

Taxonomical Studies on the Cephalopods (Cephalopoda: Mollusca) Inhabiting both the Egyptian Mediterranean and the Red Sea Waters

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Abstract: Specimens were obtained from fishing trawlers operating in the Egyptian Mediterranean Sea, the Suez Gulf, and the Red Sea. Specimens were also obtained from Alexandria and Suez fish markets. The species included in the class Cephalopoda are ecologically and commercially important around the world. The class includes four groups: Cuttlefishes, Squids, Octopuses, and Nautilii. The first three groups are present in the Egyptian Mediterranean and the Red Sea waters. They constitute a main component in the fisheries industry. In order to understand the biology and ecology of any species, their identification should be conducted properly to maximize the accuracy of any study. The present work is the first-in-kind, and was prepared to focus on the cephalopod species inhabiting both the Egyptian Mediterranean and the Red Sea waters. Six cephalopod species inhabit both the Egyptian Mediterranean and the Red Sea waters; these include one cuttlefish species: *Sepia dollfusi*, two squid species: *Loligo forbesi* and *Sepioteuthis lessonian*, and three octopus species: *Octopus vulgaris*, *Octopus macropus*, and *Octopus defilippi*. Two of them, namely *Sepia dollfusi*, and *Sepioteuthis lessoniana* dwelling in the Red Sea and migrated to the Mediterranean waters through the Suez Canal. Specimen parts were drawn by means of a zoom stereoscopic microscope provided with a camera lucida drawing tube and the specimen parts were also photographed by a Canon digital camera.

Key words: Taxonomy, Cephalopods, Mollusca, Egyptian. Mediterranean Sea, Red Sea.

Introduction

Cuttlefishes, Squids, Octopuses, and Nautilii are the most important representatives of the class Cephalopoda. The class includes about 1000 known species, which represent about 2.07% from the phylum Mollusca (Hassan, 1974). As a group, they include the largest species of both modern and fossil invertebrates in the coastal and the oceanic waters, inhabiting different kinds of grounds. Commercially, they represent a remarkable and significant fishery in many areas around the world. From the total catch of the world cephalopod fishery, about 71.8% were squids, 13.6% cuttlefishes, and 14.6% octopuses (Jereb and Roper 2005).

Many studies at the beginning of the nineteenth century concentrated on the fauna of the northern part of the Gulf of Suez. Savigny (1817) was the first to mention Cephalopoda in the Red Sea; he also identified seventy species which had not been confirmed before in the Red Sea waters (Edwards and Head, 1987).

Many twentieth-century studies of the Red Sea have provided an exciting direction to many expeditions. Although most of these expeditions were oceanographic explorations, they also served as zoogeographical studies with regional details (Edwards and Head, 1987). Robson (1926) recorded three cephalopod species from the Cambridge Expedition to the Suez Canal, namely: *Ascarosepion singhalensis* (Goodrich), which is synonymous to *Sepia pharaonis* Ehrenberg, 1831, *Lophosepion lefebvrei* d'Orbigny synonymous to *Sepia gibba* Ehrenberg, 1831, and *Octopus horridus* d'Orbigny (Zebra Octopus). Robson (1926) recorded six cephalopod species from the Suez Canal.

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Adam (1959) described ten cephalopods from the Gulf of Suez and three from the Gulf of Aqaba. Adam (1960) recorded seven cephalopod species from Aqaba Gulf. Eman (1984) recorded eight cephalopods from the Gulf of Suez and Aqaba. About ten Sepioidea species were recorded from the Egyptian waters (Steuer, 1939; Emam, 1983; Riad, 1993; 2000a, 2000b, 2008a, 2008b and 2015.). Steuer (1939) recorded one Sepioidea species. *Sepia officinalis* from the Mediterranean Sea, *Sepia prashadi*, and *Sepia savignyi* from the Red sea were studied by Emam (1983). Riad (1993) recorded nine cephalopoda species from the Egyptian Mediterranean waters, two of them were sepioidea: *Sepia officinalis* and *Sepia elegans*. Four were squids: *Loligo vulgaris*, *Loligo forbesi*, *Alloteuthis media*, and *Illex coindetii*. Emam and Saad (1998) studied the morphometric and population dynamics of *Sepia dollfusi* from the northern region of the Red sea.

There are also many studies conducted during the twenty century. Emam and Aly (2000) studied the male reproductive system of the *Sepioteuthis lessoniana* from the Suez Gulf. Riad (2008b) recorded one new record of cephalopoda species *Sepioteuthis lessoniana* from the Egyptian Mediterranean waters which migrated from the Red sea. Emam and Gareb (2010) studied the morphology, the digestible and reproductive system of the male of *Sepioteuthis lessoniana* from Abo Qir Bay in the Alexandria Mediterranean waters. Riad (2000b) recorded two first record species from Alexandria Mediterranean waters, namely *Rossia macrosoma* and *Octopus defillipi*. Riad (2008a) recorded ten cephalopod species from the Suez Gulf and the Red Sea, three of them were sepioidea: *Sepia dollfusi*, *Sepia pharaonis*, and *Sepia elongate*. Riad (2015) recorded one new record of Sepioidea species, namely *Sepia dollfusi* from the Egyptian Mediterranean waters which is dwelling in the Red Sea and migrated to the Mediterranean Sea through the Suez Canal.

The present work was conducted using

morphological features. The aim of the present work is to add more information to the limited taxonomical studies of the Cephalopoda species inhabiting both the Egyptian Red and the Mediterranean Sea waters.

Materials and Methods

The specimens were obtained from fishing trawlers operating in the Egyptian Mediterranean Sea from Sidi Abd El- Rahman, west of Alexandria to Rosetta (Figure 1) and from the Suez Gulf, Red Sea (Figure 2). Specimens were also obtained from Alexandria and Suez fish markets over the period from January 2019 to December 2019. The samples were preserved in a 5% formalin sea water solution, and were kept in the Taxonomy and Biodiversity of Aquatic Biota Lab. (reference collection center), National Institute of Oceanography and Fisheries, Alexandria, Egypt.

According to Roper *et al.*, (1984), the following characteristics were carefully examined for the identification of the species: External morphology, tentacular club, hectocotylized arm, tentacular club sucker, tentacular club sucker ring, arm sucker, arm sucker ring, radula, gill, shell, and funnel (siphon). The specimen parts were drawn by means of a zoom stereoscopic microscope provided with a camera-lucida drawing tube. The specimen parts were also photographed by a Canon Digital camera.

Results and Discussion

The species in the present work are illustrated as follows:

Phylum: Mollusca

Class: Cephalopoda Cuvier, 1798.

Subclass: Coleoidea Bather, 1888.

Order: Sepioidea Naef, 1916.

Family: Sepiidae Keferstein, 1866.

Genus *Sepia* Linnaeus, 1758

Sepia dollfusi Adam, 1941b. The Suez Gulf, the Red Sea and Alexandria, Mediterranean waters.

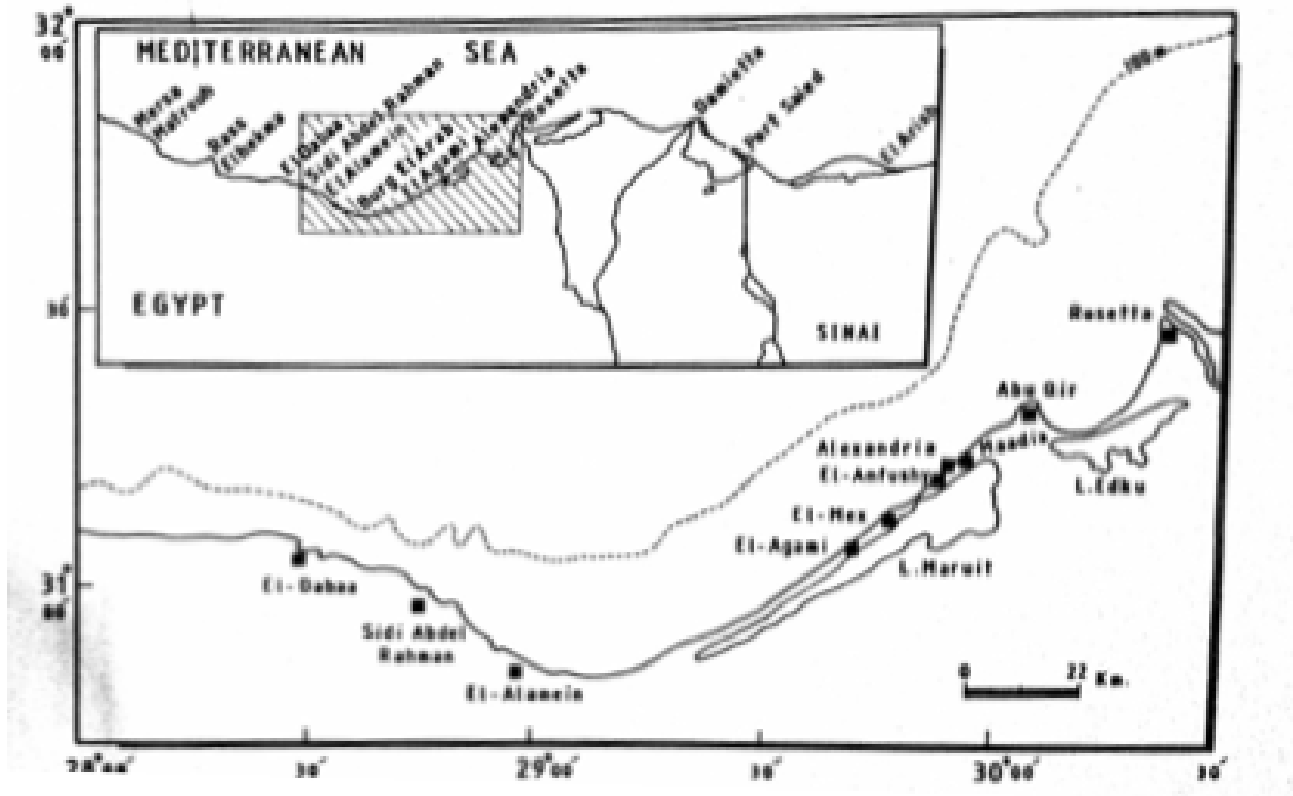


Figure 1. Alexandria coast (Egyptian Mediterranean Sea)

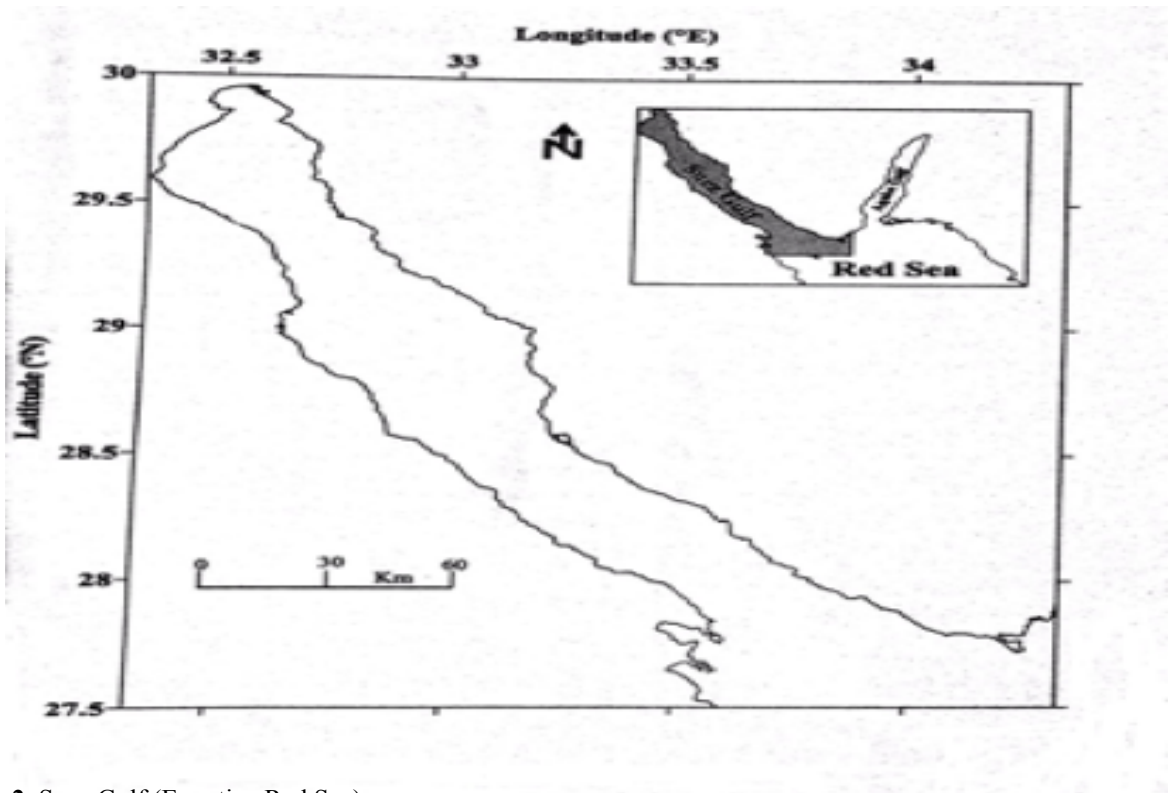


Figure 2. Suez Gulf (Egyptian Red Sea)

Order: Teuthoidea Naef, 1916.

