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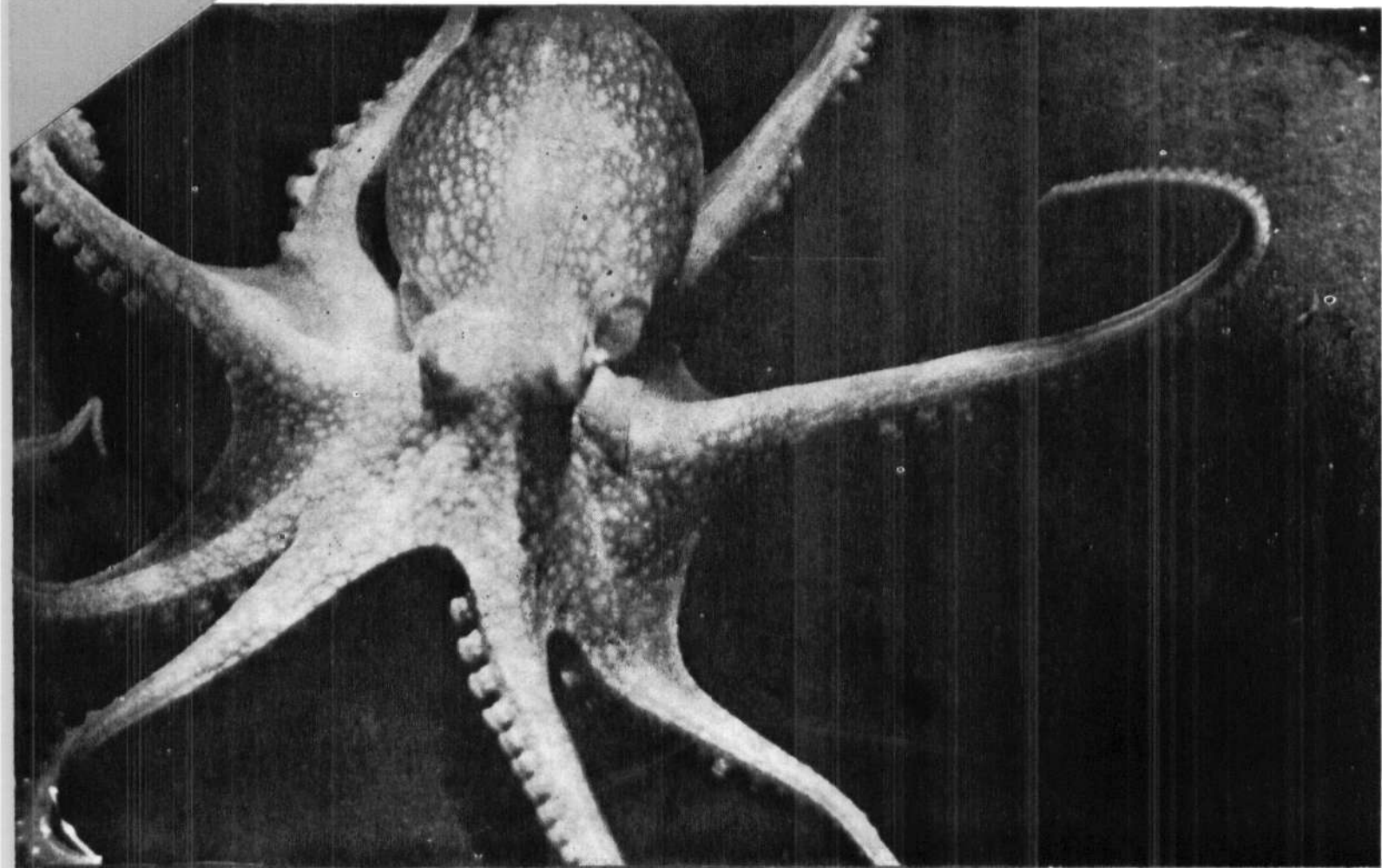
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CEPHALOPOD BIONOMICS, FISHERIES AND RESOURCES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA

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IDENTITY OF COMMON SPECIES OF CEPHALOPODS OF INDIA

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ABSTRACT

A key to the identification of the common cephalopods of Indian Seas which are of commercial importance is given with brief descriptions of nine species of cuttlefishes, six species of neritic squids, four species of oceanic squids, seven species of octopods and *Nautilus pompilius*. A Glossary of technical terms used in the descriptions of cephalopods is included.

INTRODUCTION

Cephalopods are exclusively marine molluscs and there are about 660 species in the world oceans, which are diverse in form, size and nature (Voss, 1973, 1977; Voss and Williamson 1971; Worms, 1983). Of these less than a hundred species are of commercial importance. Cuttlefishes, squids and octopods are the three major groups of cephalopods which belong to the highly evolved Class of the Phylum Mollusca, namely Cephalopoda, animals with feet around head. Owing to the rapid development of an export market for squids and cuttlefish there is a greater need felt now than ever, for more information on the identity of cephalopods of the Indian Seas.

There are about 80 species of cephalopods of commercial and scientific interest distributed in the Indian Seas (Silas, 1968; Oommen, 1977a; Sarvesan, 1974). Other literature on cephalopods also indicates the rich cephalopod fauna of our seas (Hoyle, 1886; Goodrich, 1896; Massy, 1916; Adam, 1939a, b, c, d, 1954; Adam and Rees, 1966; Rao, 1954; Satyamurti, 1956; Silas, 1969; Pickford, 1974; Silas *et al.*, 1976; Roper *et al.*, 1984). A comprehensive list of species recorded and reported from Indian Ocean till 1968 is given by Silas (1968).

For a broad classification of living cephalopods reference is invited to Voss and Williamson (1971) and Voss (1977).

Identification of Cephalopods

For the proper identification of various species of cephalopods a knowledge of the external morphology

and certain internal characters is necessary. The works of Hoyle (1886), Robson (1929), Adam (1939b), Adam and Rees (1966), Voss (1963), Voss and Williams (1971), Roper *et al.* (1969) Okutani (1973b; 1980) and Roper *et al.* (1984) are very useful works in this regard.

The key characters which are used for the identification of cephalopods are illustrated in Figs. 1-4. This will provide a general idea of the characters which are mentioned in the key and in the descriptions. The other anatomical and meristic features that are easily observable in specimens are also included in the illustrations. The definitions and explanatory notes of the unfamiliar terms are listed in the glossary.

The key is mainly based on the morphological features of the adult and fairly full grown specimens. The characters that could be readily observed externally and a few internal characters are considered. The key is intended for the identification of only those commercially important species both of food and aesthetic value which are listed and described here. The works of Voss (1963), Voss and Williamson (1971), Wormuth (1976) and Roper *et al.* (1984) have been of considerable help in developing these identification keys and descriptions which in most cases have also been corroborated with examination of actual specimens.

The three different basic body patterns of external features of cephalopods are presented in the Figs. 1, 2, 3 and 4. Based on this the main categories *viz.*, cuttlefish (*Sepia*), squid (*Loligo*) and octopod (*Octopus*) are easily distinguished. With the help of the following key and brief descriptions, the species under different families could be identified.

EXPLOITED AND POTENTIALLY IMPORTANT CEPHALOPODS
OF INDIA

Class	CEPHALOPODA
Subclass	NAUTILOIDEA Agassiz, 1847
Family	Nautilidae Blainville, 1825
Genus	<i>Nautilus</i> Linnaeus, 1758 <i>Nautilus pompilius</i> Linnaeus, 1758
Subclass	COLEDIDEA Bather, 1888
Order	Sepioididea Naef, 1916
Family	Sepiidae Keferstein, 1866
Genus	<i>Sepia</i> Linnaeus, 1758 <i>Sepia pharaonis</i> Ehrenberg, 1831 <i>Sepia aculeata</i> Orbigny, 1848 <i>Sepia trygonina</i> (Rochebrune, 1886) <i>Sepia brevimana</i> Steenstrup, 1875 <i>Sepia elliptica</i> Hoyle, 1885 <i>Sepia arabica</i> Massy, 1916 <i>Sepia prashadi</i> Winckworth, 1936
Genus	<i>Sepiella</i> Gray, 1849 <i>Sepiella inermis</i> (Orbigny, 1848)
Family	Sepiolidae Steenstrup, 1861
Genus	<i>Euprymna</i> Steenstrup, 1887 <i>Euprymna stenodactyla</i> (Grant, 1833)
Order	TEUTHOIDEA Naef, 1916
Suborder	Myopsida Orbigny, 1845
Family	Loliginidae Steenstrup, 1861
Genus	<i>Loligo</i> Schneider, 1784 <i>Loligo duvaucelli</i> Orbigny, 1848 <i>Loligo uyil</i> Wakiya and Ishikawa, 1921
Genus	<i>Doryteuthis</i> Naef, 1912 <i>Doryteuthis singhalensis</i> (Ortman, 1891) <i>Doryteuthis sibogae</i> Adam, 1954
Genus	<i>Sepioteuthis</i> Blainville, 1824 <i>Sepioteuthis lessoniana</i> Lesson, 1830
Genus	<i>Loliolus</i> Steenstrup, 1856 <i>Loliolus investigatoris</i> Goodrich, 1896
Suborder	Oegopsida Orbigny, 1845
Family	Onychoteuthidae Gray, 1849
Genus	<i>Onychoteuthis</i> Lichtenstein, 1818 <i>Onychoteuthis banksii</i> (Leach, 1817)
Family	Ommastrephidae Steenstrup, 1857
Subfamily	Ommastrephinae
Genus	<i>Ommastrephes</i> Orbigny, 1835 <i>Ommastrephes bartrami</i> (LeSueur, 1827)

Genus	<i>Symplectoteuthis</i> Pfeffer, 1900 <i>Symplectoteuthis oualaniensis</i> (Lesson 1832)
Family	Thysanoteuthidae Keferstein, 1866
Genus	<i>Thysanoteuthis</i> Troschel, 1857 <i>Thysanoteuthis rhombus</i> Troschel, 1857
Order	OCTOPODA Leach, 1818
Suborder	Incirrata Grimpe, 1916
Family	Octopodidae Orbigny, 1845
Genus	<i>Octopus</i> Lamarck, 1798 <i>Octopus dollfusi</i> Robson, 1929 <i>Octopus aegina</i> Gray, 1849
Genus	<i>Cistopus</i> Gray, 1849 <i>Cistopus indicus</i> (Orbigny, 1840)
Genus	<i>Hapalochlaena</i> Robson, 1929 <i>Hapalochlaena maculosa</i> (Hoyle, 1886)
Genus	<i>Berrya</i> Adam, 1939 <i>Berrya keralensis</i> Oommen, 1966
Family	Argonautidae Naef, 1912
Genus	<i>Argonauta</i> Linnaeus, 1758 <i>Argonauta argo</i> , Linnaeus, 1758 <i>Argonauta hians</i> , Solander, 1786

1. SUBCLASS NAUTILOIDEA Agassiz, 1847

Shell external, coiled and chambered, more than 10 (63 to 94) circumoral appendages without suckers, two pairs of gills, funnel bilobed. (Living Monotypic Genus *Nautilus* : *Nautilus pompilius*).

2. SUBCLASS COLEOIDEA Bather, 1888

Shell internal except in Family Argonautidae, embedded in tissue, calcareous, chitinous or cartilaginous, 8 or 10 circumoral appendages with suckers, only one pair of gills, funnel tube-like.

1. Order Sepioidea Naef, 1916

Internal shell (sepion) calcareous and either straight and laminated or coiled and chambered or vestigial and chitinous or absent; eyes covered with skin and a supplementary eye lid present; eight sessile arms; two tentacular arms contractile and retractile into pockets; suckers without stalks; fin lobes free posteriorly.

2. Order Teuthoidea Naef, 1916

Internal shell (gladius or pen) chitinous, feather or rod-shaped, eight sessile arms; two tentacular arms contractile but not retractile, pockets absent, tentacles lost secondarily in some, suckers stalked and with or without

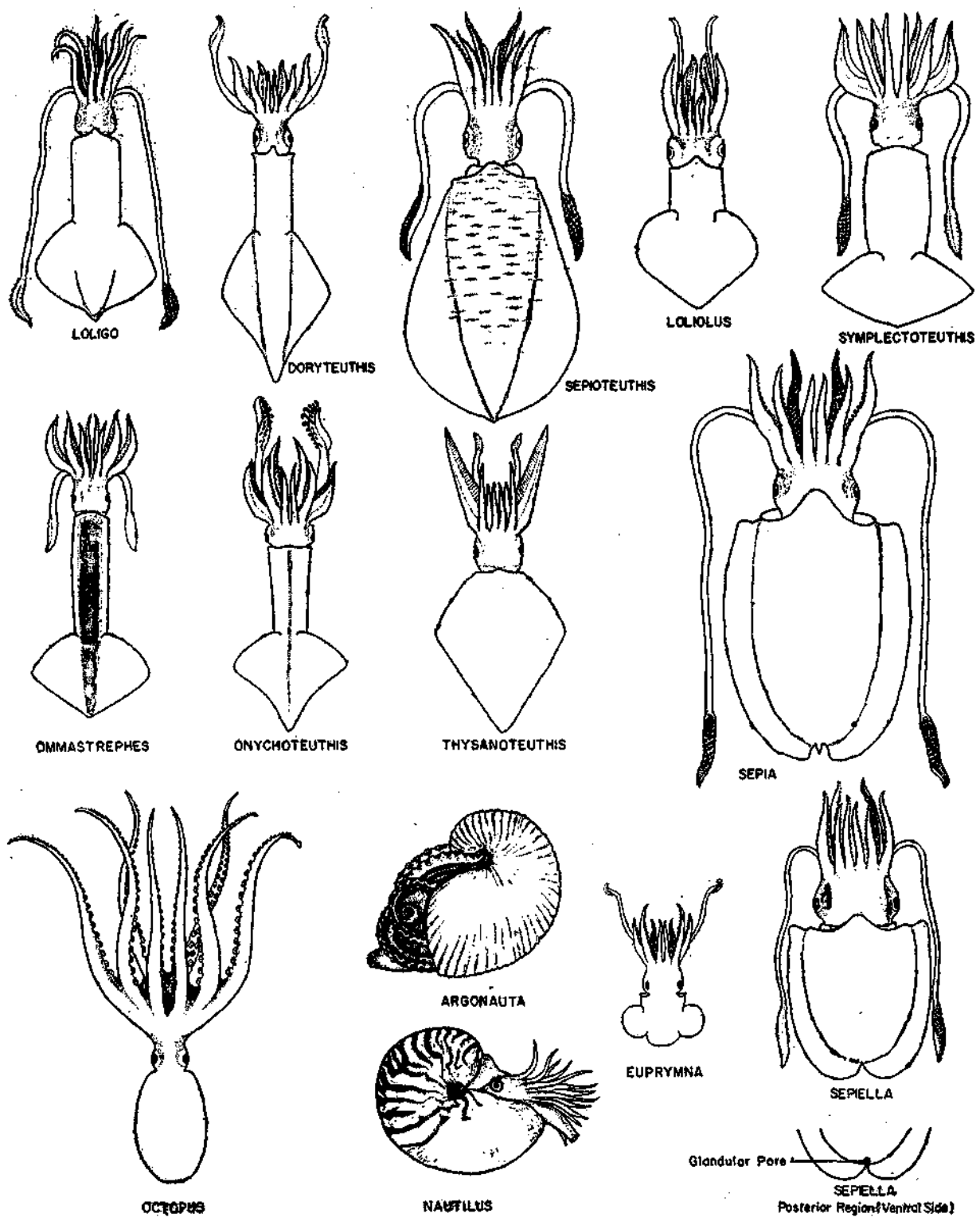


FIG. 1. Body form of some important groups of cephalopods.

