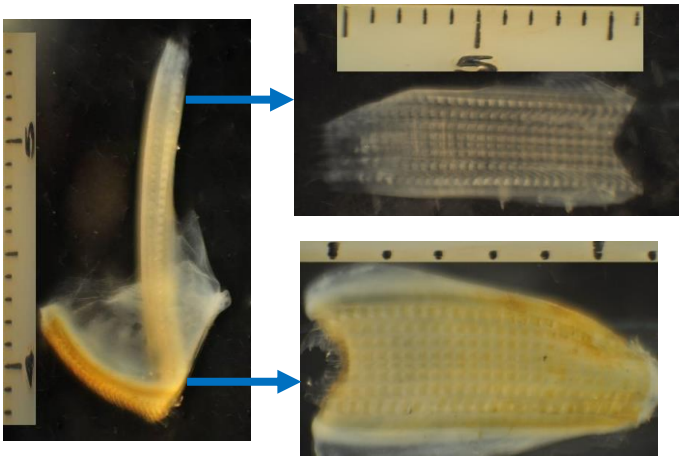

Fig. 12: Radula of *Sepia pharaonis.*

Fig. 13: The oval shape of *Sepia pharaonis* mantle.

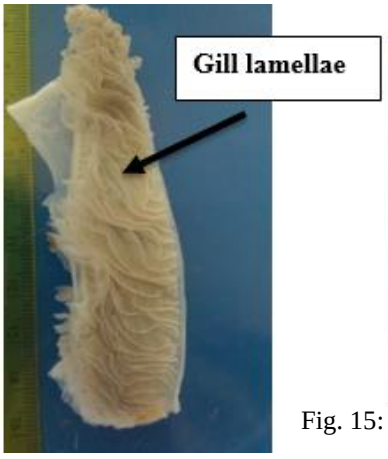

Fig. 14: Gills of *Sepia pharaonis.*

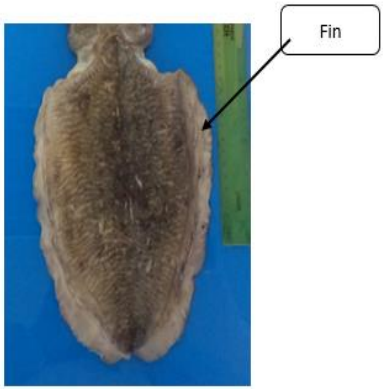

Fig. 15: Fins of *Sepia pharaonis*.

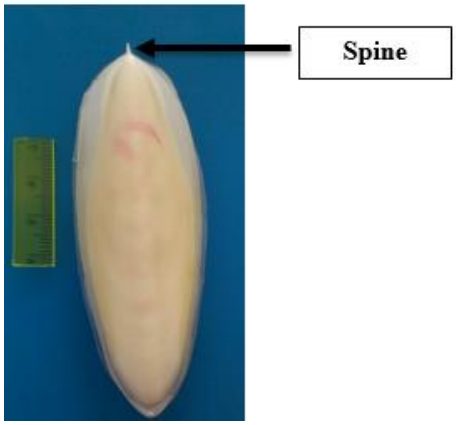

Fig. 16: .Cuttlebone of *sepia pharaonis* dorsal view.

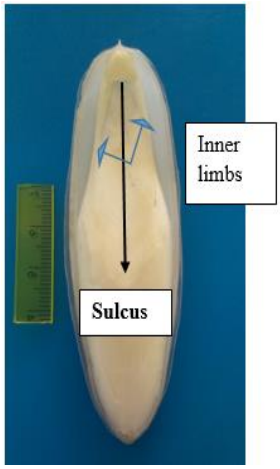

Fig. 17: The cuttlebone. of *Sepia pharaonis* ventral view.