Suborder: Myopsida d, Orbigny, 1845.

Family: Loligonidae Steenstrup, 1861.

Genus *Loligo* Schneider, 1784.

Loligo forbesi Steenstrup, 1856. The Suez Gulf, the Red Sea. Alexandria Mediterranean waters.

Genus: *Sepioteuthis*

Sepioteuthis lessoniana Lsson, 1830. The Suez Gulf, the Red sea, and Alexandria Mediterranean waters.

Order: Octopoda Leach, 1818.

Suborder Incirrata Grimpe, 1916.

Family: Octopodidae dOrbigny, 1845.

Subfamily: Octopodinae

Genus *Octopus* Lamarck, 1798.

Octopus Vulgaris Cuvier, 1797. Alexandria, Mediterranean waters and the Red Sea.

Octopus macropus Risso, 1826. Alexandria, Mediterranean waters and the Red Sea

Octopus Defilippi Verany, 1851. Alexandria, Mediterranean waters, and the Red Sea.

Phylum: Mollusca

Class: Cephalopoda Cuvier, 1798

Subclass: Coleoid Bather, 1888.

The Subclass Coleoidea embraces four orders: Sepioidea Naef, 1916; Tauthoidea Naef, 1916; Octopoda Leach, 1818, and Vampyromorpha Pickford, 1939.

Only the first three orders are represented in the current study.

Order: Sepioidea Naef, 1916.

This order is characterized by the following features: shell calcareous or chitinous; 10 circumoral appendages; tentacles retractile into pockets; suckers with chitinous rings; posterior fin lobes free, not connected at midline; eyes covered with a transparent membrane, false eyelids present; one pair of gills, without a branchial canal between the afferent and efferent branchial blood vessels; liver divided or bilobed, each tooth of radula with a single projection; buccal membrane present; olfactory organ a ciliated pit. This order comprises five families: Spirulidae Owen, 1836, Sepüdae Keferstein, 1866 Sepiadariidae Naef, 1912), Sepiolidae Leach, 1817, and Sepiadariidae Owen, 1836, Sepiidae Keferstein 1866, Appell f, 1898.

(Gereb and Roper, 2005). In the Egyptian Mediterranean waters and the Red Sea, this order is represented by only one family, Sepiidae, which has a significant commercial value.

1.3 Sepioidea Species of the East Mediterranean Waters

Seven Sepioidea species are known to occur in the Mediterranean waters:

Sepia elegans Blainville, 1827;

Sepia officinalis Linnaeus, 1758;

Sepia orbignyana Ferussac, 1826;

Sepiola rondeleti Leach, 1817;

Sepietta oweniana dOrbigny, 1840;

Rondeletiola minor Naef, 1912; and

Rossia macrosoma Delle chiaje, 1829 (Gereb and Roper, 2005; ; Katagan and Kocatas, 1990).

The Sepioidea species were recorded in both the Egyptian Mediterranean and the Red Sea waters).

The following species were recorded as follows:

Class: Cephalopoda Cuvier, 1798.

Subclass: Coleoidea Bather, 1888.

Order: Sepioidea Naef, 1916.

Family: Sepiidae Keferstein, 1866.

Genus: *Sepia* Linnaeus, 1758.

A cuttlebone with a spine (rostrum) is present on the posterior end (occasionally damaged or absent); as long as the body; bordered by a horny margin. No glandular pore on the ventral surface at the posterior end of the mantle. This genus is represented in the Egyptian waters by seven species, *Sepia Officinalis* Linnaeus, 1758; *Sepia elegans* Blainville, 1827; *Sepia dollfusi*, *Sepia pharaonis*, *Sepia elongata*, *Sepia prashadi*, and *Sepia savignyi*.

Key to the Species of the Genus *Sepia* in the Egyptian Waters.

1-The tentacular club is provided with transverse rows of suckers, five or six in each, the median longitudinal row is remarkably enlarged, Left arm IV (hectocotylized) is reduced in size, with five-eight horizontal rows of reduced suckers.....*Sepia officinalis*.

2-The tentacular club is short with six-eight suckers on each transverse row; few of the suckers are enlarged while three are greatly developed in the center.

Two thirds of the left arm IV (hectocotylized) possess about nine-eleven zigzag rows of minute suckers.....*Sepia elegans*.

3-The tentacular club has five-seven suckers in the middle row larger than the others. The left arm IV (hectocotylized) is modified in about half of the terminal part forwarded by twelve transversal rows of four minute suckers.....*Sepia dollfusi*.

4-The middle part of the tentacular club bears eight transverse rows of suckers, five or six median suckers are enlarged. There are five longitudinal rows of suckers. Hectocotylized arm: with ten-twelve quadriseriate rows of normal suckers at the base followed by ten rows with ventral suckers (two rows) normal, as for the dorsal, two rows are minute and are separated from the ventral rows by a fleshy transversely groove ridge....*Sepia pharaonis*

5-The tentacular club is small with a well-developed keel, of a length of about 15% of the tentacle. The hectocotylized arm shows a unique structure that is hard, enlarged, and wrapped around a free edge endowed with seven transverse wrinkles without suckers (The proximal and distal parts of the hectocotylized arm carry erratically normal suckers.*Sepia elongate*.

6- The hectocotylus is present on the left ventral arm: four rows of normal size suckers are proximally situated, twelve-fourteen rows of reduced suckers are medially situated, then a normal size hectocotylus in two ventral series is displaced laterally, with a gap in between on the proximal part of the modified region. *Sepia prashadi*.

7- Club straight, slender; sucker-bearing surface convex, with eight suckers in the transverse rows; suckers differ slightly in size; several suckers of the inner two or three rows are very slightly larger than rest.....*Sepia savignyi*

Cuttlefishes inhabiting both the Egyptian Mediterranean and the Red Sea waters. One species was recorded, namely *Sepia dollfuss*.

***Sepia dollfuss* Adam, 1941 (Plates 1 and 2)**

Synonymy: None

World distribution: the Red Sea and the southern part of the Suez Canal (Nesis, 1987). From the Southern part of the Suez Canal and the Suez Gulf to Zanzibar, Madagascar, Southern Japan, Indonesia, and Western and Northern Australia (Nesis, 1987).

Local name: Sobet (Mediterranean) (Riad, 1993) and Sobia (Red Sea) (Riad, 2008a).

Local distribution: The species of the present study was captured from the area off the east of Alexandria and the Suez Gulf, the Red Sea).

Description: Mantle is large with a weak open mantle cavity (Plate 1a). The tentacular club has seven subequal suckers in a longitudinal row (Plate 1 b). The tentacular club sucker ring has 35- 38 pointed teeth (Plate 1d). Arms are long with four rows of suckers (Plate 1 c). The arm sucker ring has 25-28 blunt teeth (Plate 1e). The gill has more than 25 gill lamellae (Plate 1f). The shell is oval, not rhomboidal, smoothly rounded posteriorly, its length is almost equal to the mantle length (Plate 2 a-b-c). The radula has more than eighteen teeth (Plate 2d-e).

Habitat: In the Egyptian waters. *Sepia dollfuss* dwells in the Red Sea and the Suez Gulf waters, and it is the primary fishery in the Suez Canal (Riad, 2008a). *Sepia dollfusi* migrated from the Red Sea to the Mediterranean Sea through the Suez Canal (Riad, 2015).

Order: Teuthoidea Naef, 1916

The order Teuthoidea embraces two suborders: Myopsida d'orbigny, 1845 and Oegopsida d'orbigny, 1845. There are ten arms, two of which are longer than the rest. The arms are not joined by a swimming web. The arms bear suckers on stalks with horny

rings. The lateral fins are well-developed. An internal, non-chambered, horny shell is present. They are shallow water (*Loligo*) or deep-sea pelagic animals (*Architeuthis*). The origin of the order Teuthoidea, or true squids, can be traced to the early Mesozoic (Permian Triassic) with a steady proliferation from the Jurassic through the recent times. The two suborders, Myopsida, (covered -eyed) near shore (neritic) squids, and Oegopsida, (open-eyed). Oceanic (pelagic) squids occur in the oceans and seas of the world. Some are demersal or epibenthic at some period of their life cycle, but most occur in the water column. Out of the ten circumoral appendages, the fourth pair, the tentacles, are contractile, but not retractile into pockets (occasionally tentacles secondarily lost); sucker ornamentation with chitinous rings and/ or hooks. Radula teeth commonly with a primary projection and a secondary cusp(s), especially on the median (rachidian) and the first lateral teeth; buccal membrane present. The olfactory organ consists of two projecting papillae; eyes without lids covered with a transparent membrane, with a minute pore (Myopsida) or are completely open to the sea, without a pore (Oegopsida). Gills with the bronchial canal between afferent and efferent branchial blood vessels. Shell internal, simple, rod or feather-like, chitinous. (Roper *et al.*, 1984).

(A) The Suborder Myopsida d'Orbigny, 1845.

The suborder Myopsida is comprised only of two families, the small, non-commercial, *Pickfordia teuthidae* Voss, 1953, and Loliginidae Steenstrup, 1861. In this study, one family is represented: Loliginidae. A corneal membrane covering the eye with minute pore anteriorly. Arms and clubs are with suckers, never with hooks. Suckers are present on the buccal lappets. Females with a single gonoduct, not paired; with accessory nidamental glands. (Roper, *et al.* 1984).

1.3 Teuthoidea Species of the East Mediterranean Waters (Roper *et al.*, 1984 and Katagan and Kocatas, 1990).

Twenty-nine cephalopod species are known to occur in the Mediterranean Sea. Of

these, thirteen teuthoidea species are known to extend to the Eastern Mediterranean Basin.

Loligo forbesi, *Loligo vulgaris*, *Alloteuthis media*, *Alloteuthis subulata*, *Ancistroteuthis hchiensteini*, *Histioteuthis bennellii*, *Histioteuthis elongate*, *Brochoteuthis riisei*, *Illex coindeii*, *Todaropsis eblanae*, *Todarodes sagittatus*, *Ommastrephes coroli* and *Ommastrephes pteropus*.

Morphology and Occurrence of the Teuthoidea Species Inhabiting the Egyptian Mediterranean and the Red Sea waters.

Family: Loliginidae d, Orbigny, 1848.

Shape variable from short and stout to long and slender. Fins terminal, but always united posteriorly, extending along the entire length of the mantle and quite wide (approx., 18% of the mantle length). Funnel looking apparatus, a simple, straight groove. Eyes covered with a transparent skin (corneal membrane); buccal connectives attached to the ventral borders of the fourth arms; seven buccal lappets are supplied with small suckers (except in *Lolliguncula* and *Alloteuthis*); eight arms and two tentacles around the mouth; two rows of suckers on the arms and four rows on the tentacular clubs, four rows of suckers on the manus, hooks are never present. Usually, the left arm IV (ventral) pair is hectocotylized in males (used to transfer sperm packets from the male to the female), the structure of the modified portion (hectocotylus) of the arm is useful in most species as a diagnostic character. The suckers on the hectocotylus are often reduced in size or number, or modified into fleshy papillae or flaps (lamellae), or they disappear altogether. Color: usually reddish-brown and is darker dorsally, but quite variable depending on the behavioral situation. This family embraces eight genera:

Loligo Schneider, 1784;

Doryteuthis Naef, 1912;

Lolliguncula Steenstrup, 1881;

Sepioteuthis Blainville, 1824;

Alloteuthis Wülker, 1920;