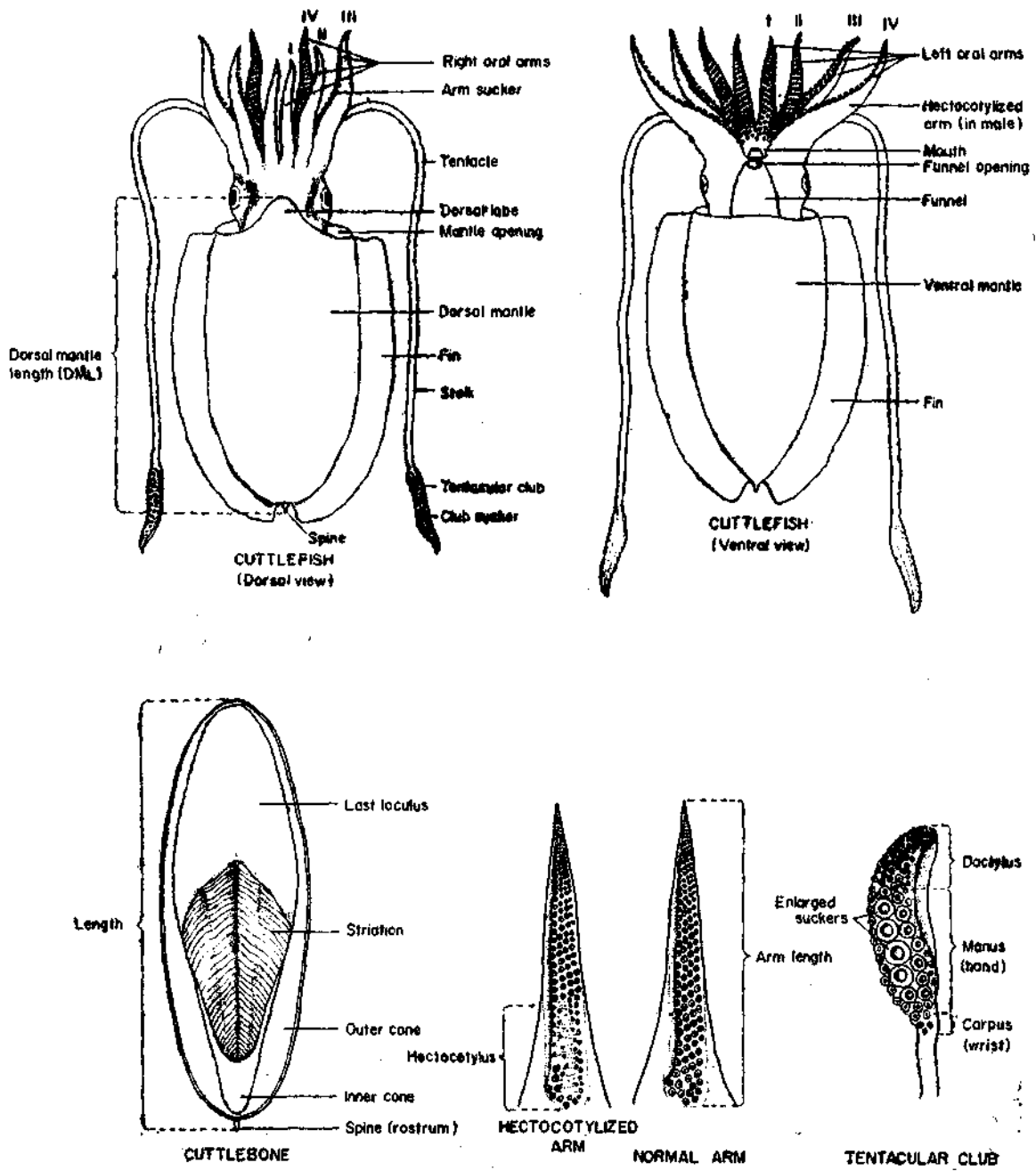


FIG. 2. Schematic drawings of a cuttlefish showing salient characters as an aid for identification.

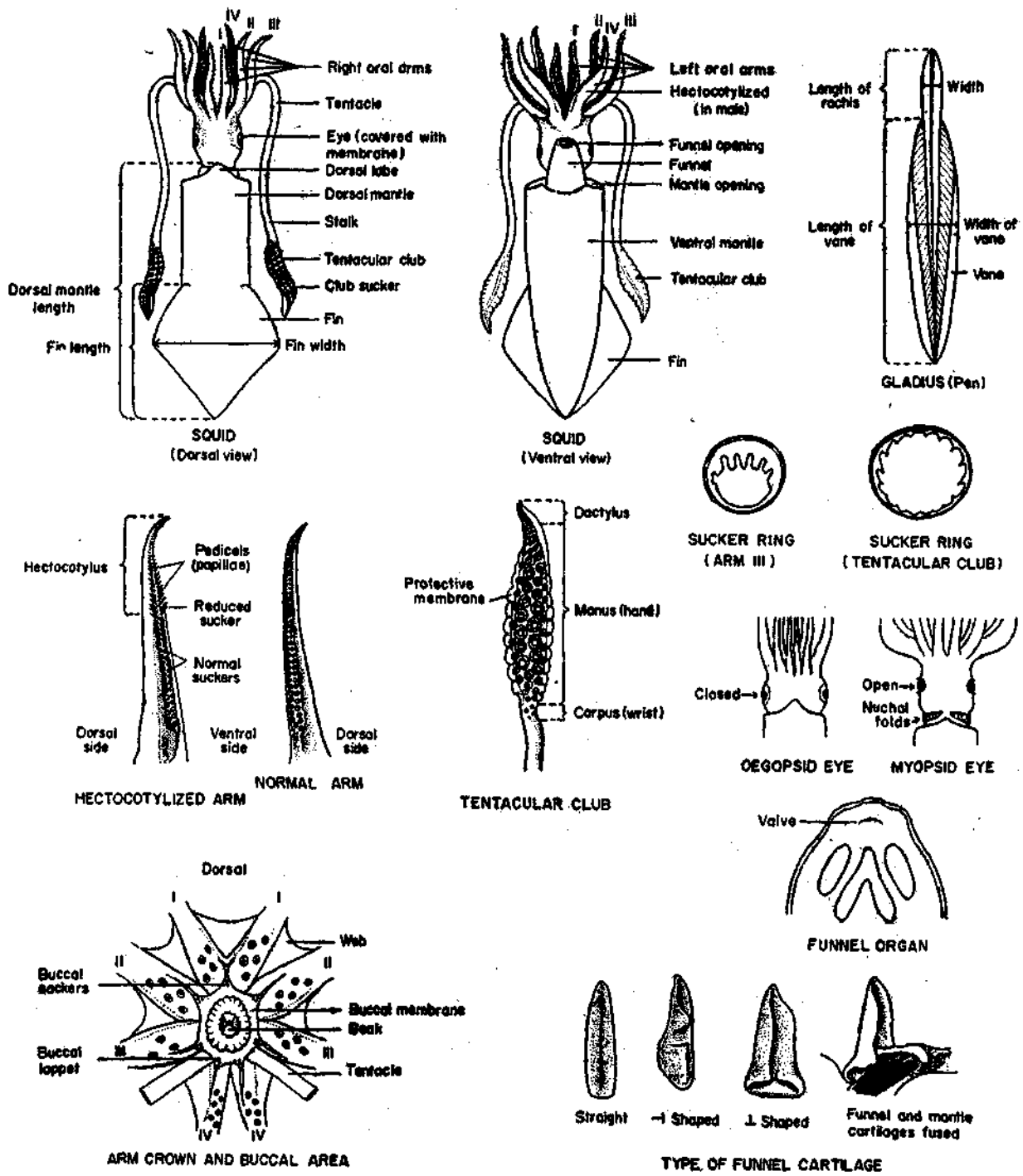


FIG. 3. Schematic drawings of a squid showing salient characters as an aid for identification (Types of funnel cartilage : From Roper *et al.*, 1969).

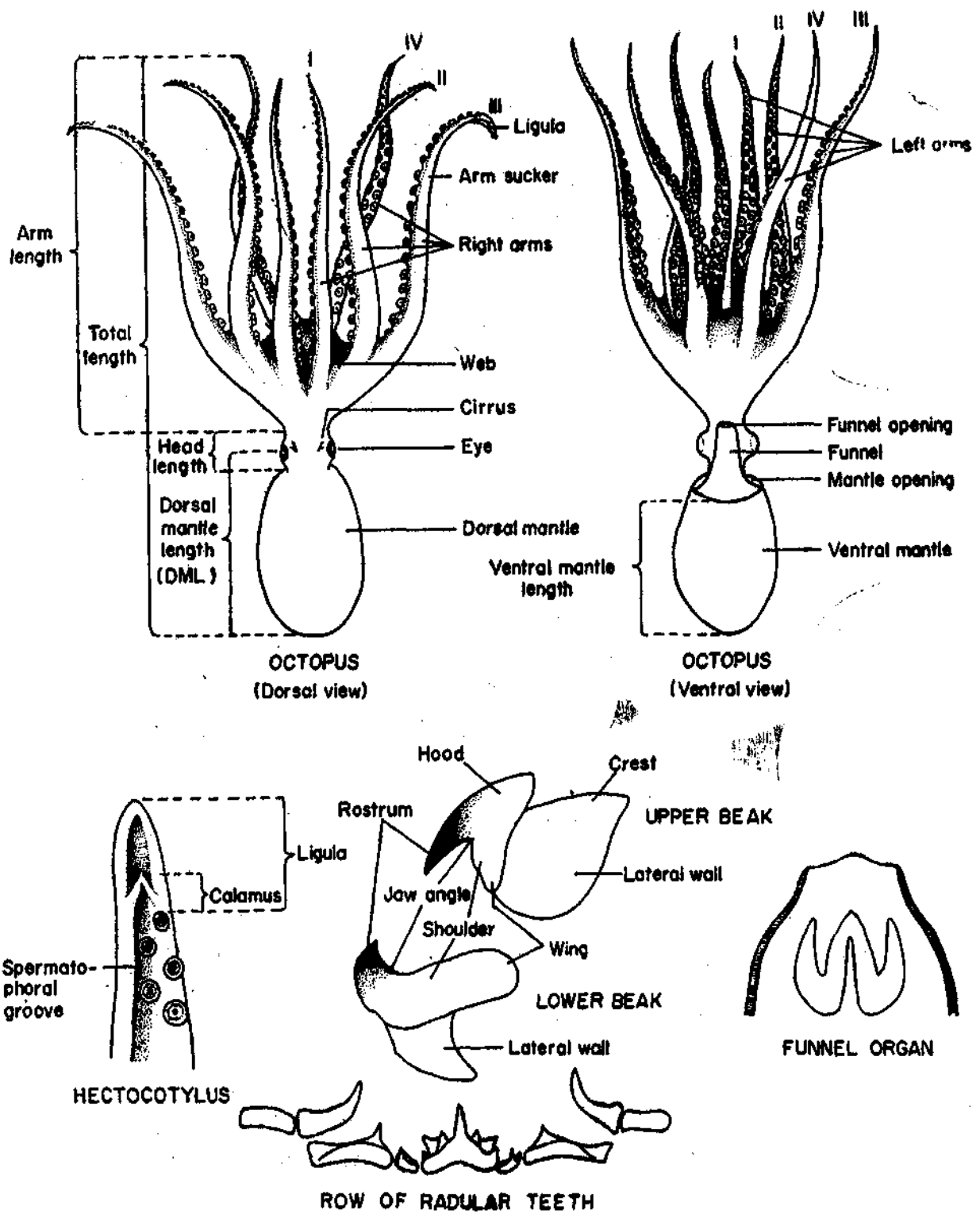


FIG. 4. Schematic drawings of an octopod showing salient characters as an aid for identification (Upper and lower beaks: From Voss and Voss, 1962).

hooks ; fin lobes fused posteriorly. Eyes either covered or open and without supplementary eyelid.

3. Order Octopoda Leach, 1818

Internal shell vestigial and cartilaginous except in females of *Argonauta* which has an external, calcified shell. Eight arms, suckers without stalks and without chitinous rings ; tentacles absent ; fins absent except in a few deep water species ; light organs absent.