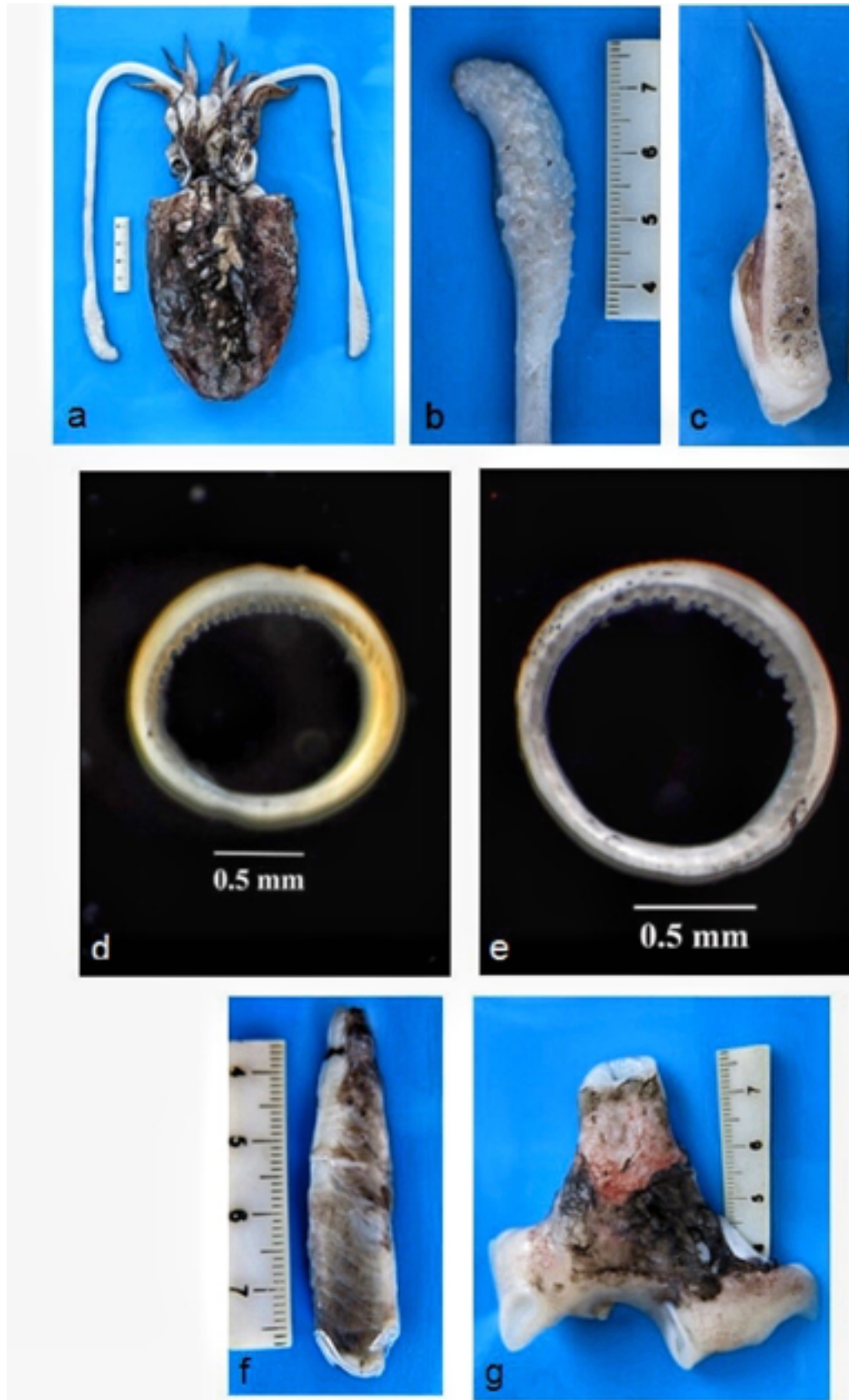


PLATE (1) *Sepia dollfusi*

(a) The animal (dorsal view). (b) Tentacular club. (c) Normal arm. (d) Tentacular club sucker ring. (e) Arm sucker ring. (f) Gill. (g) Funnel.

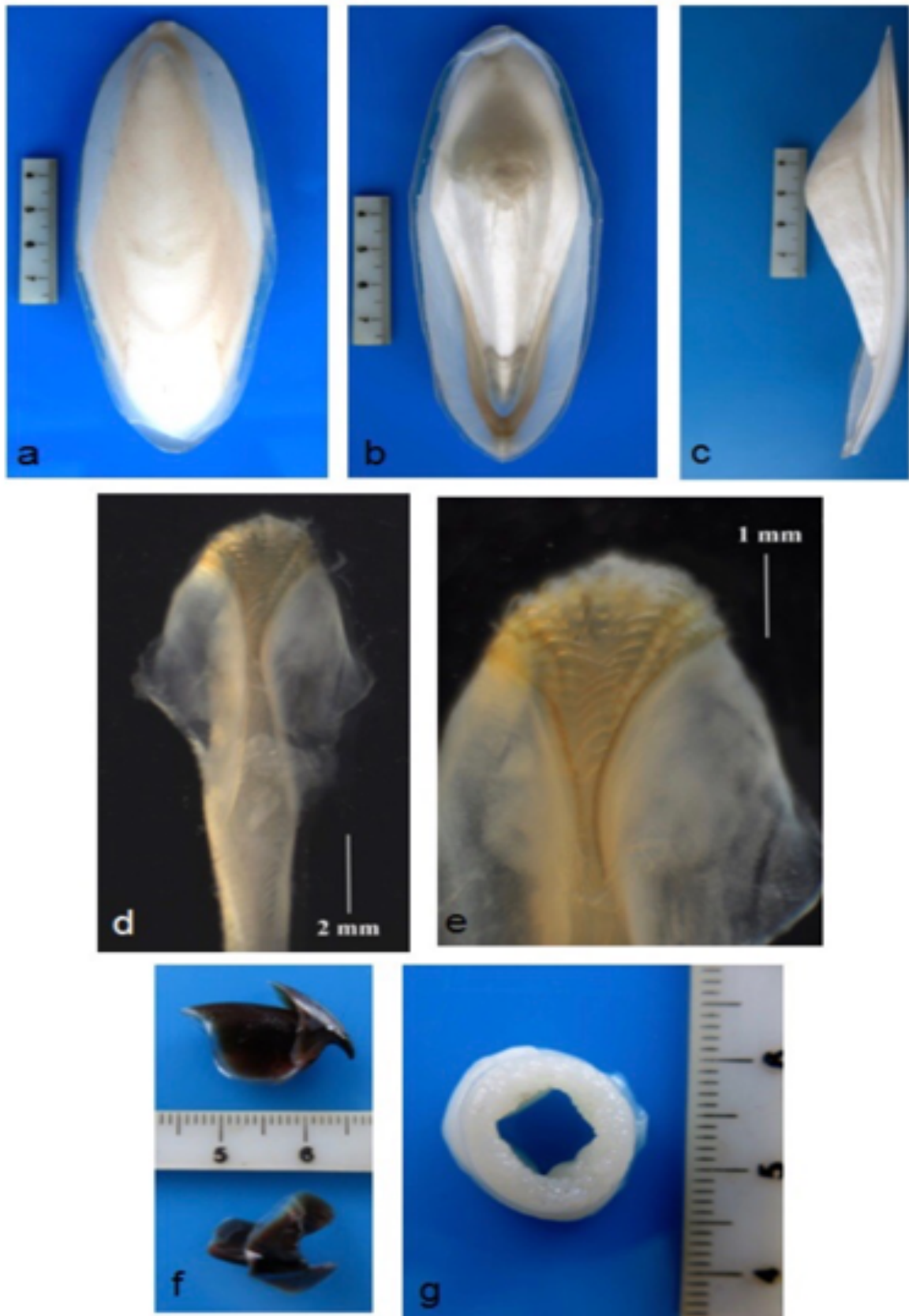


PLATE (2) *Sepia dollfusi*

(a) Shell (dorsal view). (b) Shell (ventral view). (c) Shell (lateral view). (d) Radula. (e) Enlarged part of radula. (f) Upper beak and lower beak. (g) Buccal op.

Uroteuthis Rehder, 1945;
Loliolus Steenstrup, 1856;
Loliolopsis Berry, 1929.

In this study, this family is represented by three genera only: *Loligo* Schneider, 1784; *Alloteuthis* Wülker, 1920, and *Sepioteuthis* Blainville, 1824.

Key to the Recorded Genera in the Present Study

1-Mantle elongate or short, robust, posteriorly pointed, but never produced into an elongated tail; the posterior border of fins is straight, or only slightly concave, or rounded. Fins lateral, rhombic in outline, with posterior borders straight or slightly concave; relatively long, usually over 60% of the mantle length; mantle elongate, bluntly to sharply pointed; left ventral IV hectocotylized in males; buccal arms with about fifteen small suckers in two rows.
*Loligo* Steenstrup, 1856.

2-Fins very long, over 90% of the mantle length, broad, Sepia-like, but much wider and more muscular; mantle very robust
*Sepioteuthis* Lesson, 1830. Roper *et al.*, (1984).

Genus: *Loligo* Schneider, 1784.

Keys to the Species of Genus *Loligo* in the Egyptian Waters.

1-Tentacular club with suckers, the two inner rows are larger than other suckers with about twenty transverse rows of minute suckers with about fifteen teeth in each sucker ring. ...
*Loligo vulgaris*.

2-Tentacular club with four rows of subequal sucker), each sucker ring has about sixteen-twenty sharp teeth.*Loligo forbesi*.

3-Tentacular club with larger median suckers than the marginal with fourteen to seventeen short sharp teeth.....*Loligo duvauceli*.

Loligo forbesi inhabiting only the Egyptian Mediterranean and the Red Sea Waters.

(ii) *Loligo forbesi* Steenstrup, 1856 (Plate 3, Plate 4, A- M and plate 5, a-i)

Synonymy: None.

World distribution. Mediterranean Sea (Roper *et al.*, 1984), the north-western Mediterranean Sea (Boletzky and Mangold, 1985), the Red Sea and East Africa (Roper *et al.*, 1984), Catalanian Sea (Sanchez, 1985), the eastern Atlantic Ocean from 20° N to 60° N (excluding the Baltic sea) (Roper *et al.*, 1984).

Local name: Kalemaria. (Riad, 1993).

Local distribution: A few specimens (sixteen) were obtained by trawling offshore from Rosetta (2 m. 36 m. depth), and from the Alexandria water fish markets (Anfushy, Abu Qir, Meadeia and Rosetta). From fish trawls in the Suez Gulf (Ataka Harbor) and the adjacent area, the Red Sea.

Description: The mantle is slender; the fins are elongated and posteriorly concaved, extending to about 75% of the ML (plate 3). The manus of the tentacular club is provided with subequal suckers (Plates 4b and 5b), each sucker ring has about sixty-twenty sharp teeth (Plates 4f and 5e), but some suckers had less teeth (thirteen). The distal modified part of the left arm IV (hectocotylized) occupies about 35% of its To. L, covered with long papillae (twenty-eight to thirty), decreasing in size distally (Plates 4 C and 5c). The arms have two rows of suckers, each arm sucker ring is provided with twenty to thirty sharp teeth, the largest arm sucker rings has seven-eight teeth (plate 4h). Each gill is provided with about 60-gill lamellae (Plates 5e and 6h). There are seven radulae (Plate 5J), each radula has five-six suckers (Plates 5K and L), and each sucker ring has twenty teeth (Plate 5M).

Differentiation between *L. forbesi* and *L. vulgaris* depends mainly upon the relative size of the suckers on the tentacular club. In *L. forbesi*, there are four rows of subequal suckers, while in *L. vulgaris*, the suckers on the two inner rows are

considerably larger than other suckers. Some characters given in the present description have not been reported before in the literature such as the number of papillae of left arm IV (hectocotylized), the number of gill lamellae, the number of the radula, and the number of radula suckers, and the teeth of the radula sucker ring.

Out of the sixteen specimens collected, the largest had an ML of 28.1 cm, TL 52.5 cm, TW 180 gm (for the male) and an ML of 17.3 cm, TL 42.6 cm, TW 105 gm (for the female). The smallest showed the following measurements: an ML of 7.5 cm, TL 20.6 cm, TW 13.09 gm (for the male), and ML of 8cm, TL 21.3 cm, TW 14.74 gm (for the female). Poper *et al.*, (1984) reported larger sizes for the ML.

Habitat: A temperate shelf species found in the deeper waters of subtropical areas. The depth range extends from 100 to 400 m (Roper *et al.*, 1984).

Genus: *Sepioteuthis* Blainville, 1824.

Sepioteuthis lessoniana Lesson, 1830. (Plates 6,7,8 and 9)

Material: one male and one female were only available from a commercial fish trammel net. The first was with a dorsal mantle length of 19.5 cm and a total weight of 300 gm., while the second was with a dorsal mantle length of 20 cm, and its total weight was 350 gm.

Synonyms:

Sepioteuthis guinensis Quoy and Gaimard, 1832 *Sepioteuthis Lunulata* Quoy and Gaimard, 1832; *Sepioteuthis Mauritania* Quoy and Gaimard, 1823; *Sepioteuthis sinensis* d, Orbigny, 1835-1848; *Sepioteuthis arctipinnis* Gould, 1852; *Sepioteuthis brevis*, Owen 1881; *Sepioteuthis neoguinaica* Pfeffer, 1884; *Sepioteuthis indica* Goodrich, 1896; *Sepioteuthis sieboldi* Joubin, 1898; *Sepioteuthis malayana* Wiiker, 1913; *Sepioteuthis krempfi*, Robson, 1928. (Roper *et al.* 1984).

World distribution: Widespread in the Indo-Pacific: the Red Sea, Arabian Sea eastward to 160°E, eastward to the Hawaiian Islands,

northern Australia, and northward to central Japan. (Roper *et al.*, 1984).

Common name: Big fin reef squid. (Roper *et al.*, 1984).

Local name: Kalimaria (Riad, 1993).

Local distribution: the Suez Gulf, the Red Sea (Emam and Aly, 2000). Alexandria, Mediterranean waters (Riad, 2008b).