ORDER SEPIOIDEA

The salient features to be examined for the identification of genera and species of cuttlefishes are as follows :

1. Cuttlebone : General shape, nature of the dorsal surface, structure of the inner cone, number and nature of grooves and ridges on the ventral side, the nature of growth lines found in the striated area and the spine.
2. Tentacular clubs : Number of transverse rows of club suckers and their relative size (diameter), the nature of protective membrane on the sides of the clubs.
3. Hectocotylization : Structure of the hectocotylized arm with regard to the modified portion, the number and arrangement of normal and modified suckers and the extent of modification of the arm.
4. Shape and disposition of fins along the mantle.
5. In some species the characteristic external colouration and colour pattern of the mantle, head and arms noticeable in fresh material.

KEY TO THE IDENTIFICATION OF GENERA AND SPECIES OF
COMMERCIALY EXPLOITED CUTTLEFISHES OF THE INDIAN
SEAS

1. Body either elongate and broad or very slender and dorsoventrally flattened ; fins marginal and narrow, extending all along mantle on either side ; internal shell (sepion) present ; head free from dorsal mantle ; light organs absent (Family : Sepiidae)..... 2
- Body saccular, wide, round bottomed ; fins circular ; internal shell lacking ; dorsal mantle and head united by a nuchal commissure ; saddle-shaped light organ present on ink sac. (Family :

Sepiolidae).....
..... *Euprymna stenodactyla*

2. Body without a glandular pore at posterior extremity ; cuttlebone mostly with a spine (rostrum) at posterior end. (Genus : *Sepia*) 3
- Body with a distinct glandular pore at posterior extremity on ventral side ; with brownish fluid oozing out ; cuttlebone devoid of spine (Genus : *Sepiella*) *Sepiella inermis*
3. Body small and narrow, broadest part of body excluding fins distinctly less than half mantle length ; fins narrow and marginal ; cuttlebone very much slender and lanceolate in shape 8
- Body wide and muscular, ovoid or elliptical in shape ; broadest part of body excluding fins equal or distinctly more than half of mantle length ; fins marginal, moderate to wide ; cuttlebone chalky, elongate, wide and nearly ovoid in shape 4
4. Tentacular clubs with suckers of unequal size, a few in the manus very much enlarged ; mantle, head and arms with transverse stripes 5
- Tentacular clubs with smaller and subequal suckers but none greatly enlarged ; no transverse stripes on mantle, head and arms 6
5. Body robust, fins broad commencing from edge of anterior mantle margin ; tentacular clubs moderately long and well expanded ; 5 or 6 suckers in middle row of manus greatly enlarged ; cuttlebone broad, thick and with a midventral groove flattening anteriorly in striated area ; striae 'A' shaped ; inner cone forms a conspicuous yellowish flat ledge ; a sharp thick spine present ; when live, body brownish, tigerstripe pattern prominent *Sepia pharaonis*

Body not robust ; fins narrow commencing a few mm behind edge of anterior mantle margin ; tentacular clubs short, expanded ; not more than 3 suckers in middle row of manus greatly enlarged ; cuttlebone narrow, midventral groove narrow and distinct, striae anteriorly broadly truncate with lateral corners slightly produced forward ; dorsal surface pinkish in colour ; a sharp thin spine present. When live, dusty brownish, transverse stripes less distinct.....
..... *Sepia prashadi*

6. Tentacular clubs very long, with 10-14 rows of minute subequal suckers. Cuttlebone broad and thick with a median longitudinal ridge with a faint groove running medially on striated area ; inner cone forms a ledge-like callosity
 *Sepia aculeata*

Tentacular clubs either short or moderately long, with 6-10 rows of small suckers. Cuttlebone thin and elliptical or acuminate in shape with or without ridges on striated area, innercone without callosity 7

7. Tentacular clubs short with 6-8 small subequal suckers. Cuttlebone flat and distinctly acuminate anteriorly, dorsal surface rugose, a shallow median groove in the striated area, the striae 'A' shaped with a median shallow groove broadening anteriorly ; inner cone and its limbs pinkish in colour ; spine small, sharp and slightly curved
 *Sepia brevimana*

Tentacular clubs moderately long, with 10 rows of small suckers of uniform size. Cuttlebone thin, elliptical in shape, dorsal surface smooth ; two conspicuous lateral ridges more prominent antieriad resulting in three longitudinal furrows in striated area ; spine thick, sharp, long and well curved *Sepia elliptica*

8. Two prominent ear-shaped fleshy projection present on head below eyes. Fins do not extend upto end of mantle ; tentacles with short and curved clubs, small subequal suckers in 5 or 6 rows. Cuttlebone lanceolate with rounded anterior tip ; spine absent and edges of cone not winged but spatulate posteriorly
 *Sepia arabica*

No fleshy projections on head ; fins extend upto end of mantle ; tentacles with short clubs, suckers in eight rows, about five in third row enlarged. Cuttlebone lanceolate with acuminate anterior tip with edges of outer cone winged giving an arrow head appearance ; spine small
 *Sepia trygonina*

Apart from the above species of cuttlefishes which are included in the key, a number of other species viz. *Sepia latimanus* Quoy and Gaimard, *S. murrayi* Adam and Rees, *S. omani* Adam and Rees, *S. kobiensts* Hoyle, *S. recurvirostra* Steenstrup, *S. savignyi* Blainville, *Sepiadartum kochii* Steenstrup, *Euprymna berryi* Sasaki and *E. morsei* (Verrill) have been recorded from the

Indian Ocean. Some more sepiids which have been reported from the fater parts of Indian Ocean viz. *Sepia apama* Gray, *S. australis* Quoy and Gaimard, *S. braggi* Verco and *S. esculenta* Hoyle are also likely to occur in Indian Seas.

ORDER TEUTHOIDEA

The various characters used in identifying the different species of neritic and oceanic squids (Order Teuthoidea) are given below. The definitions and details of important characters and terms are given in the glossary of technical terms.

1. General shape of the mantle.
2. The shape and proportion of fins, the contour of the anterior and posterior margins of the fin lobes ; position of fins on the mantle viz. terminal or marginal ; united or separated at the posterior end.
3. The relative size of head and arms ; size, shape, number and arrangement of suckers on the arms and tentacular clubs ; the nature and dentition of the chitinous rings of the suckers.
4. Presence of hooks and/or suckers on the arms and tentacular clubs.
5. Details of hectocotylyzation, the number and arrangement of normal and modified suckers and the extent of other modifications affecting the arm.
6. Presence or absence of light organs (photophores), their shape, number and position.
7. Nature of the funnel locking apparatus.
8. Presence or absence of accessory nidamental glands.
9. Shape of gladius.
10. Shape of eggs and egg clusters.

KEY TO THE IDENTIFICATION OF COMMERCIALY IMPORTANT NERITIC AND OCEANIC SQUIDS OF THE INDIAN SEAS

1. Eyes completely covered with a corneal membrane (MYOPSIDA : Neritic Squids) 2
- 2
- Eyes not covered with a corneal membrane and open to the surrounding medium (OEGOPSIDA : Oceanic squids) 7
- 7
2. Body elongate, cylindrical in outline ; fins marginal, wide and muscular, very long almost running along entire length of mantle ; elliptical in shape

- *Sepioteuthis lessoniana*
 Body elongate, narrow, either slender or stout, sides parallel or tapering; fins narrow, terminal running less than 65 per cent of mantle length and either rhombic (*Loligo*) or heart-shaped (*Lololus*) 3
3. Body elongate or short and stocky, posterior end of mantle blunt; fins broad, rhombic or heart-shaped, with head and arm crown more than 50 per cent of mantle length; vane of gladius broad with thin curved margins 4
 Body narrow and slender, posterior end of mantle pointed; head with arm crown distinctly less than 50 per cent of mantle length 6
4. Small squids, mantle length of adults less than 60 mm; fins heartshaped; vane of gladius conspicuously broad at midlength.....
 *Lololus investigatoris*
 Moderately large squids; fins typically rhomboid; vane of gladius narrow throughout 5
5. Body elongate, mid-rib of gladius not visible through mantle skin; fins 50-57 per cent of mantle length; tentacular clubs large median manal sucker ring with 14-17 teeth; in males distal half of left ventral arm hectocotylized, papillae not fused
 *Loligo duvaucelii*
 Body short and stout; mid-rib of gladius clearly visible through dorsal mantle skin as a median dark line; fins 55-65 per cent of mantle length; Tentacular clubs large median manal suckers with smooth rings; in males left ventral arm hectocotylized almost the entire arm; papillae on ventral margin fused with membrane.....
 *Loligo wyl*
6. Mantle very long and slender with a ridge along midline in males; fins wide and long and more than 60 per cent of mantle length; more than half of left ventral arm hectocotylized distally in males; gladius narrow with almost straight margins and tapering gradually to a narrow point *Doryteuthis singhalensis*
 Mantle long, narrow and slender, no ridge but chromatophore concentration ventrally along midline; fins narrow and less than 60 per cent of mantle length; less than half of left ventral

arm hectocotylized distally in males; gladius narrow, sharply acuminate posteriorly
 *Doryteuthis sibogae*

7. Oceanic squids with muscular body; head with nuchal folds on dorsal side at posterior end; rachis of gladius visible as a longitudinal ridge middorsally along the entire length of mantle; tentacular clubs with two rows of hooks, marginal suckers lacking.....
 *Onychoteuthis banksii*
 Oceanic squids with muscular body; head without nuchal folds on dorsal side at posterior end; rachis of gladius not visible through dorsal mantle; tentacular clubs without hooks 8
8. Funnel locking-cartilage '—|' shaped consisting of a narrow longitudinal groove and a short transverse groove branching from it medially (Fig.3). Fins broad and rhombus-shaped occupying nearly entire length of mantle
 *Thysanoteuthis rhombus*
 Funnel locking-cartilage '┐' shaped consisting of a vertical groove and a transverse groove at right angles to it posteriorly (Fig. 3). Fins terminal and less than 60 per cent of mantle length 9
9. Funnel and mantle cartilages of the locking apparatus fused together. An oval photophoric patch present middorsally near anterior margin of mantle; muscle of mantle ventrally without embedded light organs; two intestinal photophores present
 *Symplectoteuthis oualantensis*
 Funnel and mantle cartilages of the locking apparatus not fused. An elliptical gold coloured stripe present midventrally from mantle opening to level of fin insertion; muscle of mantle ventrally with numerous closely packed small irregularly shaped light organs, some interconnected; no intestinal photophores
 *Ommastrephes bartrami*

A number of other species of oceanic squids viz. *Ancistrocheirus lesueuri* (Orbigny) (Pl. IX C and D), *Taningia danae* Joubin, *Architeuthis* sp., *Histioteuthis dofleini* (Pfeffer), and *Todarodes eablnae* (Ball) have been reported from the Indian Ocean (Roper *et al.*, 1984). Several other species of squids such as *Loligo chinensis* Gray, *L. edulis* Hoyle, *L. forbesi* Steenstrup, *Sepioteuthis australis* Quoy and Gaimard, *Moroteuthis robsoni* Adam, *Pholidoteuthis boschmai* Adam, *Histioteuthis*

bonnellii (Ferussac) and *Nototodarus gouldi* (McCoy) are distributed in the neritic and oceanic regions of the contiguous areas of Indian Ocean. It is likely that some of these species may occur in the EEZ of India and adjacent high seas.

ORDER OCTOPODA

In the present report four genera of the family Octopodidae and one genus under the family Argonautidae are included. The majority of commercially important octopods belong to the family Octopodidae whereas *Argonauta* is a collectors item, valued for its beautifully sculptured external fragile shell popularly known as Paper Nautilus. The *Argonauta* is distributed in tropical and warm-temperate waters, living in the surface waters of the open ocean forming forage to predatory fishes such as Tunas and Billfishes (Voss and Williamson, 1971).

The systematics of the family Octopodidae have not yet been studied thoroughly and a state of uncertainty persists (Robson, 1929; Voss and Williamson, 1971; Roper *et al.*, 1984). This is also true for the Octopodidae of Indian seas and very little work has been carried out so far. It was considered that 'Morphologically this group is featureless' (Robson, 1929). However, there are certain characters which are useful in the identification of octopods :

1. The shape and sculpture of mantle such as warty, smooth and rugose.
2. The comparative lengths of arms and relative sizes of the suckers; structure and modification of the hectocotylized arm, especially the ligula.
3. General shape and structure of spermatophores.
4. Structure of the reproductive organs.
5. Gills and number of gill filaments.
6. Structure of the radula.
7. Permanent colour and colour pattern.
8. Habit and habitat.

KEY TO THE IDENTIFICATION OF IMPORTANT OCTOPODS OF THE INDIAN SEAS

1. Cephalopods with eight arms; without an external shell; internal shell either vestigial or lacking; no great disparity between males and females in size; benthic in habit (Family Octopodidae) 2
- Cephalopods with eight arms; external shell

present (in females); sexual dimorphism very marked, males very small; pelagic in habit (Family Argonautidae)..... 6

2. Right third arm in males hectocotylized with well developed ligula, calamus and spermatophoric groove; no water pores and embedded pouches between arm bases 3

Hectocotylized arm only slightly modified, ligula small about 3 per cent of arm. Small water pores leading to embedded pouches between bases of arms on oral surface *Cistopus indicus*

3. Body either globular or slightly elongate and of firm consistency; arms long and tapering with moderately developed web between them; funnel not fused with head 4

Body short and stumpy, of semi-gelatinous consistency and posteriorly rounded; arms very short with well developed web between them; funnel fused with head; ligula prominent (11 to 15 per cent of arm) and cone shaped with deep calamus and groove *Berrya keralensis*

4. Body elongated oval; moderately large in size; dorsal surface of body and arm with reticulate pattern; no concentric rings of chromatophores on the body; ligula about 5 to 10 per cent of arm; penis and diverticulum long 5

Body globular, smaller in size; skin smooth without reticulate pattern; while fresh dusty brown in colour with prominent bluish rings on mantle, head, web and arms *Hapalochlaena maculosa*

5. Eyes prominent; a single large cirrus posterior to each eye. Ligula small, 5 to 8 per cent of arm; with shallow groove; penis and diverticulum together form U-shaped loop; spermatophores long and unarmed *Octopus aegina*

Eyes inconspicuous; no eye cirrus. Ligula 8 to 10 per cent of arm; with well formed groove and calamus. Long penis and short diverticulum together form reversed 6-shape; spermatophores long and armed with spines *Octopus dollfusi*

6. Shell and aperture narrow and not inflated; compressed laterally; keel narrow with numerous sharp nodules (knobs); ribs on sides bifurcated; colour white with faint brownish markings on shell and nodules *Argonauta argo*

Shell and aperture wide and strongly inflated ; nodules prominent, rounded and widely spaced on keel ; on sides long full ribs alternate with short ribs *Argonauta hians*

In addition to the above mentioned species, some more species of octopods such as *Octopus cyaneus* Gray, *O. globosus* Appellof, *O. membranaceus* Quoy and Gaimard, *O. macropus* Risso, *O. vulgaris* Cuvier, *O. varunae* Oommen, *O. tetricus* Gould, *Beryta arnae* Oommen, *Scaevurgus unicolor* Orbigny are also known to occur in the Indian Seas and other parts of the Indian Ocean.

GLOSSARY OF TECHNICAL TERMS

While describing various species of cephalopods many scientific terms are used. As these terms are not generally very familiar, brief descriptions and explanations of the same are given here.

Aequiferous pores : A pair of small openings present on the dorsal and ventral surfaces of head at a short distance below the base of arms in *Tremoctopus*.

Anal flaps : A pair of papillae present on either side of the anterior opening of the anus.

Arms : Cephalopods possess circumoral arms or appendages arising from the head (Cephalopoda — Head footed). In Decapods (squids and cuttlefishes) there are eight such sessile arms and two long tentacles ; Octopods have only eight arms ; Nautiloids possess numerous appendages.

All arms are paired and designated as left or right arms (Figs. 2, 3 and 4). The dorsal arms are known as the first pair, the dorsolateral arms are the second pair, the ventrolateral arms are the third pair and the ventral ones are the fourth pair of arms ; they are provided with one or more rows of suckers on the oral side.

Armature : Arrangement of either or both of suckers and hooks on the arms and tentacular clubs.

Arm formula : The relative lengths of arms are expressed in 'arm formula' in order of decreasing length e.g., 2.3.4.1 to denote 2>3>4>1.

Beak : Refers to the beak-like jaws of cephalopods ; also known as mandibles or jaws ; in shape they are like a parrot's beak (Fig. 4).

Buccal lappets : Small 6-8 lobed triangular flaps of the buccal membrane (Fig. 3) which in some cephalopods bear one or more minute suckers.

Buccal membrane : Web-like membranous sheath surrounding the mouth in squids and cuttlefishes (Fig. 3). Absent in octopods.

Calcification : Deposition of calcium carbonate. Cuttlebone in cuttlefishes—chalky calcified or calcareous.

Calamus (Calimus) : A small conical projection of the extreme tip of the spermatophoral groove in the hectocotylized arm of octopods (Fig. 4). The length of calamus is the distance from the distal sucker of the arm to the tip of ligula.

Carpal clusters : A group of small suckers and fleshy knobs on the basal (carpus) portion of tentacular clubs.

Carpal knobs : Small roundish, fleshy protuberances on the carpus portion of tentacular clubs.

Carpal suckers : Cup-like small suckers on the carpus of tentacular clubs.

Carpus : Proximal portion of the clubs also known as wrist where small suckers and sometimes also knobs are present (Figs. 2 and 3).

Chitin : A horny polysaccharide material that forms the gladius, sucker rings, hooks and beaks.

Chromatophores : Contractile pigment sacs in the outer skin of cephalopods. They are under nervous control and responsible for colour, colour pattern and colour change of cephalopods.

Cirri : Small, slender, fleshy protuberances of the skin, usually over the eyes (ocular cirri) and mantle.

Corneal membrane : A thin, transparent membranous skin, covering the eyes of myopsid and sepioid cephalopods ; absent in oegopsids (Oceanic squids).

Cuttlebone : The thick chalky, calcified internal shell of cuttlefishes (Fig. 2).

Dactylus : The distal portion of tentacular clubs where usually small suckers are present (Figs. 2 and 3).

Dentition : The presence of teeth on horny rings of arm suckers.

Diverticulum : The tube-like structure posterior to the penis (mainly in octopods).

Faveola : Membranous folds or ridges of skin that form a pocket-like structure in the funnel groove found in some oegopsid squids.

Fins : The pair of muscular flaps which originate along the dorsolateral plane of the mantle and are useful in locomotion.

Fixing apparatus : Small fleshy knobs and suckers on the carpal portion of the tentacular clubs that

facilitate the two clubs to adhere during capture of prey.

Funnel : Also known as siphon is situated below the head in a groove on its ventral side. Exhalent water from the mantle cavity is pumped through the funnel.

Funnel groove : The pit-like excavation in the postero-ventral part of head in which the free portion of funnel lies.

Funnel locking apparatus : Refers to funnel and mantle locking mechanism found in squids and cuttlefishes to keep the base of the funnel and the inner mantle wall in locked-up position. This is effected by cartilaginous grooves or depressions on each side of the funnel on the posteroventral region (Fig. 3) into which corresponding cartilaginous thickenings on the inner wall of the mantle fit so that exhalent water passes through the funnel and not through the mantle opening.

Funnel organ : A glandular structure present on the inner wall of funnel; usually a 'W' or 'VV' shaped structure in octopods (Fig. 4) and an inverted V-shaped one with two oval patches on either side in decapods.

Gill lamellae : The series of elongate leaf-like folded structures of the gills (Ctenidia). They are also known as gill filaments.

Gladius : Thin, feather-like chitinous internal shell present in squids. Also known as pen (Fig. 3).

Hectocotylus : The structural modification of one of the arms in male cephalopods for transfer of spermatophores (Figs. 2, 3 and 4). Suckers, pedicels and protective membranes of the arms are modified variously in squids (Fig. 3), cuttlefish (Fig. 2) octopods (Fig. 4) and Nautilus.

Hooks : The sharp curved chitinous structures of the suckers present on the arms and or tentacular clubs in some oceanic squids.

Ink sac : A bag-like structure in which ink is produced and stored in cephalopods. The sac is located anteriorly in squids and posteriorly in cuttlefishes and octopods. In some octopods (deep sea) it is greatly reduced or absent.

Keel : The membranous extension of arms, tentacle and clubs on the aboral surface; also known as swimming membrane. In *Argonauta* keel is the narrow flattened connecting portion of the two sides of the shell.

Light organ : A specialized structure in some cephalopods that produces bioluminescence, either by

chemical action or through symbiotic bacteria. Also known as photophores and luminous organs.

Ligula : The spoon-shaped tip of the hectocotylized arm in octopods; generally its oral surface is grooved and has transverse ridges (Fig. 4).

Mantle : The muscular body wall of cephalopods that surrounds the internal organs.

Manus : Refers to the mid-portion of the tentacular club; also known as hand; usually the suckers in manus portion are larger in size (Figs. 2 and 3).

Pedicel : The conical shaped fleshy stalks of sucker-of arms and tentacular clubs in squids and cuttle fishes.

Protective membranes : The web-like membranes present on the sides of oral surface of arms and tentacular clubs which are strengthened by trabeculae.

Rachis : The thickened midaxis of gladius (Fig. 3).

Radula : The chitinous band in the buccal mass of cephalopods with several transverse rows of teeth (Fig. 4) on its surface used for rasping food.

Side pockets : The small slender fleshy ridges that form pocket-like structures on the lateral sides of faveola.

Spermatophore : A complicated tube-like structure produced by male cephalopods for storing sperms; it consists of a proximal sperm reservoir, a middle cement body and a distal ejaculatory apparatus.

Spermatophoral groove : The groove formed by the curbing of membrane of the ventral margin of the hectocotylized arm which ends in calamus in octopods. Along the groove the spermatophores are conducted to the ligula during mating.

Suckers : The muscular cup like structures on the arms and tentacular clubs; some are pedunculated i.e., placed on contractile stalks as in squids and cuttlefishes; some are sessile and directly embedded on arms as in octopods.

Sucker ring : The horny dentate rings that encircle the sucker opening in decapods (squids and cuttlefishes); the suckers of octopods have no rings.

Tentacle : Two elongate slender appendages arising by the side of the mouth and terminating in expanded clubs in squids and cuttlefishes. They are contractile and retractile into pockets at the base in between the third and fourth arms in cuttlefishes; they are only contractile in squids. Absent in octopods.

Tentacular club : The flattened and expand terminal portion of the tentacle which bears suckers, hooks or both (Figs. 2 and 3).

Trabeculae : The muscular rod-like transverse ridges which lend support to the protective membranes.

Vane : The thin, transparent lateral expansion of the gladius (Fig. 3).

Water pores : The small openings leading to internal small pouches embedded in the oral surface of each interbrachial web between the arm bases in *Cistopus*.

BRIEF DESCRIPTIONS OF EXPLOITED AND POTENTIALLY IMPORTANT CEPHALOPODS OF INDIA

CUTTLEFISHES

Sepia pharaonis Ehrenberg, 1831

(Plate I ; A-F)

This is the largest cuttlefish known from Indian seas. The body is ovoid in shape, broadest at about the middle, slightly narrow at the anterior end and narrower at the posterior part of the mantle. Body is robust with muscular mantle and fins. The latter are broad, originate from the anterior margin of the mantle opening, have a slight forward projection anteriorly and extend along the entire margin of mantle ; the fins are wider near the posterior end. On the dorsal side the skin of mantle has numerous minute granular papillae, a series of small longitudinal faint ridges along the periphery of the mantle and a narrow whitish line along the base of fins demarcating the mantle and the fins. The head is short and about as broad across the two prominent eyes as long.

The oral arms are long, subequal in length, with well developed keels and with tapering ends. Dorsal arms are the shortest and the lateral arms are much compressed. The suckers on all arms are arranged in four transverse series ; suckers in the basal rows are larger and become gradually reduced in size towards the distal end, those at the tips very minute. The buccal membrane is thick and the lappets bear minute suckers at the tips ; the dark coloured rostrum of the horny beak embedded in the buccal mass is seen in the middle.

The tentacles are moderate in length and not very much longer than the body ; the stem is thick and triangular in cross section. The tentacular clubs are broad, moderate in length being only about one fourth in dorsal mantle length ; clubs are distinctly broader than those of *Sepia aculeata* and have a broad swimming membrane the end of which reaches a little beyond the base of the club. The protective membranes on either side are narrow, extend slightly beyond carpus and not united at the base. Club suckers are unequal in size and very characteristic. Suckers of the carpus and

dactylus portions are small ; those in the middle part of manus are large in size and arranged in eight transverse series ; about six suckers in the two median series are much enlarged and prominent ; the sucker rings have wavy edge without denticulation.

The left ventral arm is hectocotylized in males ; the modified part is in the middle portion of the arm ; basally 12-14 transverse series of suckers of this arm are normal in size, the next 4-10 series have normal ventral rows of suckers but the dorsal rows of suckers are much reduced. These two rows are separated by a thick ridge with grooves across. The females are more robust than males ; in the latter the mantle is comparatively slightly narrower.

The cuttlebone is elongate, broad and oval in shape, the surface is rugose in texture and has three longitudinal faint ribs. The Chitinous outer edges are broad and yellowish brown in colour on the dorsal side of the cuttlebone.

The ventral surface has a characteristic wide, deep, longitudinal groove in the middle, running along the entire length of striated zone. The striae or growth lines are distinctly ' \wedge ' shaped. The inner cone is broad in the middle and forms a plate-like prominent callosity. The spine is short, stout and without keels.

Males attain a maximum mantle length of about 430 mm and females 330 mm (Roper *et al.*, 1984).

In fresh condition, the dorsal surface of the mantle, head and oral arms have dark brown transverse stripes. This colouration is conspicuous in adult males. The colour pattern is variable.

Sepia aculeata Orbigny, 1848

(Plate II ; A-D)

The mantle is broadly ovate in outline, width $3/5$ in length ; fins moderately broad and extend along the entire length of mantle. The head is large, about as long as wide and narrower than the mantle opening.

The oral arms are short, subequal in length in the order 3.4.2.1. The dorsal arms are rounded on the outer side, the lateral arms are keeled and the ventral ones broad at the base with strong swimming membrane. The buccal lappets bear a few minute suckers with smooth, chitinous rings. The arm suckers are uniformly arranged in four rows and bordered by protective membranes on either side. The left ventral arm in male is hectocotylized with modification at the proximal half of the arm. At the base of the arm, there are

about 12 rows of normal suckers followed by about 6 transverse rows of very minute suckers, with a pit-like excavation in the middle of the modified portion and this is distinct in adult males.

The tentacles are comparatively very long, slender and keeled on the outside; the stem is triangular in cross section. The tentacular clubs are long, about 1/3 mantle length and slender but not much expanded; beyond the base of the club the protective membranes run as two ridges on the oral side of the tentacular stem. The club suckers are minute, subequal in size and arranged in about 10-12 longitudinal series in males whereas females possess 13 or 14 series; the numerous minute suckers on the tentacular clubs give them a spongy appearance.

The cuttlebone is elongate oval in shape with granular rough dorsal surface and has three low longitudinal ribs; the chitinous margin is very narrow. The ventral surface has a slightly convex striated zone anteriorly and is concave at the posterior end where the posterior innercone has a thick, rounded ridge in contrast to the distinct plate-like form in *S. pharaonis*. On the ventral surface, in the striated zone there is a longitudinal medial ridge with a faint groove running medially; the striae are notched in the middle. The last loculus is short and its medial portion is slightly concave. Spine is small, strong and not keeled.