Description: Mantle long, robust, its width is about 43% of the mantle length (plates 6a and b) Fins very long, more than 90% of the mantle length, broad: Sepia-like but much wider and more muscular; and their width is up to 73% of the mantle length, greatest width occurs posterior to the midpoint of the fins (plate 6 e and plate 9f). The head width is much larger than the head length and bears two lateral oval eyes (plate 6a). The tentacular club is long, expanded with four rows of suckers, median manus suckers enlarged (plate 6c and plate 8a). Tentacular club sucker ring with seventeen to twenty-two sharp teeth (plate 8 j and plate 9h). Dactylus sucker ring with fourteen to sixteen teeth (plate 8i and plate 10j). Arm sucker ring with twenty-twenty-five long sharp teeth (plate 7k and plate 9g and i). Buccal lappets bear a small number of suckers (plate 6i and plate 9f). The buccal mass contains two beaks and a radula, the upper beak has a short blunt, curved rostrum, crest, large wings, and large lateral walls with posterior margins slightly indented (plate 7a and plate 8e). The lower beak has a short blunt rostrum, long hood, crest, large lateral walls, and small wings (plate 8b and plate 9g). The radula is small and consists of nine rows of rachidian teeth (plate 7g and h and plate 9e). The funnel lies below the head on the ventral side. It opens into the mantle cavity (plate 7e and plate 9a). The gill consists of about more than sixty pairs of Gill lamellae (plates 6f and g and plate 8d).

Order: Octopoda Leach, 1818

The order Octopoda is divided into two suborders, namely **Cirrata**, mostly deep-



PLATE (3) *Loligo forbesi*

sea pelagic and epibenthic forms that possess cirri along the arms and have paddle-shaped fins, and **Incirrata**, moderately deep to shallow-living benthic and epipelagic forms which possess neither cirri nor fins. Only the Incirrata are of a commercial interest, with some Octopus species. Eight circumoral arms, no tentacles; fins subterminal (on the sides of the mantle), widely separated, or absent; shell reduced, vestigial, “cartilaginous”, or absent; suckers without chitinous rings, set directly

on arms without stalks; eye open to the sea with primary and secondary (concentric) lids; a branchial canal present on the gills between down-folded filaments (some exceptions); liver a single with incorporated pancreas; central (rachidian) tooth of radula with one large projection and two or more small lateral cusps, first and second lateral teeth multicuspid; buccal membrane absent; olfactory organ a ciliated pit. This order is represented by one suborder in the Egyptian waters Incirrata

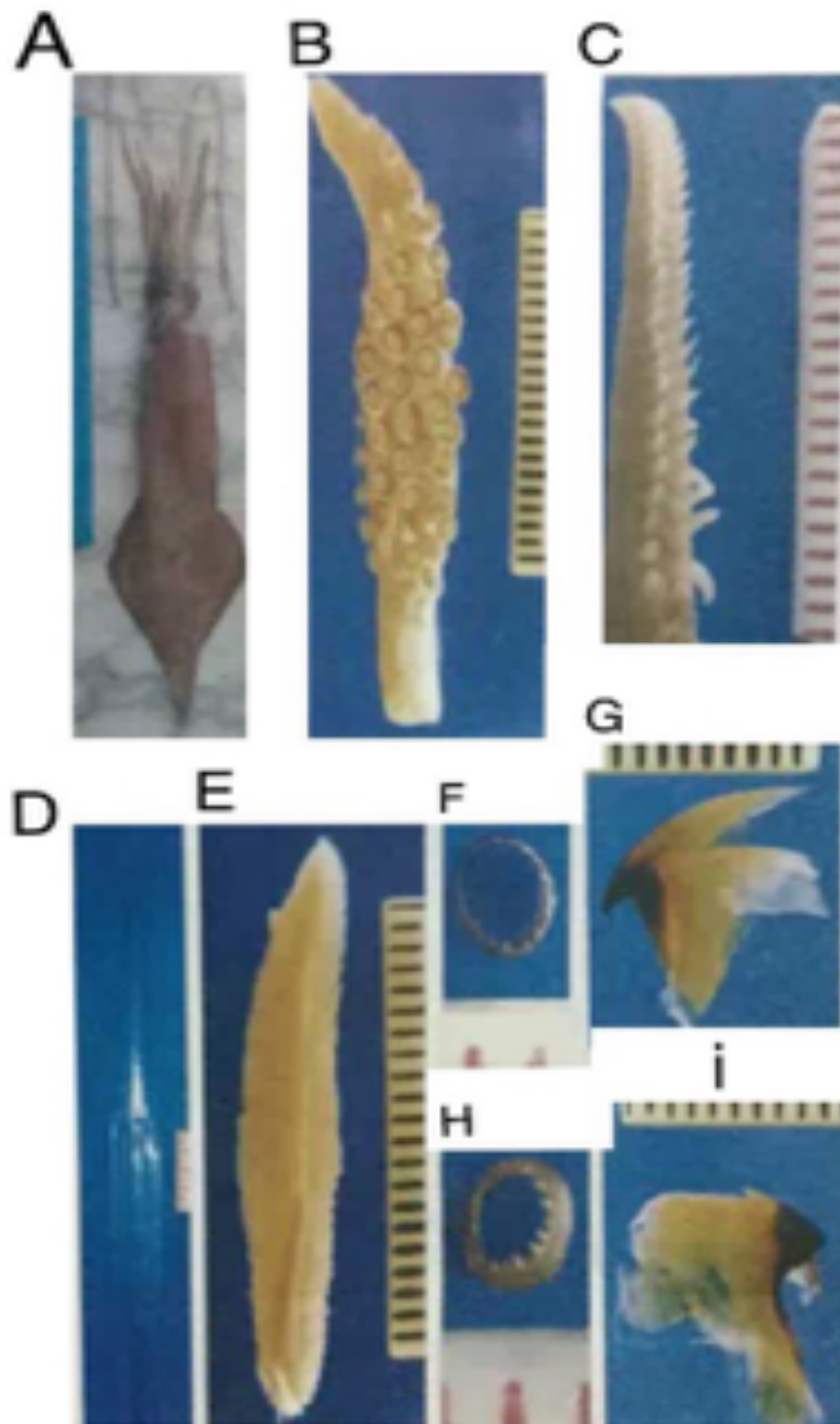


PLATE (4) *Loligo forbesi*

(A)The animal. (B) Tentacular club. (C) Left arm IV of male hectocotylized. (D) Shell. (E)Gill. (F) Tentacular club sucker ring. (G) Upper beak. (H) Arm sucker ring. (I) Lower beak.

Grimpe, 1916.

1845 is represented in the Egyptian waters.

Suborder: Incirrata Grimpe 1916.

Eight arms with suckers only, no cirri, fins absent. The web is usually shallow. Only one of the eight families, Octopodidae d'Orbigny,

Family: Octopodidae d'Orbigny, 1845

This family has inflated bodies. They have rather small heads; prominent eyes protected by eye-lids, fleshy lips to their mouths, and

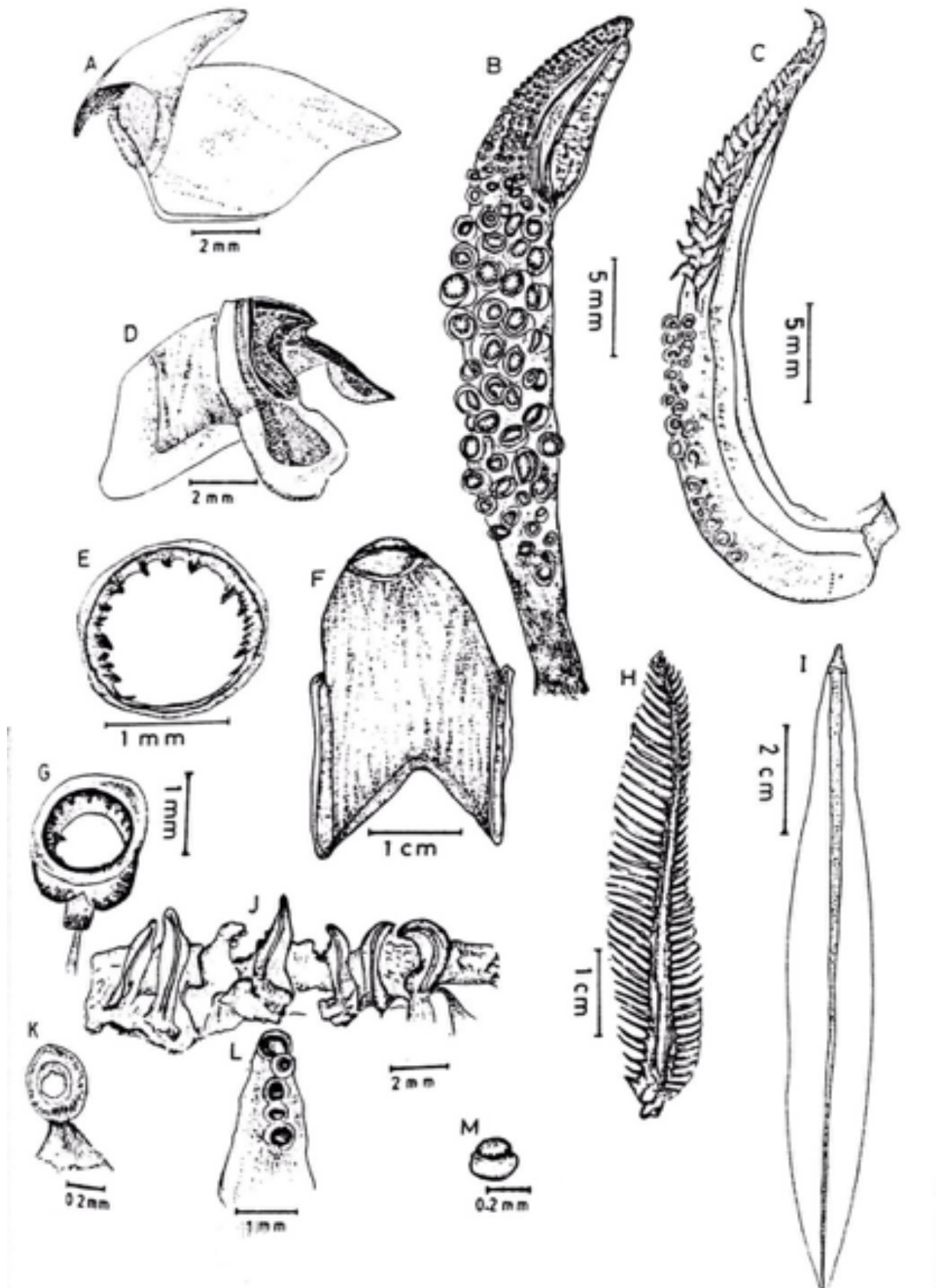


PLATE (5): *Loligo forbesi*

A-Upper beak. B-Tentacular club. C- Left arm IV of male hectocotylized. D - Lower beak. E- Tentacular club sucker ring. F- Funnel. G- Tentacular club sucker. H- Gill. I- Shell. J- Radula. K- Radula sucker. L- Enlarged part of radula. M- Radula sucker ring.

strongly-curved compressed beaks. Their arms are eight in number, and all similar, though more or less unequal; they bear sessile suckers. The mantle is always attached to the neck. The members of this group have no internal shell. They are active animals, swimming and creeping with the facility, but living chiefly among the crevices of rocky grounds. Most species with a W- or VV-shaped funnel organ. Three subfamilies are known: Eledoninae Gray, 1849; Octopodinae Grimpe, 1921; and Bathypolypodinae Robson, 1929. The third only is represented in this study.

Subfamily: Octopodinae

Ink sac present, sometimes small and deeply-buried in the liver, but ink always secreted. Arms with two rows of suckers.

Genus: *Octopus* Cuvier, 1797.

The hectocotylized arm is the third right one. Body firm, more or less muscular. Funnel organ W- or VV-shaped. Mantle aperture not narrow or slightly narrow. Hectocotylus is well developed, with more or less long differentiated ligula and calamus. Mantle aperture wide. No bright color rings scattered over the body and arms, no ocellar spots on the mantle, only round ocellar spots may be present on the web in front of eyes as well as different stripes, spot patterns, etc., there is rarely a coloration uniform.

The genus is represented in the present study by three species, namely *Octopus Vulgaris*, *Octopus Macropus*, and *Octopus Defilippi*.

Keys to the Species of the Genus *Octopus* in the Present Study.

Three cirri over each eye, arms are about equal in length, the modified part of arm III (hectocotylized) is very small and spoon-shaped, 11-gill lamellae per each gill.

.....*Octopus vulgaris*

The dorsal body is ornamented with white spots, the arms are very long, right arm III of the male is hectocotylized with a large tubular ligula, extending to about 13-15% of its length, no cirri over the eyes, twelve gill lamellae per each gill.....*Octopus macropus*
Funnel elongate tube, third arm very much

longer than other arms, right arm III of the male is hectocotylized and shorter than the opposite arm.....*Octopus defilippi*

***Octopus vulgaris* Cuvier, 1797. (Plates 10, 11, and 12)**

Synonymy:

Sepia rugosa Bosc, 1792;

Octopus granulatus Lamarck, 1798 *Octopus vulgaris*. Lamarck, 1798;

Octopus cassiopeia Gray, 1849;

Octopus tuberculatus Risso, 1862;

Octopus trascheli Targioni- Tozzetti, 1869;

Octopus rugosus. Robson, 1929.