The maximum size recorded is 230 mm (Voss and Williamson, 1971).

The colouration of the dorsal mantle is very variable and consists of different shades of gray or brown with white spots, streaks or patches in varying patterns with numerous chromatophores.

Sepia brevimana Steenstrup, 1875

(Plate III; A-E)

The mantle is broadly ovate, its anterior margin projects prominently in the middorsal plane into a lobe which is very acuminate; the ventral anterior margin is slightly emarginate in the middle. The posterior end is also very much acuminate owing to the presence of a long and pointed spine at the extremity of the cuttlebone. The fins are narrow, originate a little posterior to the mantle margin and extending along the sides do not unite at the end. The acuminate contour of the posterior end of the mantle is distinctly seen on the ventral side. The head is as long as wide and eyes are prominent. The buccal membrane is seven lapped.

The oral arms are short, subequal and less than half the length of mantle. The arm suckers are quadriserial and small in size.

Tentacles are slender and moderate in length. Clubs are very short and bear about eight oblique rows of small suckers; enlarged suckers absent.

The cuttlebone is very distinct, thin, flat and elongately ovoid in outline. On the dorsal surface it is rough due to the presence of numerous small tubercles which form three definitive longitudinal ridges. On the ventral side, the cuttlebone is concave and a deep median groove is present in the striated zone. The striated area and the outer cone are separated laterally by a broad, smooth area on either side. The inner cone and its lateral limbs are distinctly pink coloured. The spine is long, thin and slightly keeled. The cuttlebones of male and female differ in shape. The cuttlebone of female is generally broader and more acuminate than that of male. The tubercles on the dorsal side are not prominent in the female.

The maximum size attained by this species is 95 mm.

The dorsal surface of the cuttlefish is generally dark coloured. The arms, neck region, sides and ventral surface are whitish in fresh condition.

Sepia elliptica Hoyle, 1885

(Plate IV; A-D)

The mantle is broadly ovoid in outline, stout and broad at the mantle opening, not very much tapering at the posterior end. The mid-dorsal projection, over the head inbetween the eye lobes, is sharp and prominent. The funnel is conical, short and does not reach the base of ventral arms. The head is short but broad with prominent eye lobes.

Arms are short, stout, subequal in length, about half in mantle length and have acuminate tips; the arm formula is 4.3.2.1. or 4.2.3.1. The suckers are arranged in four uniform series on all the oral arms; they are moderate in size and gradually become reduced towards the distal ends. The horny rims of the suckers are not provided with distinct teeth but marked with notches. The left ventral arm in male is hectocotilyzed. The hectocotilyzed arm is normal for one third of its length from the base and the middle third of the arm is modified with great reduction of the suckers especially the dorsal suckers. The distal portion of the arm is not affected by hectocotilyzation.

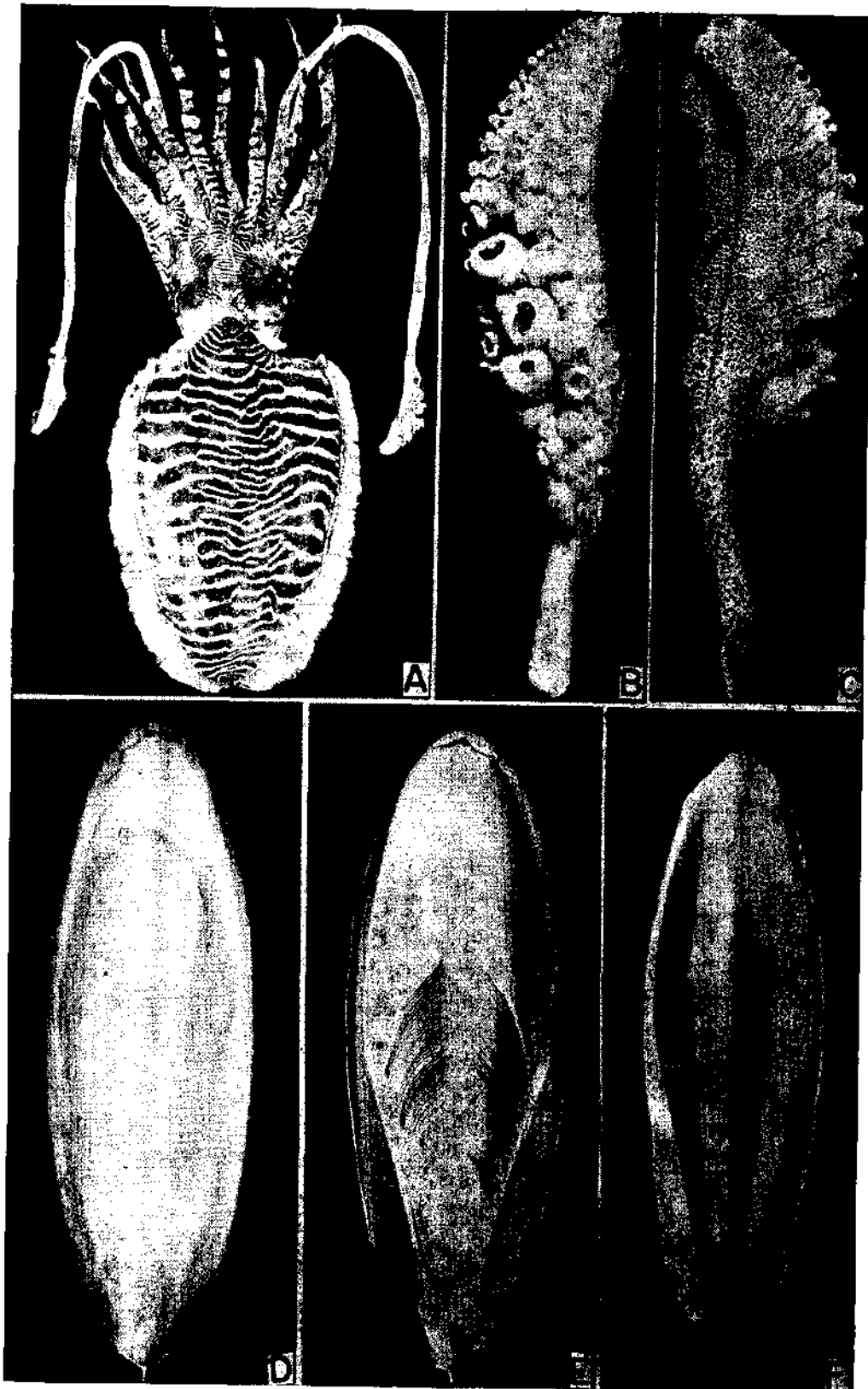


PLATE I. *Sepia pharaonis*. A. Dorsal view of male. B. Oral view of tentacular club. C. Aboral view of tentacular club. D. Dorsal view of cuttlebone (female). E. Ventral view of cuttlebone (female). F. Ventral view of cuttlebone (male).

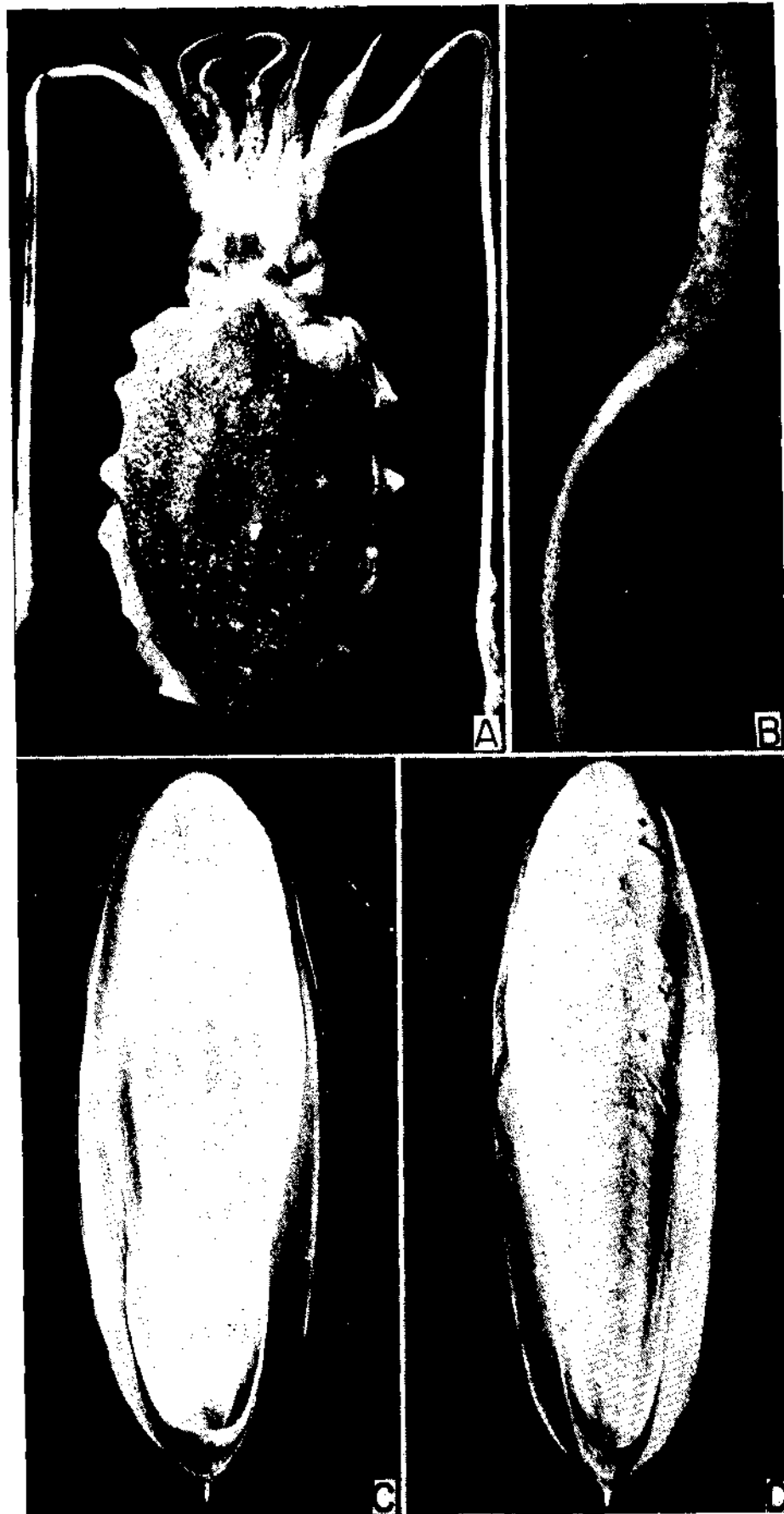


PLATE II. *Sepia aculeata*. A. Dorsal view of female. B. Tentacular club. C. Ventral view of cuttlebone (female). D. Ventral view of cuttlebone (male).

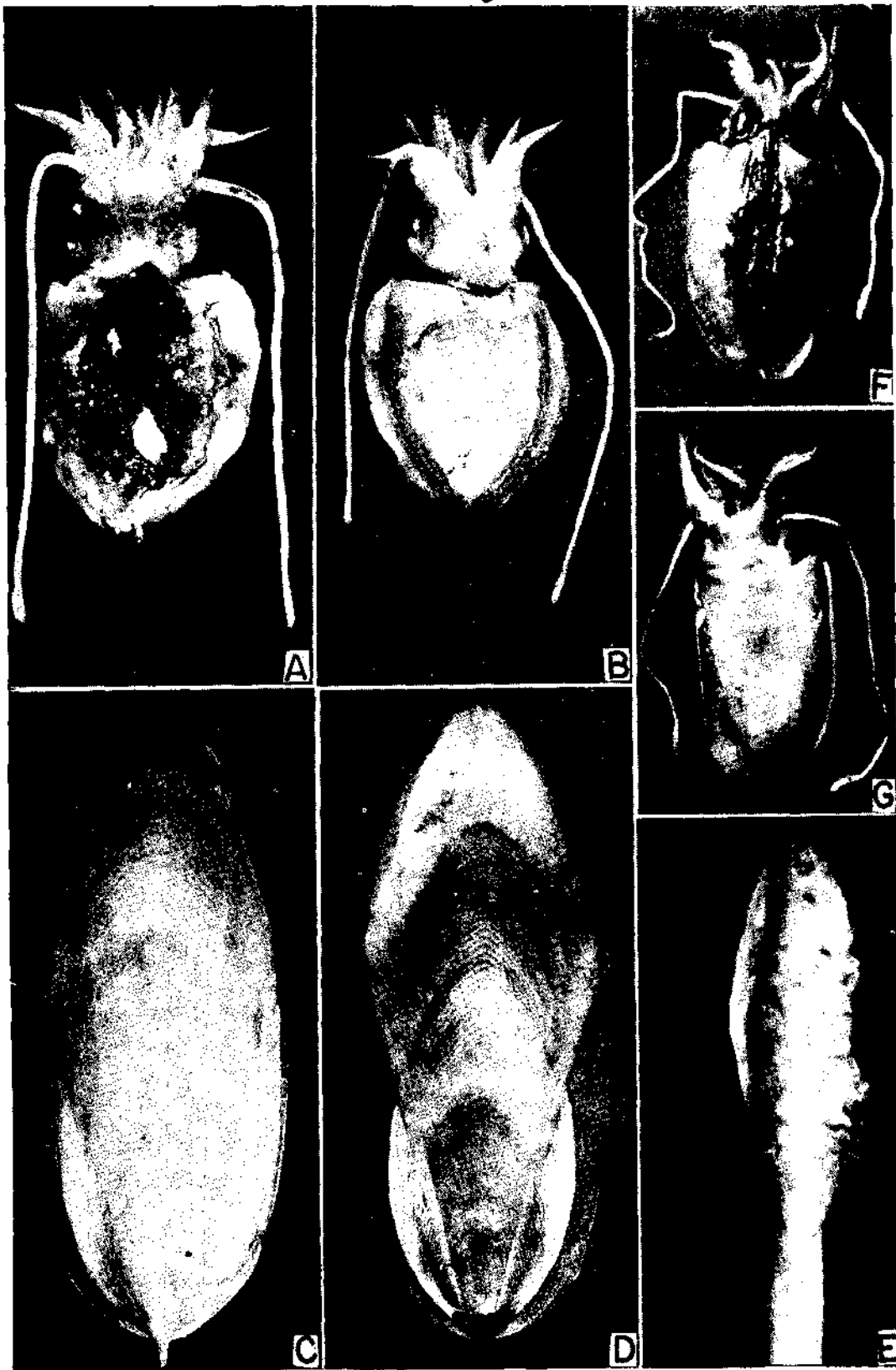


PLATE III. *Sepia brevimana*. A. Dorsal view of female. B. Ventral view of female. C. Dorsal view of cuttlebone (female). D. Ventral view of cuttlebone (female). E. Tentacular club. *Sepia trygonina*. F. Dorsal view of male. G. Ventral view male.