World distribution. West Mediterranean Sea, including Adriatic Sea (Roper *et al.*, 1984) Turkish waters, (Catagan and Kocatas, 1990), East Atlantic (Roper *et al.*, 1984). In the Atlantic Ocean from Long Island to southern Brazil and from the Southern North Sea to the Cape of Good Hope, Common in the Gulf of Mexico and the Caribbean Sea, (Nesis, 1987).

Local name: Okhtaboot, Folby, and Saba dule (Riad, 1993).

Local distribution. During this study the specimens were collected off shore from Abu Qir Bay (50-70 m. depth), El-Agamy (25-45 m. depth), Elhamra at Sidi Abd- Alrahman (40-80 m. depth), off El-Montazah (50 m. depth), Sidi Kreer. (40-50 m. depth) EL-Max (40 m. depth), off Kayet Bye (40 m. depth), and also from the commercial fish trawls in the Suez Gulf (Ataka Harbor). It is common in the Suez and Alexandria fish markets (Anfushy, Abu Qir, Maadeia, and Rosetta) (Riad, 1993).

Description: The body of *Octopus vulgaris* is oval and small compared with the head and arms, covered with flattened tubercles (Plate 10). The head is large, with prominent eyes; three cirri are placed over each eye. The arms are thick and about equal in length, seen on their inner surface are the suckers arranged in double rows (Plates 11i and 12 k), the bases of the arms are strongly

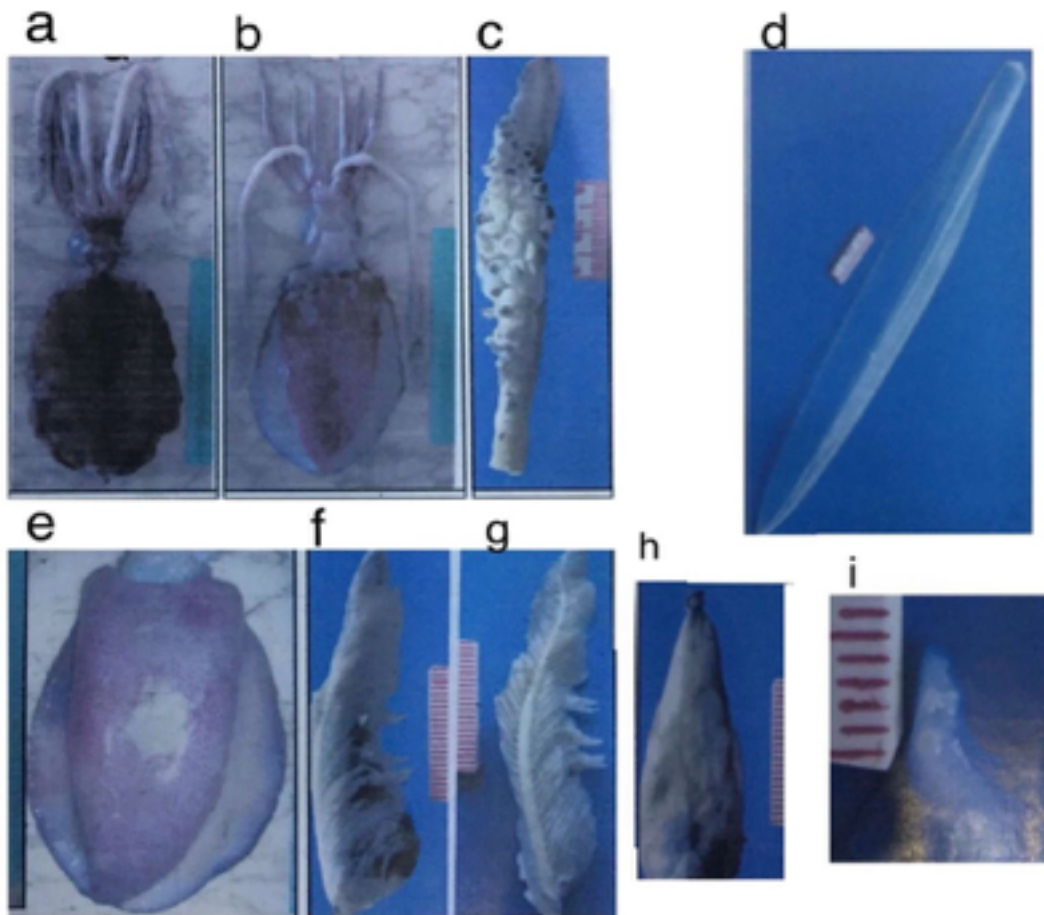


PLATE (6) *Sepioteuthis lessoniana*

a-The animal (dorsal view) b- The animal (ventral view).c-Tentacular club. d- Shell.e-Fin f- Gill (lateral view).g- Gill (dorsal view).h-Ink sac. I-Buccal lappets.

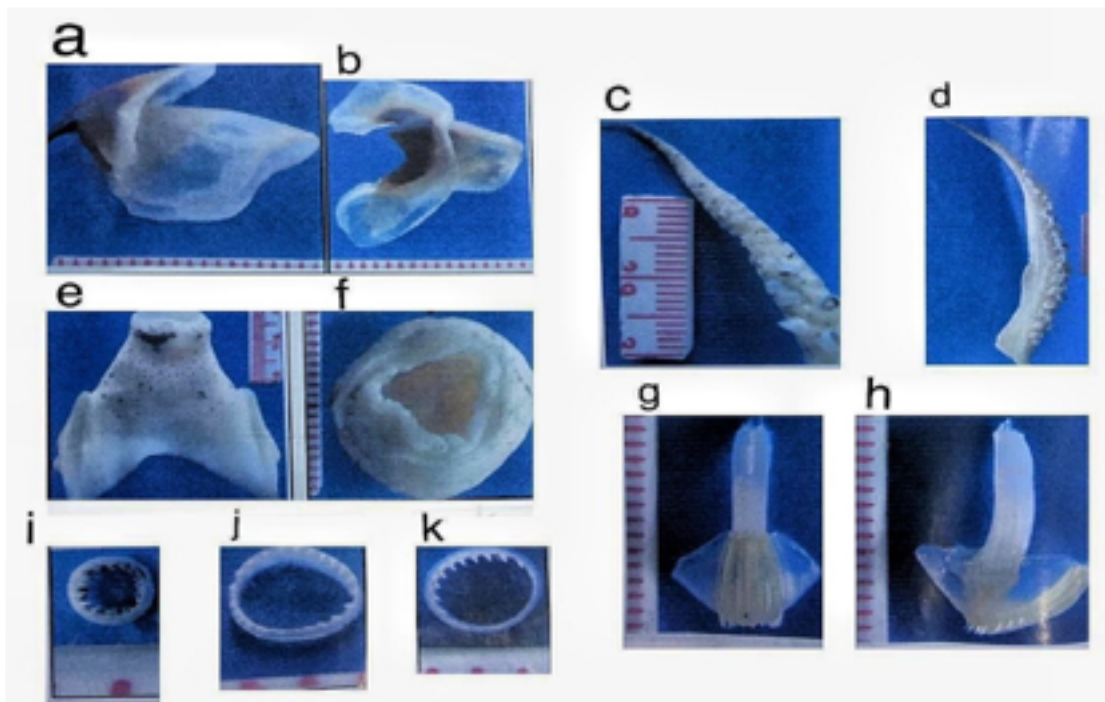


PLATE (7) *Sepioteuthis lessoniana*

a-Upper beak. b- Lower beak. C-Normal arm. d- Normal arm (lateral view). E-Funnel f- Buccal.g-Radula h-Radula (lateral view).i-Dactylus sucker ring.j-Tentacular club sucker ring.k- Arm sucker ring.

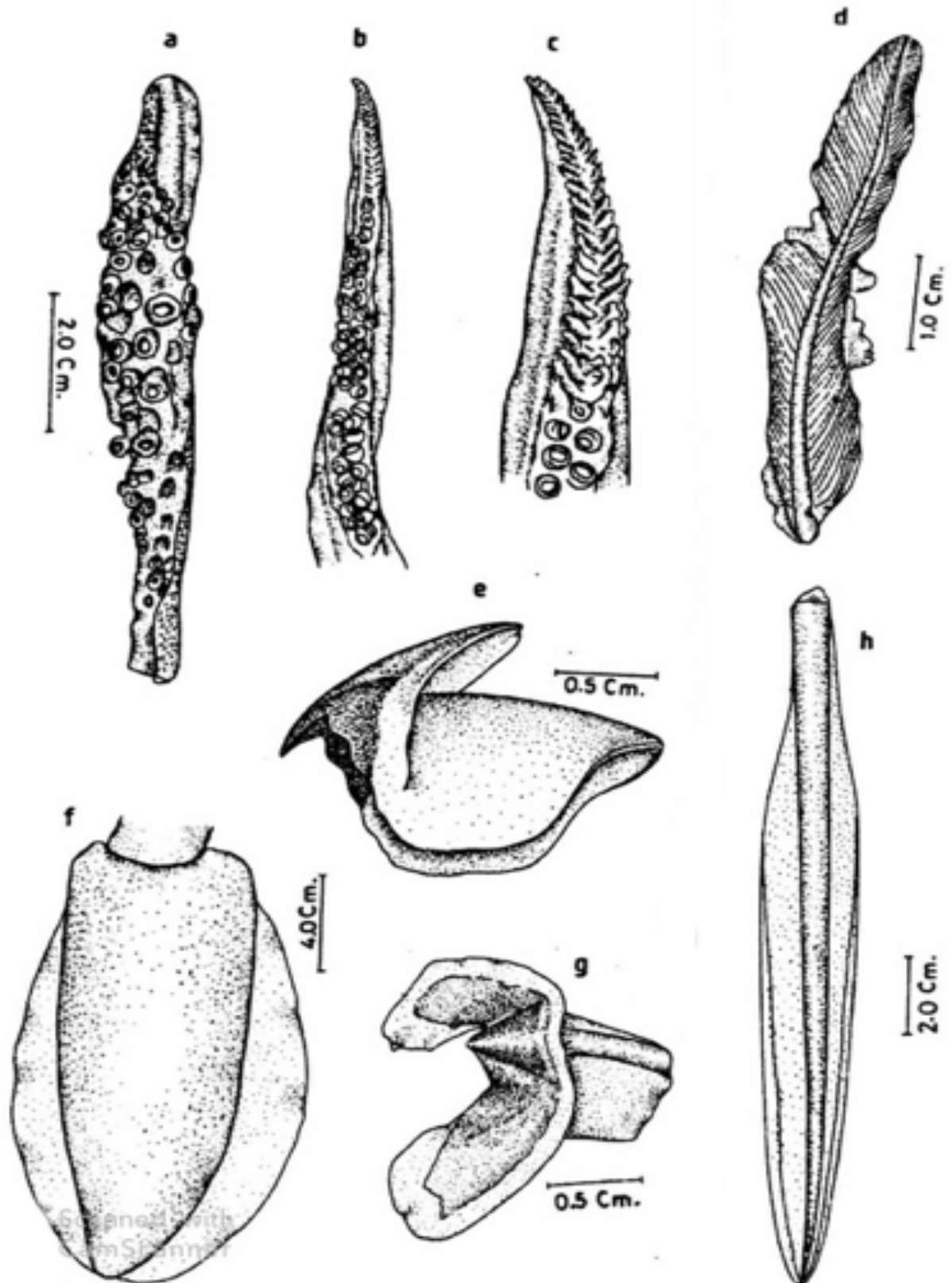


PLATE (8) *Sepioteuthis lessoniana*

(a) Tentacular club. (b) Left arm IV of male hectocotylized. (c) Modified part of hectocotylized arm. (d) Gill. (e) Upper beak. (f) Fin. (g) Lower beak. (h) Shell.