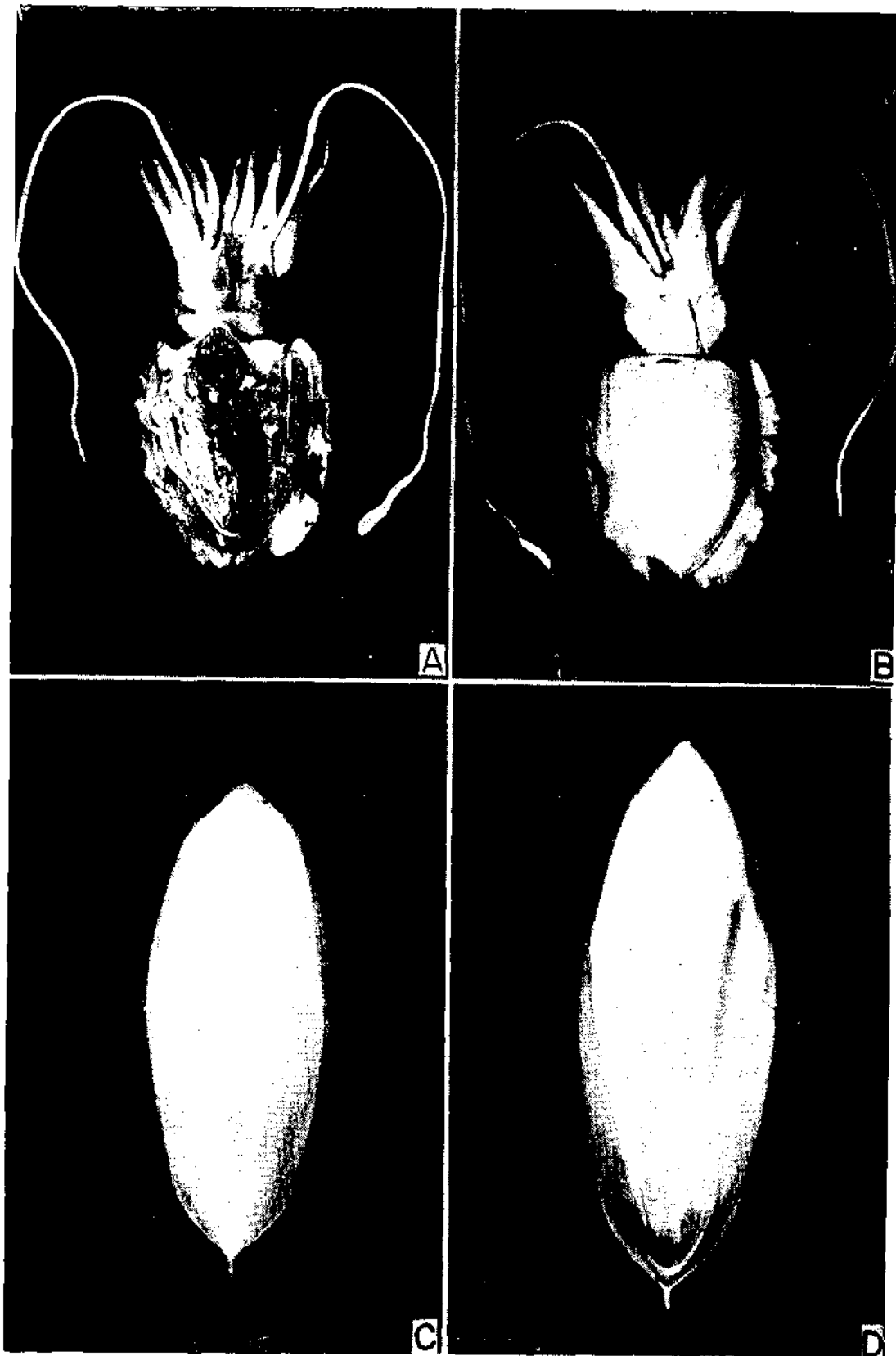


PLATE IV. *Sepia elliptica*. A. Dorsal view of female. B. Ventral view of female. C. Dorsal view of cuttlebone (female). D. Ventral view of cuttlebone (female).

The tentacles are short and about as long as mantle length ; the stem is thin and triangular in cross section ; the clubs are moderate in size, slightly expanded and bear about eight to ten rows of minute suckers of uniform size ; the protective membrane is well developed on either side and united at the base, swimming membrane is broad. The horny rings of the suckers are smooth without teeth.

The cuttlebone is broad, thick, and typically elliptical in outline. The shell is acuminate at the anterior end, more so in females, and the posterior part is slightly wide. The terminal spine is thick, sharp and curved dorsally. The dorsal surface of the cuttlebone is somewhat smooth and there are three feeble longitudinal ridges. The ventral surface has two prominent lateral ridges and three longitudinal furrows in the striated area and consequently the striae show three or more sinuations along the entire length. The last loculus is convex whereas the posterior part is hollowed.

The maximum size of males reported is 129 mm and that of females 119 mm.

The dorsal surface of mantle and head is pale greyish in fresh specimens and becomes very dark sometime after capture.

Sepia prashadi Winckworth, 1936

(Plate V ; A-E)

Body is rather slender, elongate and oval in outline; the anterodorsal margin projects strongly with well excavated sides. The fins are moderate in width, begin a short distance before the anterior mantle margin and extend along the sides. At the posterior end of the mantle they are distinctly separated. The head is rather small, as long as broad.

The arms are subequal and well tapering. The arms are provided with but narrow protective membranes. The dorsal arms are slightly keeled on the outer sides at their distal ends, the lateral arms are strongly keeled along their ventral margins, whereas the ventral ones have strong outer swimming membranes. The arm suckers are more or less globular in males and arranged quadriserially throughout the length. The outer marginal suckers of the arms are smaller in size than the inner ones in the greater proximal portion of the arms ; but at the distal tapering end, the outer suckers are slightly bigger than the inner ones except on the ventral pair of arms (Adam and Rees, 1966). The left ventral arm is distinctly hectocotylized in males. It has two groups of normal quadriserial suckers at its base. The

modified portion occupies the greater length of the arms with prominent transverse folds. The suckers are very much reduced in size, the two ventral rows of suckers are arranged very closely and it appears as though they are set in a single row. The dorsal series of suckers are larger in size in the transformed portion. There are 12 to 14 transverse rows of four suckers each on the modified portion.

The tentacles end in short and broad clubs. The stem is rounded. A strong swimming membrane is present on the dorsal side of the tentacular clubs and extends a little beyond the end of clubs ; the manus of the club is distinctly separated from the tentacles by a deep furrow under the dorsal protective membrane. The protective membranes are well developed and come very closely at the base but they do not unite. The club suckers are arranged in eight oblique transverse series. The suckers are very much unequal in size. In the middle portion of the clubs, three suckers of the third series are very much enlarged.

The cuttlebone of this species is very distinct, its dorsal surface being pinkish in colour. The cuttlebone is elongately ovoid ; the dorsal surface is rugose with granulose texture especially in the anterior region and the lateral margins of the posterior end and bears three longitudinal ridges. On the ventral side, the striated zone is rather thick and convex and has a median distinct furrow along the entire length of its ventral surface. The striations are very closely set and broadly truncated with lateral corners slightly produced forwards. There is a small, slender but strong spine at the posterior part which is slightly directed upwards.

The maximum size recorded is 140 mm (Roper *et al.*, 1984).

The general colouration is light brownish with conspicuous streaks on the surface of the dorsal mantle and base of the arms. The presence of the transverse stripes gives a 'Zebra' pattern to the animal which makes this species distinctive.

Sepia trygonina Rochebrune, 1884

(Plate III ; F and G)

Mantle is elongate and narrow, tapering posteriorly and slightly compressed dorso-ventrally. The mid-dorsal projection of the mantle is blunt and reaches the point between the eyes. Fins narrow originate a few millimetres behind the anterior margin of mantle and are separate at the end of the body. The head is

slightly wider than long. The buccal lappets are devoid of suckers. The funnel is very small and does not reach the interbrachial space between the ventral arms.

The arms are unequal in length and in the order 1.2.3.4. in the female and 1.4.3.2 in the male. The ventral and ventrolateral arms are laterally compressed and keeled. The web is absent between the ventral arms and it is rather shallow between the other arms. In males, suckers are arranged in four rows on all arms except the dorsal ones. The dorsal arms possess quadriserial suckers in the proximal two thirds of their length and biserial in the rest. In the females all the arms have quadriserial suckers in the proximal two thirds portion and biserial in the rest. The biserial suckers are minute in size and widely spaced.

The fourth left arm in male is hectocotylized. It has a single or two transverse rows of normal suckers basally. The middle one third of the arm is the modified portion where the suckers are situated wide apart. The protective membranes are well developed on the ventral and dorsal margins. The distal portion of the arm becomes abruptly slender and the narrow oral surface has four rows of minute suckers.

The tentacles are very slender and long. The clubs are very short and provided with a well developed swimming membrane extending from the proximal part to the tip of the club. The suckers of the club are arranged in seven or eight oblique rows of which five suckers of the third row are enlarged.

The cuttlebone is slender, long and lanceolate in shape; widest at the anterior third and the posterior end is more acuminate than the anterior end. The dorsal surface is finely granular and possesses a median low ridge. There is a distinct narrow groove medially which becomes shallow anteriorly and is feeble in the last loculus. The striated area is separated and elevated from the marginal zone on either side by two slender ribs of the inner cone. The spine is small and sharp. The dorsal surface of the cuttlebone is reddish in colour (Adam, 1966; Sarvesan, 1976).

This is a small sized cuttlefish with a maximum recorded size of 50 mm.

The head and mantle are pale brownish. There is a series of small, circular dark brown blotches along the fins on the dorsal surface of mantle in males.

This cuttlefish is easily recognised by its small size, very slender tentacles, short tentacular clubs and lanceolate shaped cuttlebone with a small spine at the posterior end.

Sepia arabica Massy, 1916

(Plate VI; E-G)

The mantle is narrow, elongate and slightly compressed; size small and posterior end blunt. The mid-dorsal projection of the mantle is well excavated on the sides. The head is small, narrower than the mantle opening and slightly flattened. The funnel is small and wide. Eyes are large. Two prominent ear-shaped fleshy lobe-like projections are present one on either side of the eyes, their outer surface bear bluish transverse stripes in fresh condition. Originating a few millimetres behind the anterior margin of the mantle, the fins are narrow at the anterior end and become slightly broader posteriorly; the fins do not reach the extreme posterior end of mantle. The arms are short, subequal in length and have attenuate tips; they are well compressed and consequently the sucker bearing surface is narrow; the protective membranes of the arms are broad and therefore the quadriserially arranged small suckers are covered by the membranes to a large extent; suckers on the outer rows are smaller than those on the inner rows. The interbrachial web is well developed between the lateral arms, shallow between the dorsal arms and absent between the ventral ones. The horny rings of the arm suckers are generally smooth without teeth but have a few notches (Massy, 1916).

The left ventral arm in male is hectocotylized, but the hectocotylization does not involve much modification; only the sucker bearing surface is almost completely covered by its protective membranes (Adam and Rees, 1966).

The females are slender and thin; the terminal clubs are crescent shaped; the suckers are subequal and arranged in 5 or 6 transverse rows; swimming membranes are well developed and exceed slightly the length of the clubs; the horny rings of the suckers have some minute widely spaced teeth.

The cuttlebone is long, slender, extremely narrow, rounded anteriorly and tapers posteriorly. The posterior portion of the cuttlebone is curved. The dorsal surface is granulated and possesses a broad calcareous median rib; lateral surface is chitinous and shows faint striae. On the ventral side, a longitudinal narrow groove runs along the entire length of the cuttlebone. The striae which begin as transverse lines at the posterior end deepen and are 'V' shaped at the last loculus. The striated area is separated from the outer cone by a smooth zone in between the limbs of the inner and outer cones; the former extends anteriorly to about half the length of the cuttlebone. The outer cone is narrow

and enlarged to surround the posterior part of the innercone. At the posterior end a number of sharp keeled ridges radiate from the inner cone which are united with each other with calcareous material to give a rounded spatulate shape at the posterior end. A spine is lacking.

The maximum size recorded is 67 mm.

This cuttlefish is generally brownish; the dorsal side is darkish; ventral mantle is pale; 10-12 circular purplish patches are present at the base of the fins at the posterior half of the mantle.

Septiella inermis Orbigny, 1848

(Plate VI; A-D)

This species is readily recognized by the smaller size, absence of a spine in the cuttlebone, the oval outline of the shell and the presence of a distinct glandular pore at the extreme posterior end of the mantle.