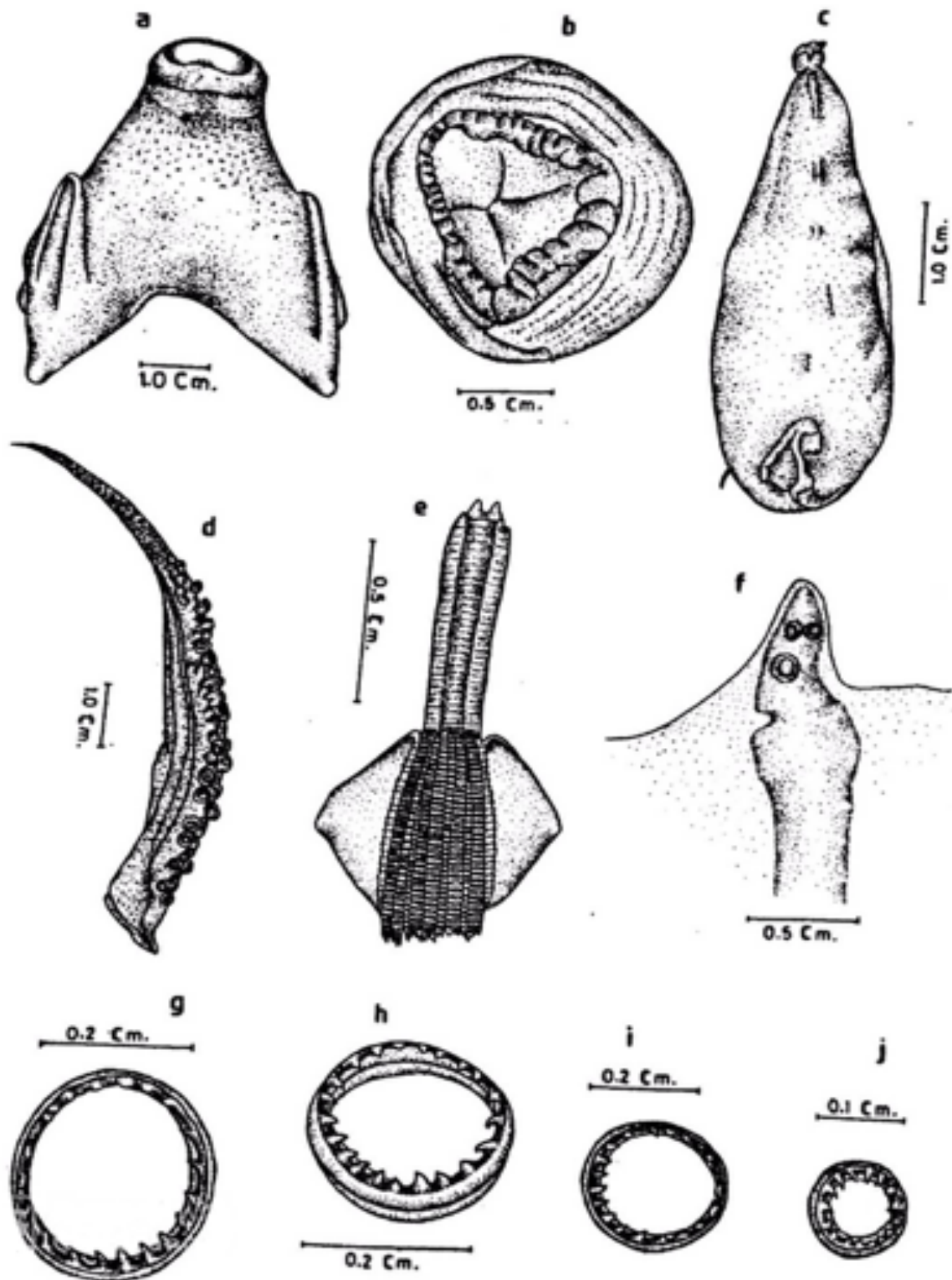


PLATE (9) *Sepioteuthis lessoniana*

(a) Funnel. (b) Buccal. (c) Ink sac. (d) Normal arm. (e) Radula. (f) Buccal lappets. (g) Arm sucker ring. (h) Tentacular club sucker ring. (i) Arm sucker ring. (j) Dactylus sucker ring.

webbed together. The dorsal pair of the arms is shorter than the other arms, and the length of the arms is about three times the body length (plate 10). The modified part of the right arm III of the male (hectocotylized) is very small and spoon-shaped; the ligula occupies about 2.25% of its length (plates 11c and 12f). The gill is provided with eleven-gill lamellae, (Plates 11d and 12g). *Octopus vulgaris* is differentiated from *Octopus macropus* by its shorter arms, the possession of a well-developed interbranchial membrane (connecting the arms up to 1/5 of their length), and the presence of three cirri over each eye. On the other hand, *Eledone moschata* differs from *Octopus vulgaris* by having a single row of suckers on the arms and by the presence of only one cirrus over each eye. The morphology of *Octopus vulgaris* from Alexandria waters and the Red Sea is in agreement with the literature, except for the following additional characteristics; three cirri over each eye; this character was only stated by Forbes and Hanley (1852). Of the specimens collected, the largest specimens had a total length of 104 cm for male and 99.6 cm for females. Fischer, (1973) gave a maximum total length of 90-110 cm. Roper *et al.*, (1984) reported much larger sizes, a total length of 130 cm for male and 120 cm for female. The largest specimens had a mantle length of 16.5 cm for the male and 13.9 cm for the female, and a total weight of 2285 g for males and 1470 g for females. The smallest specimens caught had a total length of 27.5 cm for the male and 26 cm for the female. Mantle length was of 5 cm for the male and 4.6 cm for female and the total weight was of 50 g for the male and 30 g for the female.

Habitat: On muddy sandy gravelly bottoms and also dwelling in cavities. Depth ranges from 10 to 300 m, Robson, (1932) and Roper *et al.*, (1984).

Octopus macropus Risso, 1797. (Plates 13, 14, and 15)

Synonymy:

Octopus macropodus, San Giovanni 1829.

Octopus cuvieri d'Orbigny, 1840;

Octopus longimanus d'Orbigny, 1840;

Octopus alderi Verany, 1851;

Octopus bernudensis Hoyle, 1885;

Octopus chromatus Heilprins, 1888.

World distribution: Worldwide in warm waters (Roper *et al.*, 1984). The Western and Eastern Mediterranean (Fischer, 1973). The Adriatic Sea (Riedle, 1970). The north Atlantic Ocean, the Indian Ocean, the central and western Pacific Ocean, the Gulf of Aqaba (Adam, 1960). North African coast (Fischer, 1973). Tropical Atlantic, Indo-West Pacific species, in the western Atlantic mainly near the Bermuda and Bahama Islands, Southern Florida to Brazil, the Caribbean Sea, western Africa to the Gulf of Guinea, Ascension and Santa Helena Islands (Nesis, 1987).

Local name: Okhtaboot or Saba dule and Hebal (Riad, 1993).

Local distribution: During the present study, the species was collected offshore from Abu Qir Bay (50-70 m depth), El-Agamy (25-45 m depth), Sidi-Abd- Alrahman (40-80 m depth), off El-Montazah (50 m depth), Sidi-Kreer (40- 50 m depth), El-Max (40 m depth), off Kait Bye (35 m depth) and from commercial fish trawl from Suez Gulf (Ataka Harbor). It is common in Suez and Alexandria fish markets (Anfushy, Abu Qir, Maadeia, and Rosetta) (Riad, 1993).

Description: The dorsal body is ornamented with white spots. The arms are very long, six-seven times longer than the body length (plate 13), each has two rows of suckers; the first pair of arms I is much longer (Plate 13). The right arm III of the male is hectocotylized with a large tubular ligula, extending to about 13-15% of its length (ligula index), (Plates 14a and 15a). The cirri over the eyes are absent. The gill is provided with thirteen gill lamellae (Plates 14f and 15c). This species differs from *Octopus vulgaris* by the following characteristics. Its slender and longer arms, its poorly-developed interbranchial membrane. *Eledone moschata* differs from *Octopus macropus* by

its single row of suckers on the arms and by its single cirrus over each eye, while the cirri are absent in *Octopus macropus*.

The morphology of *Octopus macropus* in the present study is in agreement with that given in the literature. The largest specimens had a mantle length of 16.2 cm for the male and 15.8 for females. The total length is 137 cm for males and 130 cm for the female and the total weight is 880g for males and 625g for females. The maximal total length recorded for the same species by Fischer, (1973) ranged from 90-110 cm Jereb and Roper, (2005) gave greater measurements; total length 120-150 cm, mantle length 14 cm and total weight 2 kg. The smallest specimens collected during this study showed the following measurements.

Total length 55 cm for males and 52 cm for the female. The mantle length is 5 cm for the male and 4.8 cm for the female. The total weight is 48g for the male and 40g for the female.

Habitat: The species lives on rocky bottoms, in crevices and holes, sometimes also on vegetated substrates (Fischer, 1973). A benthic shallow-water species occurring in coral reefs, reef flats, and on open bottoms (Jereb and Roper, 2005). In the present study, the species was captured from muddy sandy grounds at Abu Qir Bay.

Octopus defilippi Verany, 1845. (Plates 16, 17, 18, and 19)

Material: Seventeen individuals ranging between 5 cm for the mantle length of an animal weighing 30 g and 8.8 cm for the mantle length of an animal weighing 100g

Synonymy: *Macrotritopus species*.

World distribution: the Mediterranean Sea, the eastern Atlantic Ocean from Morocco to Angola, Cape Verde Islands, The western Atlantic, Bahamas, the Gulf of Mexico, the Caribbean Sea, Brazil, the Indian Ocean, Arabian Peninsula to Burma, and the south western Pacific Ocean (Roper, *et al.*, 1984 and Nesis, 1987).

Local name: Akhtaboot or Sabaa dule (Riad, 1993).

Local distribution: The species was encountered through the present study from Sidi Abdel Rahman locality and from the commercial fish trawl in the Suez Gulf (Ataka Harbor) and the adjacent area. It is common in Suez and Alexandria fish markets (Anfushy, Abu Qir, Maadeia and Rosetta) (Riad, 1993).

Description: Mantle relatively very small, smooth-skinned, head narrower than the mantle, no pigmented ocellus, spots, or rings. (plates 16 and 18a) Funnel elongate tube and W-shaped (plates 19c, 18e, and 19b). All arms are very long, slender, symmetrical, 3rd arms very much longer than the other arms. Arm length exceeding 70-85% of the total length, arms with delicate tips (plates 16 and 18a). Arms formula III > II > IV > I or III > IV > II > I] (plate 16). Right arm III of the male (hectocotylized) shorter than the opposite arm bearing 60-100 suckers. Ligula well differentiated 1.8 to 2.5% of the hectocotylized arm length, groove very shallow calimus very small (plates 19b, 18c, and 19a), gill lamellae on outer demibranch (plates 17g 18d and 19e). Web depth 20-25% of the longest arm length. Web formula C > D > B > E > A (plate 18f) Suckers widely set, of a medium size. One cirrus over each eye (plates 18a and b).

Habitat: The present record inhabits the bioclastic bottom at 30-60 m depth. According to Roper *et al.*, (1984), the species is little known as benthic species inhabiting sandy to muddy bottoms at 6 to 60 m water column depth, but was occasionally reported down to 200 macrotritopus larvae) and is characterized by extremely long arms III. The present work's samples showed the mantle length of the largest specimen to be 8.8 cm in an animal weighing 100 gm and in the smallest specimen to be 5 cm in an individual weighing 30 gm, while according to Roper *et al.*, (1984), the maximum mantle



PLATE (10) *Octopus vulgaris*

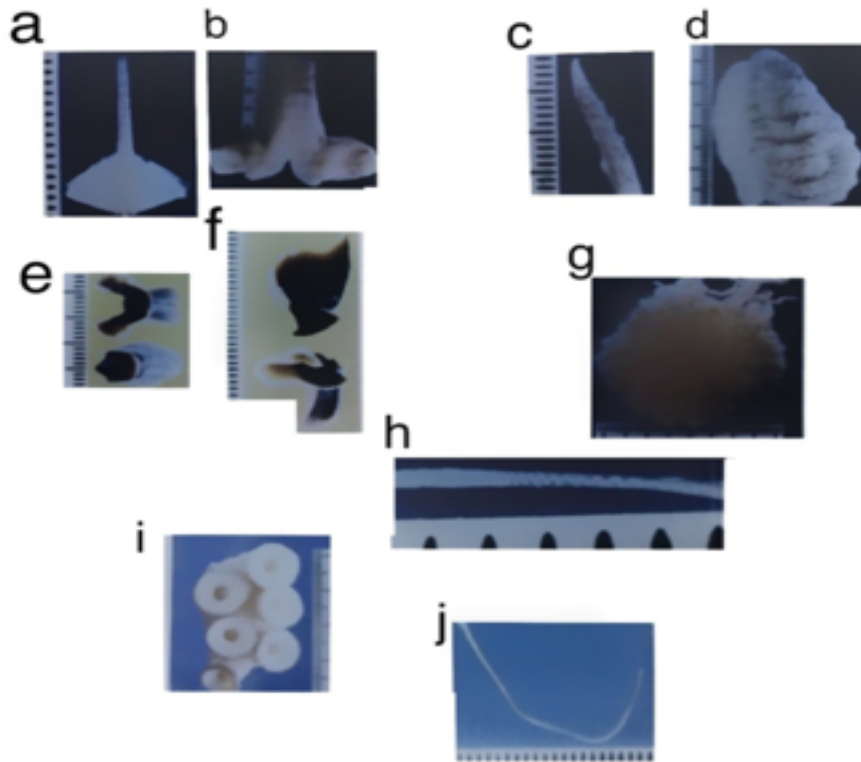


PLATE (11) *Octopus vulgaris*

A-Radula. B- Funnel. C- Right arm III of male hectocotylyzed . D- Gill E-Upper & lower beaks (dorsal view). F-Upper & lower beaks (lateral view). G- Egg cluster. H-Magnified part of spermatophore .I-Part of arm j- Spermatophore.

length is 9 cm and according to Mangold, (1998), the animal is small to medium in size (3.3 5.5 cm) (Roper *et al.*, 1984).

Remarks: Distinction of *Octopus defilippi* from the other *Octopus* spp. previously recorded in the Egyptian waters can be summarized as follows: *Octopus defilippi*: The mantle is relatively very small. Arm III is the largest arm, and there is a cirrus over each eye. *Eledone moschata*: One row of suckers exists on each arm and there is a clear cirrus over each eye. *Octopus vulgaris*: Shorter arms, a well-developed inter-brachial membrane (connecting the arms up to 1/5 of their length), the presence of three cirri over each eye. *Octopus macropus*: Slender and longer arms poorly- developed interbranchial membrane. Cirri are absent.

Conclusion

The specimens for the study were obtained from fishing trawlers operating in the Egyptian Mediterranean Sea, the Suez Gulf, and the

Red Sea. The specimens were also obtained from Alexandria and Suez fish markets. The species that are included in class Cephalopoda are ecologically and commercially important in the world. The class includes four groups Cuttlefishes, Squids, Octopuses, and Nautilii. The first three groups are present in the Egyptian Mediterranean waters and the Red Sea. They constitute a main component in the fisheries industry. To understand the biology and ecology of any species, their identification should be conducted properly to maximize the accuracy of any study. The present study is the first of its kind, and was prepared to focus on the cephalopod species inhabiting both the Egyptian Mediterranean and the Red Sea waters. The present work was conducted using morphological features. It is aimed at obtaining more information about the limited taxonomical studies on Cephalopoda species inhabiting both the Egyptian Red Sea and the Mediterranean waters. Out of the six cephalopod species inhabiting the Egyptian Mediterranean and the Red Sea waters, there is only one cuttlefish species *Sepia dollfusi*, two squid species *Loligo*

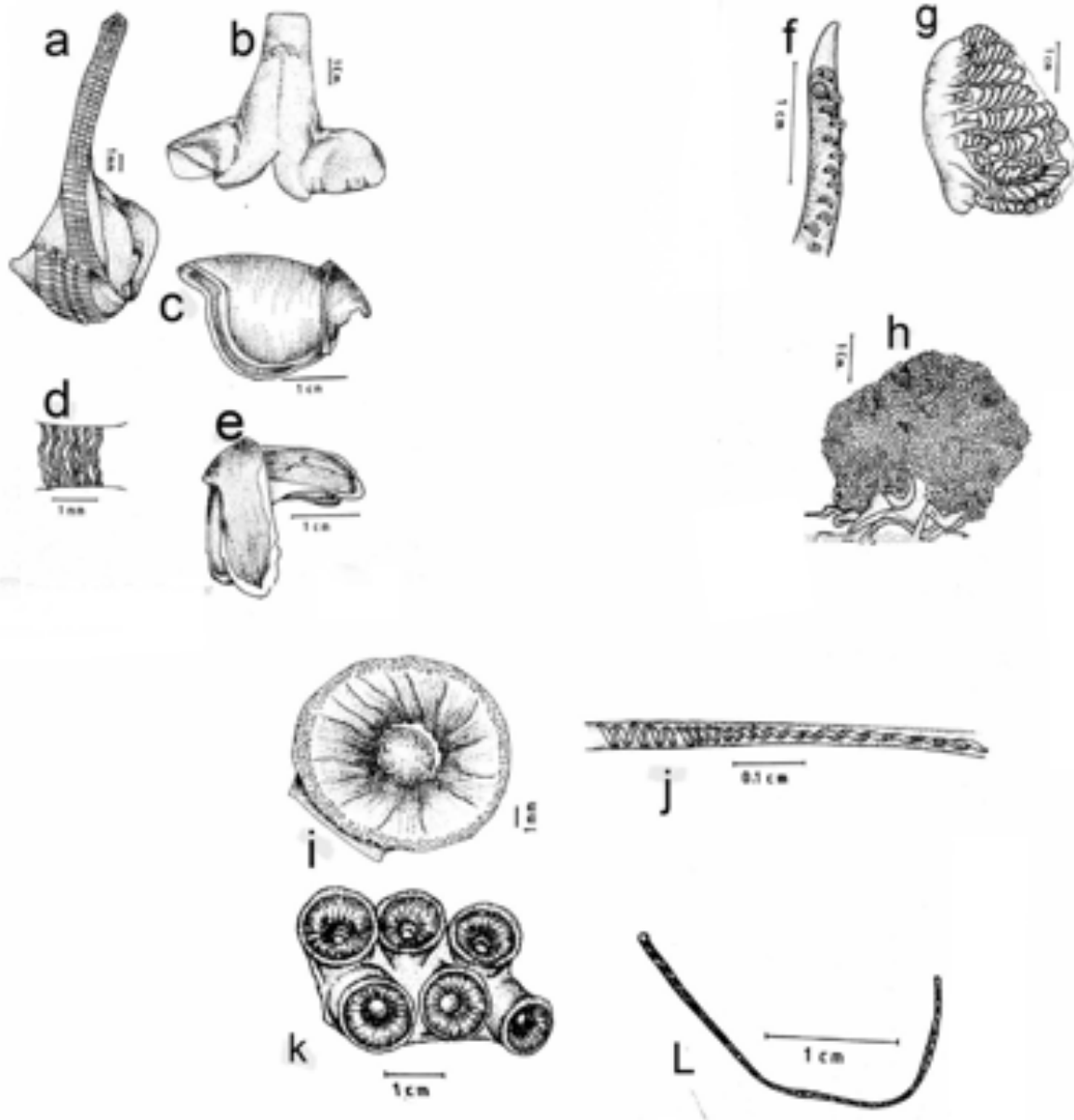


PLATE (12) *Octopus vulgaris*

A-Radula. B- Funnel. C- Upper beak D- Enlarged part of radula teeth. E- Lower beak.

F- Right arm III of male hectocotylized . G- Gill .H- Egg cluster. I- Arm sucker. J- Magnified part of spermatophore. K- Part of arm. L- Spermatophore.

forbesi and *Sepioteuthis lessonian*, and three octopus species *Octopus vulgaris*, *Octopus acropus*, and *Octopus defilippi*. Two of these, namely *Sepia dollfusi*, and, *Sepioteuthis lessoniana* are dwelling the Red Sea and migrated to the Mediterranean waters through

the Suez Canal. Specimen parts were drawn using a zoom stereoscopic microscope provided with a camera lucida drawing tube and. The specimen parts were also photographed by a Canon digital camera.



PLATE (13) *Octopus macropus*

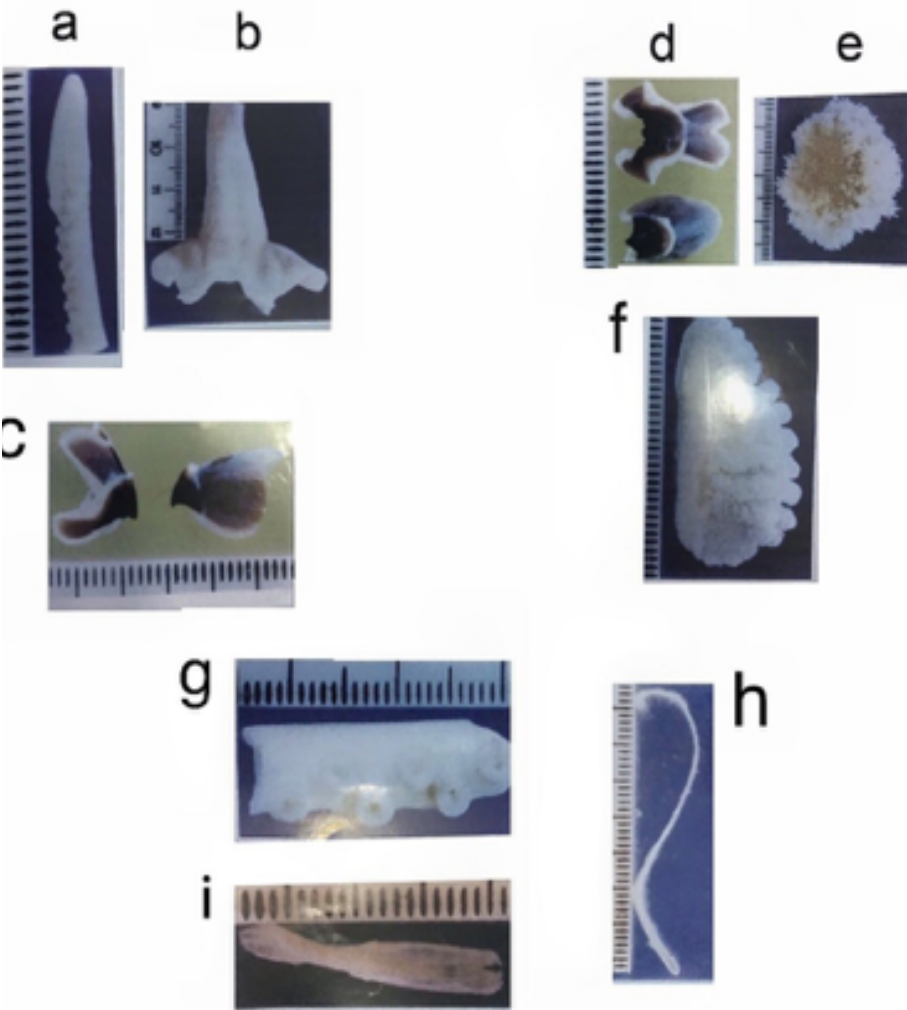


PLATE (14)
Octopus macropus
 A- Right arm III of male hectocotylized.
 B- Funnel.
 C- Upper & Lower beaks (lateral view).
 D- Upper & Lower beaks (dorsal view).
 E- Egg cluster
 F- Gill.
 G- Part of arm.
 H- Spermatophore. I- Radula.

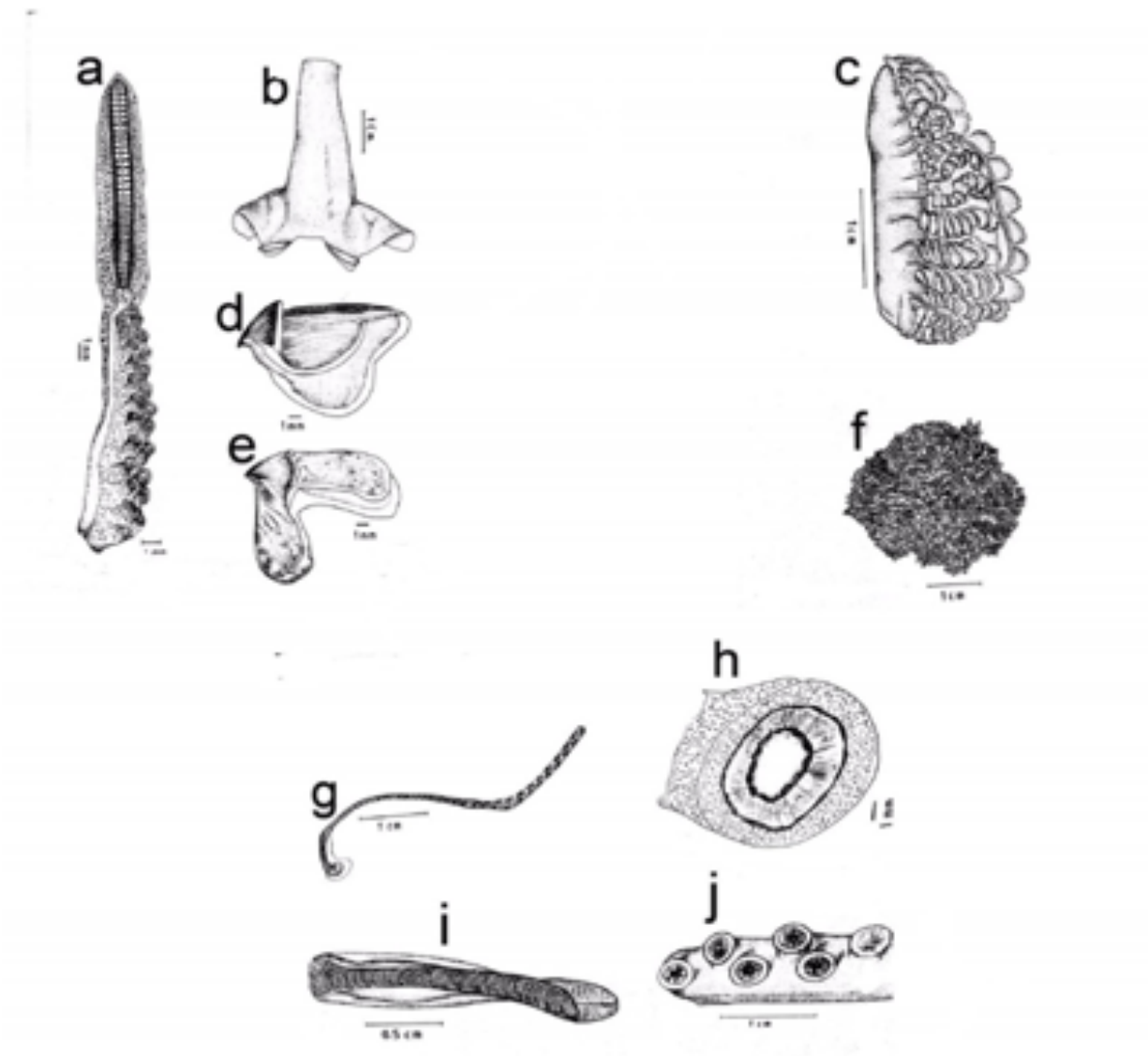


PLATE (15) *Octopus macropus*

A-Right arm III of male hectocotylied. B- Funnel. C- Gill. d- Upper beak. e- Lower beak. F- Egg cluster. G-Spermatophore. H- Arm sucker. I Radula. J- Part of arm.