The mantle is broadly oval; the dorsal margin is angularly rounded and mid-dorsal projection is not much pronounced; the ventral margin of the mantle is emarginate; the mantle has a pigmented gland and an orifice at its posterior end ventrally. The funnel is short and thick. The fins begin slightly behind the anterior mantle margin, are narrow anteriorly and are broader posteriorly. The head is rather short and broad. The arms are stout, subequal in length, laterally compressed and tapering to slender tips. The arm suckers are uniformly minute and arranged quadriserially. The basal suckers are larger and are progressively reduced in size towards the distal end. The protective membranes of all arms are well developed. In females the arm suckers are provided with smooth rings whereas those of males have strong dentate ring.

The tentacles are very long and slender. The swimming membrane of the tentacular clubs is slightly shorter than the club. The clubs are provided with minute, subequal, numerous suckers arranged in 16 to 24 transverse rows. The clubs are long but not very much expanded.

In males the left ventral arm is hectocotylized and in its proximal half there are ten rows of minute suckers set widely apart in four rows and transverse ridges are also present. The distal half of the arm is narrow and has quadriserially arranged normal suckers.

The cuttlebone is oval in shape and without spine. The dorsal surface is granulose and has a low mid-rib and the ventral surface has wavy striae with a distinct

median narrow groove and many jointed radiating furrows on the striated area. The last loculus is short and concave. The inner cone has 'V' shaped limbs and a small thick rounded knob at the end. The outercone is broad and extends beyond the innercone and is rounded at the posterior end with a slight marginal notch on either side. The outer cone is very brittle and thin.

This is a moderate size cuttlefish with a maximum mantle length of 124 mm.

The dorsal surface of head, mantle and arms is greyish with numerous melanophores; in the fresh condition faint longitudinal stripes extending from the base of arms to their tips on the aboral side are seen. There is a row of dark ornamental ocelli on either side of the fins on the margins on the dorsal side in males.

Euprymna stenodactyla Grant, 1833

(Plate XI; D and E)

The body is saccular and bell-shaped, the mantle is broad and rounded posteriorly. The fins are semi-circular in outline and originate at the middle of the mantle on the dorsal side. There is no internal shell or gladius. The mantle and head are united by a broad dorsal commissure in the nuchal region. Excepting for this connective commissure the head is free from the mantle opening. The funnel is long and tubular and its proximal portion is completely covered by the mantle.

The arms are long, slender and subequal in length; the second pair are longest and the fourth pair shortest. The arms are keeled and the web between them is not prominent. The arm suckers are globular, have long stalks and are arranged in four rows on all arms, excepting for proximal few pairs. The suckers differ considerably in shape from those of other cephalopods and are placed on pedicles laterally. The suckers are lost easily on handling because of their delicate pedicles. Sexual dimorphism exists in size and arrangement of suckers.

The left dorsal arm is hectocotylized in males in a very characteristic form. The basal suckers in the first few rows of the hectocotylized arm are normal, and distal to these there are two fleshy papillae on the ventral margin followed by a dense group of elongate pedicles of the suckers fused together giving a palisaded effect to the dorsal portion of that arm. As a result, this makes the tip of the arm very thick.

The tentacles are short with round stem. The clubs are very short and have numerous rows of very minute

suckers crowding to give a 'swab' like appearance. A pair of saddle-shaped luminous organs are present on the inksac.

This is a small species, about 35 to 45 mm in dorsal mantle length.

While fresh the mantle is whitish with numerous dark chromatophores both on dorsal and ventral sides; the fins have a few chromatophores at the base where they are united with the mantle. In live condition these animals live with their body partly buried in the bottom and covered by sand.

SQUIDS

Loligo duvaucelii Orbigny, 1848

(Plate VII ; C and D)

The mantle is cylindrically elongate and tubular with almost parallel sides up to the point where the fins originate, then tapers to a blunt posterior point. The mid-dorsal projection of the anterior margin of mantle is rounded. The fins are small and short, 50-55 per cent of mantle length and rhombic in outline. They are broadest near the middle, the anterior margin is nearly straight or slightly convex and the posterior margin is concave. The head is small, as long as broad and slightly flattened dorsoventrally. There is a strong pit-like excavation on the ventral side in between the eye lobes to accommodate the free end of the funnel.

The oral arms are moderately long and in the order 3.2.4.1. They are laterally compressed and keeled along the length, the third pair being the broadest. The suckers of the arms are uniformly in two rows and well protected by membranes; they are provided with horny rings which bear about seven plate-like teeth on the distal margin while the proximal margin is smooth without dentition. The left ventral arm in the male is hectocotylized for over half of its distal portion. The pedicles of the suckers in the modified portion are prominent and produced into fleshy papillae-like projections. The papillae in the ventral row are larger than those in the dorsal row. The proximal rows are provided with greatly reduced minute suckers, and the distal papillae are devoid of suckers. Inside the mantle cavity near the rectum the ink sac possesses two small ovoid light organs on each side.

The tentacles are slender and long with expanded clubs. Club suckers are arranged in four rows; the suckers on the manus of the club are largest, the median ones being much more enlarged than the marginal

ones. The large manus suckers bear about 14-17 pointed teeth on the rings.

A maximum size of 290 mm has been reported for this species.

In fresh condition immediately upon capture the squid is colourless and mantle transparent showing the internal visceral organs. There are numerous light brown chromatophores scattered all over the mantle, fins, head and arms. On the ventral side chromatophores are less dense and appear whitish.

Loligo uyli Wakiya and Ishikawa, 1921

(Plate VII ; A and B)

The body is short and stout with the posterior end bluntly pointed. Females are larger than males; The fins are rhombic in shape, their length 55-65 per cent of mantle length and angles are rounded. The midrib of gladius shows distinctly through the dorsal mantle skin along the anterior part as in *Loliolus* spp. Comparatively the head is longer than in other *Loligo* spp. The head is large, eyes prominent; the arm crown is conspicuously large and more than half of mantle length.

The oral arms are in the order 3.4.2.1 with the ventral arms by far conspicuously longer and robust. The dorsal arms are distinctly shorter than others. The arm suckers are globular and arranged biserially on all the arms of both male and female. The suckers of the third arm pair are more globular and bigger among arm suckers. The large suckers of this arm have four very broad plate-like teeth on the distal margin of the horny rings. The proximal margin of the rings are smooth without dentition.

The left ventral arm is hectocotylized in males. It is not the usual type that is found in *Loligo* but is similar to that of *Loliolus*. The distal portion of the arm remains unmodified whereas the proximal portion is involved in the modification. The ventral row of the arm bears several papillae fused together with the protective membrane to form a single sheath-like crest, gradually which decreases in width distally. On the dorsal side the row consists of normal conical papillae with minute suckers separated from each other. The top of the crest also bears reduced suckers.

The tentacles are slender, more than twice the length of mantle. tentacular clubs are distinct, long, slightly expanded and lanceolate in shape; club has quadri-serial suckers throughout; about eight suckers in the manus are much enlarged; club suckers have smooth rings.

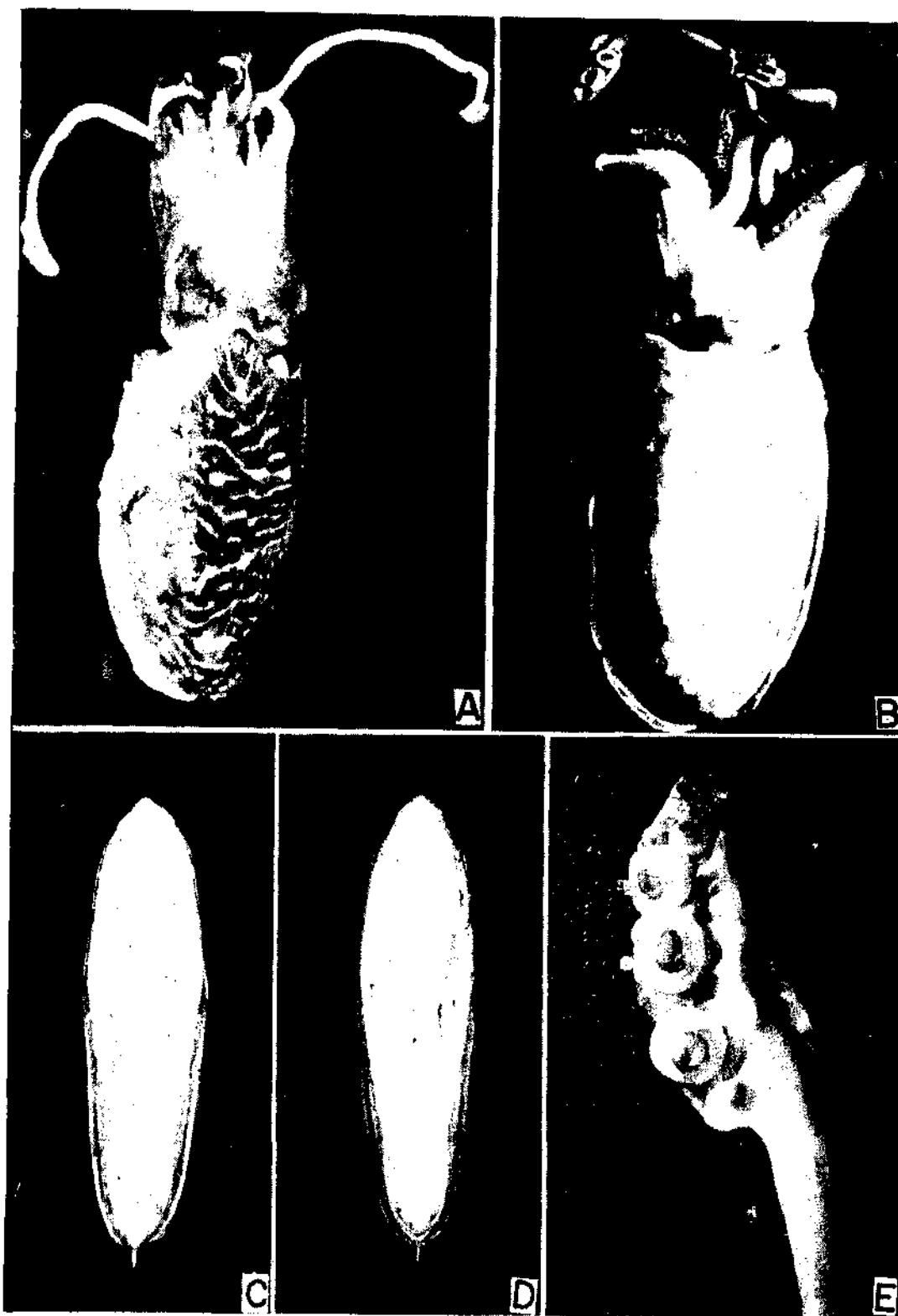


PLATE V. *Sepia prashadi*. A. Dorsal view of female. B. Ventral view of female. C. Dorsal view of cuttlebone (male). D. Ventral view of cuttlebone (male). E. Tentacular club.

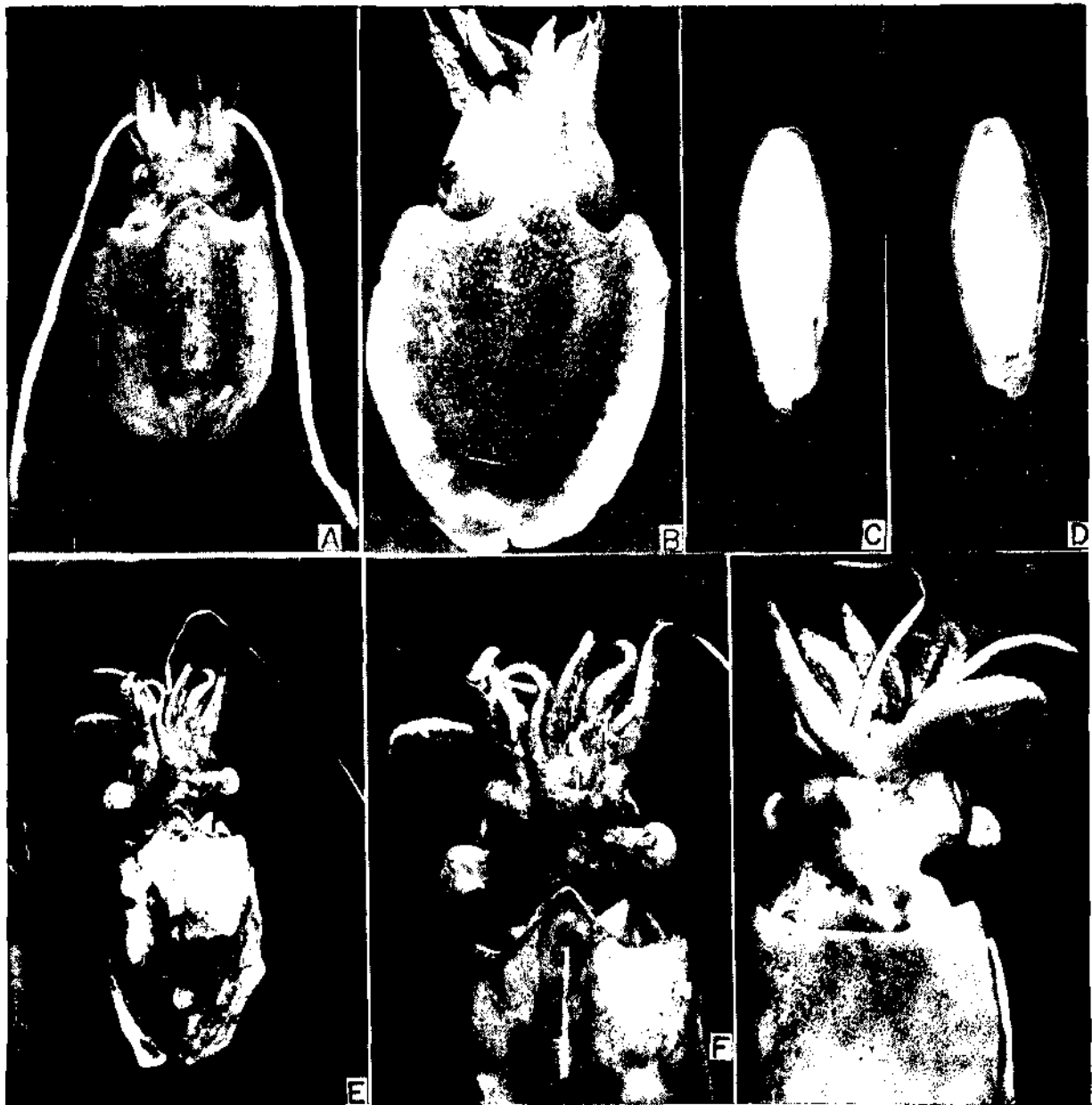


PLATE VI. *Sepiella inermis*. A. Dorsal view of female. B. Dorsal view of juvenile (male). C. Dorsal view of cuttlebone (female). D. Ventral view of cuttlebone (female). *Sepia arabica*. E. Dorsal view. F. Dorsal view of head G. Ventral view of head.