PLATE (16) *Octopus deflippi*

Arm formula (III > II > IV > I or III > IV > II > I)

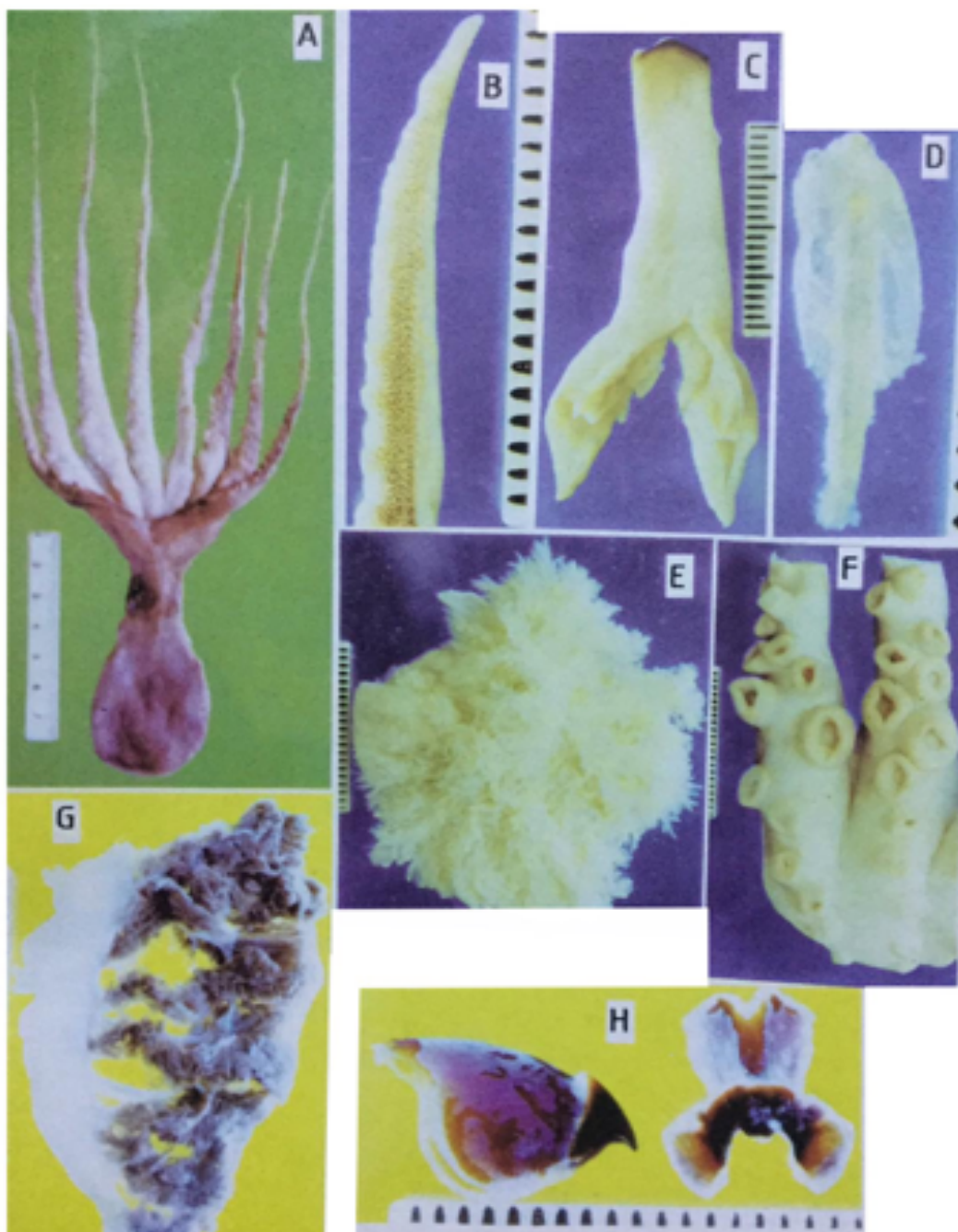


PLATE (17) *Octopus defilippi*

A-The animal. B- Right arm III of male hectocotylized. C- Funnel. D- Radula. E-Egg cluster. F- Arm suckers. G- Gill. H- Upper and lower beaks.

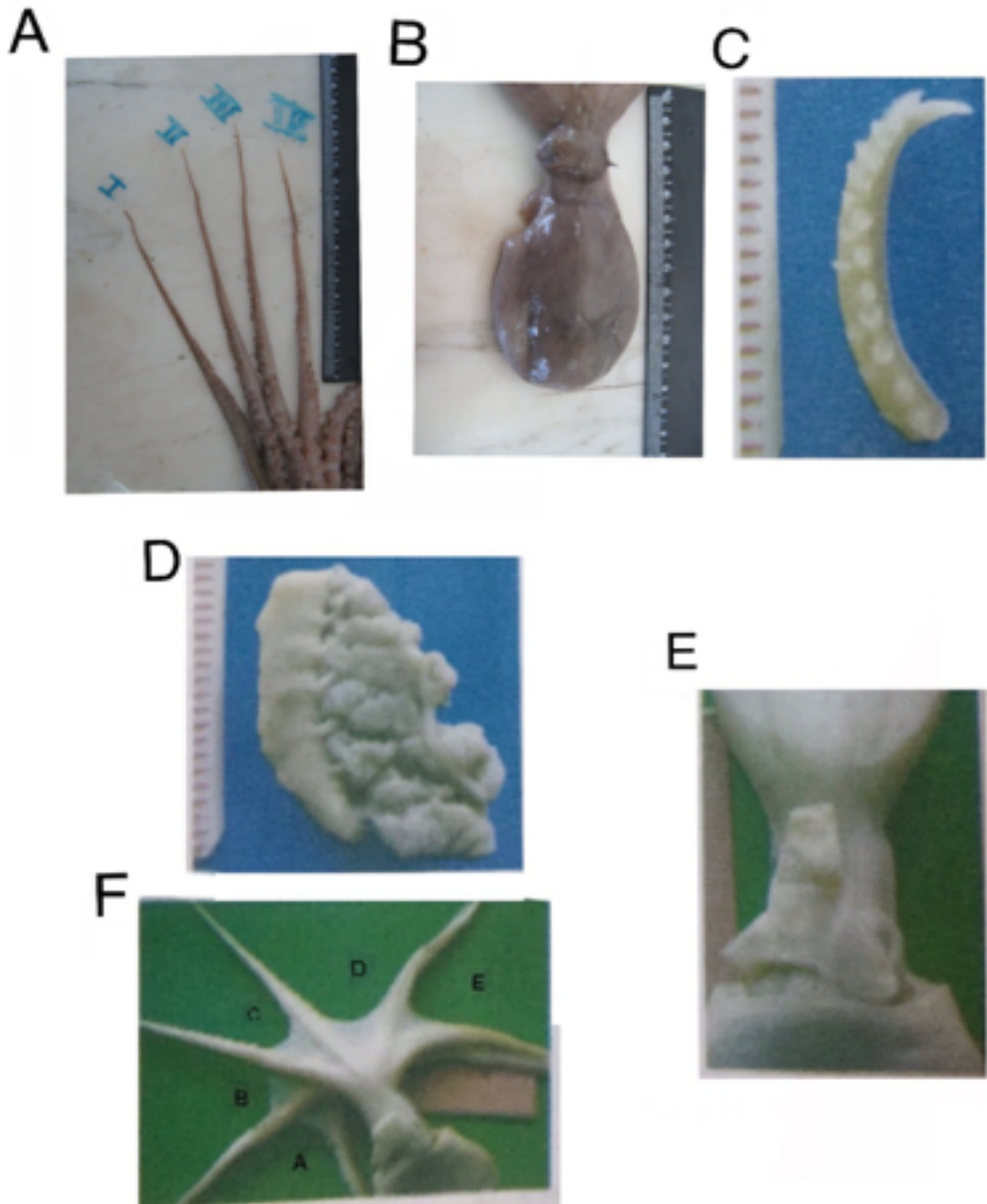


PLATE (18) *Octopus deflippi*

A-Animal arm (arm formula). B- One cirri over each eye. C- Right arm III of male hectocotylized. D- Gill. E- Funnel. F-Arm web (Web formula(C > D > B > E > A))

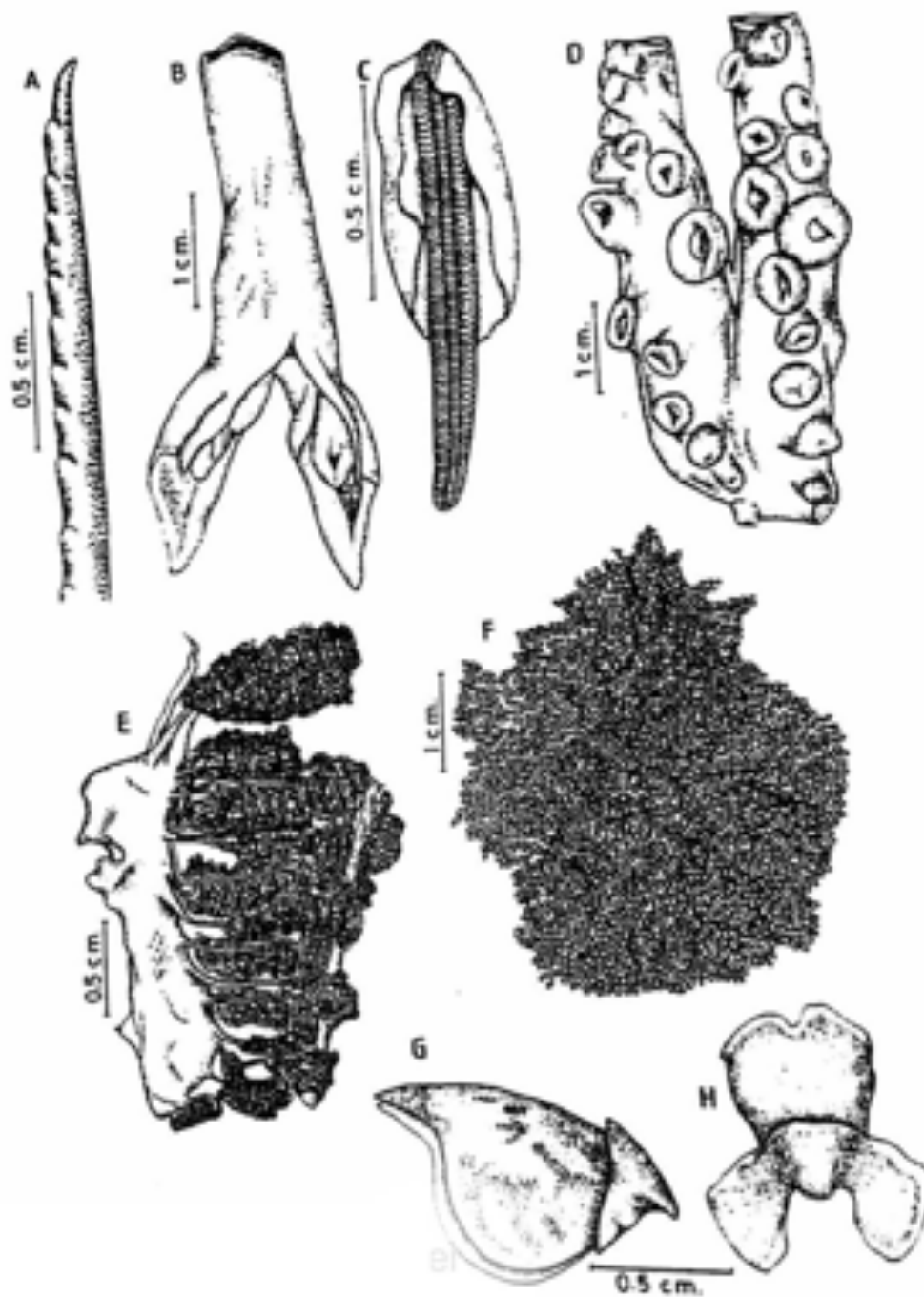


PLATE (19) *Octopus defilippi*

A-Right arm III of male hectocotylized. B- Funnel. C- Radula. D- Arm suckers. E- Gill. F- Egg cluster. G- Upper beak. H- Lower beak.

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