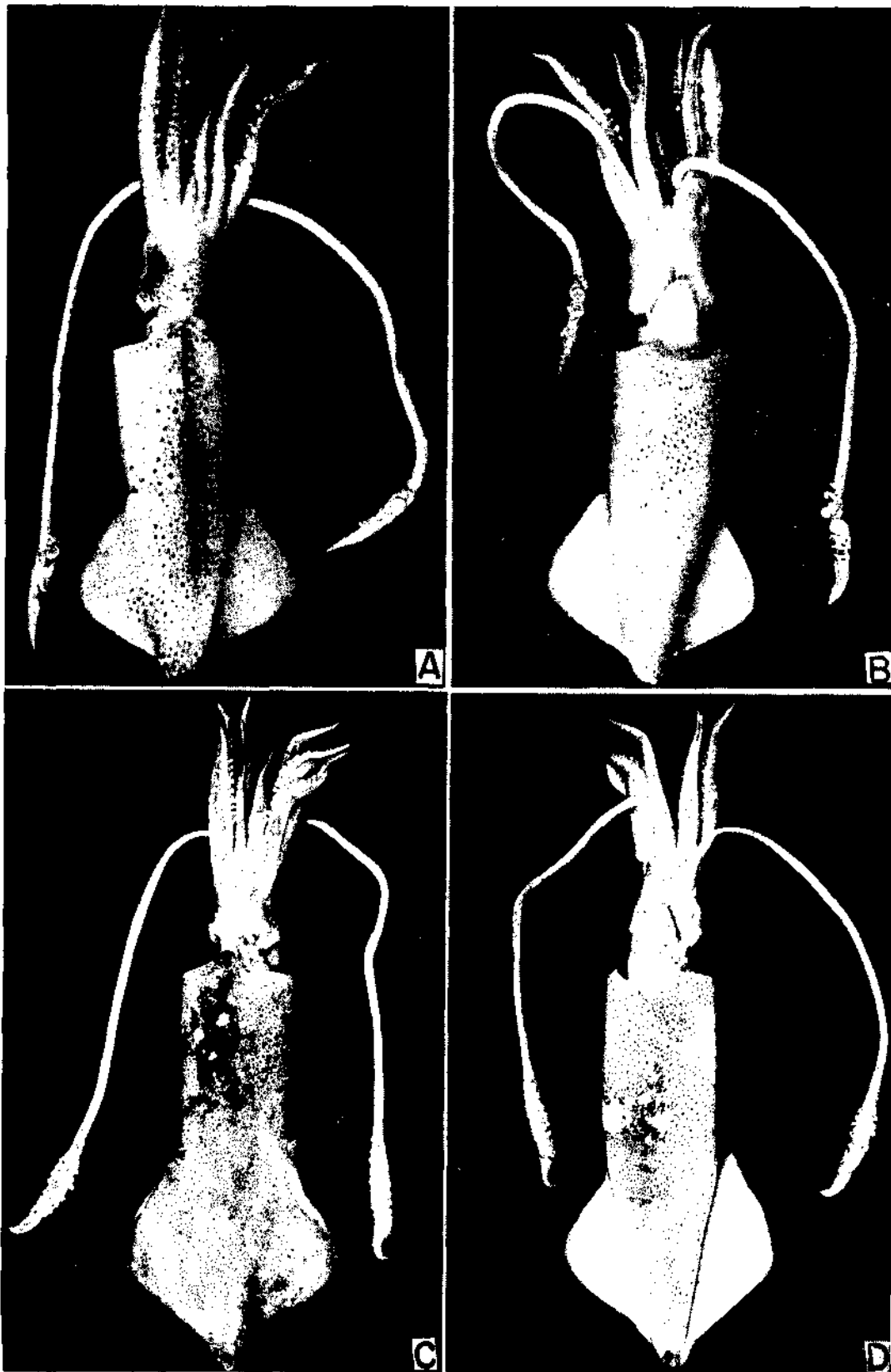


PLATE VII. *Loligo uyii*. A. Dorsal view of female. B. Ventral view of female. *Loligo duvaucelii*. C. Dorsal view of male. D. Ventral view of male.

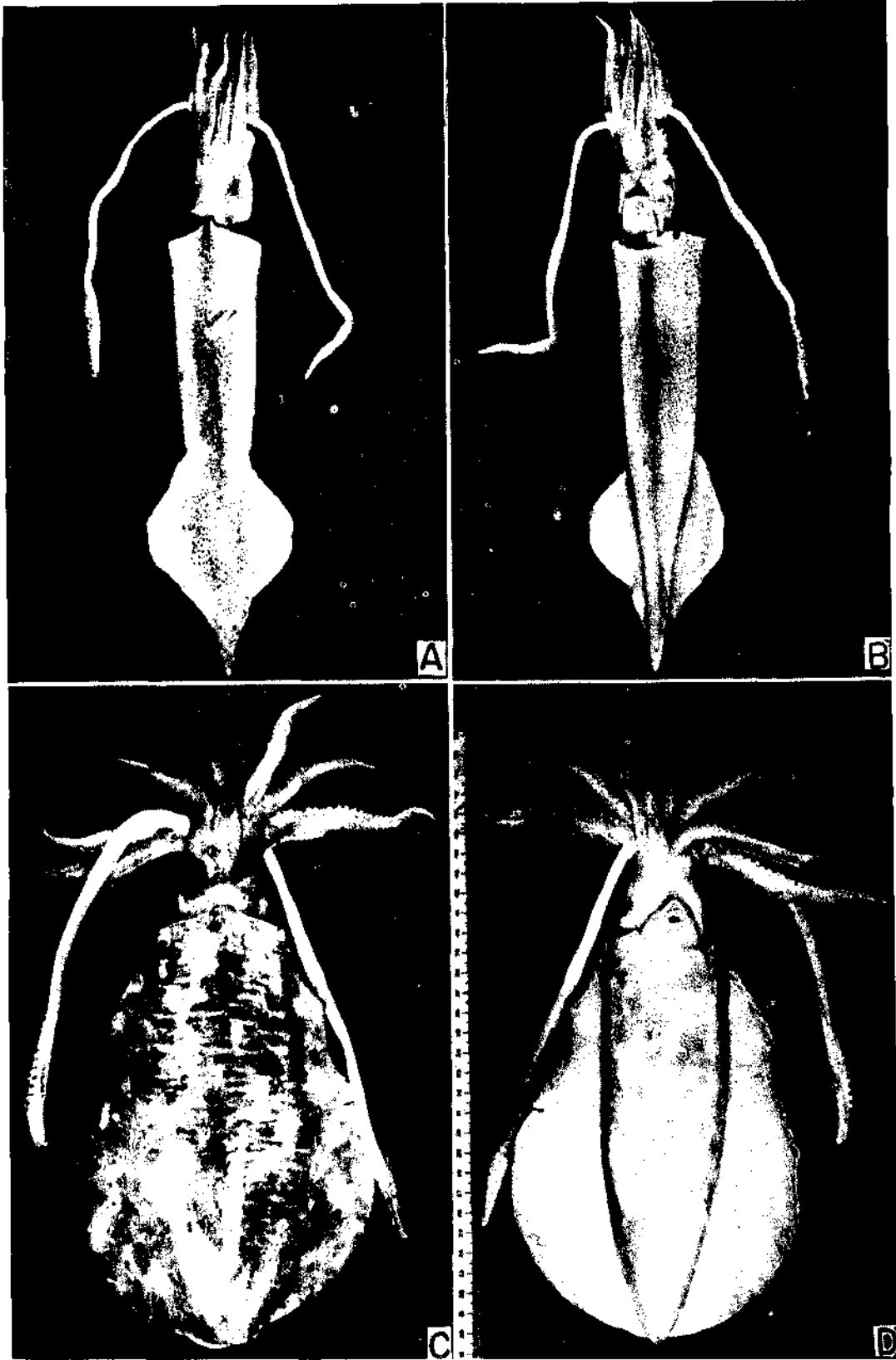


PLATE VIII *Doryteuthis sibogae*. A. Dorsal view of male. B. Ventral view of male. *Sepioteuthis lessoniana*. C. Dorsal view of male. D. Ventral view of male.

The maximum size reported for males and females of this species is 81 mm and 113 mm respectively (Natsukari, 1983).

In fresh condition, the mantle, head and fins are pale whitish with a large number of chromatophores.

Doryteuthis singhalensis (Ortmann, 1891)

Mantle long, thick, muscular and narrow tapering posteriorly to a sharp end. The anterior middorsal projection is rounded at the tip. The ventral margin is emarginated at the middle. Fins large and rhombic in shape extending along more than 60 per cent of the length of the mantle. They are widest at about the middle; the anterior margin of fin lobes is slightly convex and the posterior margins are concave. Head relatively small, eyes large. The buccal membrane has seven projections and each possess about eight minute suckers. The funnel is small, stout and placed in a deep furrow beneath the head.

Arms are rather short 20 to 30 per cent of the mantle and in the order 3.4.2.1 or 3.2.4.1. The third pair of arms are longer and stout, well compressed and have poorly developed swimming membrane; the protective membrane on either side is well developed. The horny rings of the larger arm suckers bear on the distal side 6 to 11 slender teeth; the proximal side is smooth (Okutani, 1970).

The distal half of the left ventral arm of males is hectocotylized and the proximal portion of the arm bears about fifteen pairs of normal suckers which are more or less equal in size but smaller than those on other arms. The pedicels of the suckers in the modified distal portion are fleshy and enlarged and those on the ventral row are greatly enlarged. The pedicels in the modified portion bear minute suckers without horny rings.

The tentacles are moderately long, slender and compressed. The clubs are short and slightly expanded with a trabeculate protective membrane on either side. The club suckers are arranged in four rows; those on the two median rows are slightly larger than the lateral suckers. The rings of the suckers bear about 20-22 sharp curved teeth. The teeth are not of uniform size; a few of them are smaller and arranged alternately with long curved teeth. An oval shaped light organ is present on either side of the rectum (Okutani, 1971). The gladius is narrow with nearly straight margins gradually tapering to a point.

The maximum mantle length recorded for this species is 50 cm in males and 31 cm in females (Roper *et al.*, 1984).

Doryteuthis sibogae Adam, 1954

(Plate VIII; A and B)

The mantle is long and slender, widest at about the middle; from the point of insertion of fins it becomes narrow and tapers to a sharp end posteriorly. The middorsal projection of the mantle is pointed anteriorly; the corresponding ventral margin of mantle is emarginated. A distinct longitudinal concentration of chromatophores is present midventrally on the mantle. Excepting for this there is no ridge present on the ventral side. Such concentration of chromatophores is distinct only in males and is feeble in females. There are a pair of light organs on the ink sac far behind the anal flaps. The fins are typically rhombic in shape, occupying less than half of the mantle length. Head is very small, slightly longer than wide; eyes are large. The funnel is short with the anterior free portion reaching upto the anterior margin of the eyes. The funnel furrow is deep.

The arms are short, usually in the order 3.4.2.1. All arms are keeled and slightly compressed. The aboral keels on the ventro-lateral arms are well developed in the form of swimming membrane. Suckers are arranged in two rows on all the arms and bordered by protective membranes. The horny ring of the largest arm sucker has 5-9 blunt, squarish teeth on the distal half, whereas the proximal half of the ring is either smooth or wavy edged.

The left ventral arm in males is hectocotylized. It is longer than the corresponding arm on the right side and possesses 15-19 normal suckers at the base; distal to these suckers are 20-22 fleshy, conical pedicels arranged in two rows along the margins of the arm, gradually reducing in size anteriorly and becoming very minute at the tip.

The tentacles are slender and moderate in length; the clubs are only slightly expanded with feebly developed swimming membrane. The club suckers are arranged quadriserially, the lateral ones being smaller in size than the median row suckers in the manus portion. The chitinous rings of the large club suckers bear 22-26 sharp, curved and conical teeth on the margin; the teeth on the distal margin are slightly larger than the others. Larger males tend to have about 31-35 such teeth on the club sucker rings. The suckers of the arms and club are generally moderate in size and the largest sucker of arm III and the largest club sucker are almost of the same size. There are seven lappets on the buccal membrane each lappet having 5-11 minute suckers.

The vane of the gladius is broad at the anterior region but tapers to a sharp posterior end with straight margins. The gladius of females is slightly wider than that of males. There are five ribs on the gladius, one median and two lateral ribs extending along the whole length of the gladius including the rachis, the two marginal ribs extending from the vane to the posterior slender tip.

The maximum size recorded for this species is 205 mm in males and 165 mm in females (Silas *et al.*, 1982).

In fresh condition, the mantle is whitish with dark brownish chromatophores on the dorsal side. On the ventral side the chromatophores are concentrated medially in the form of a thin line. Eyes are dark in colour.

Seploteuthis lessoniana Lesson, 1830

(Plate VIII ; C and D)

The mantle is elongate, conico-cylindrical and tapering to a rounded blunt point posteriorly. Antero-dorsally the mantle extends over the neck region as a small rounded point; the ventral margin at mantle opening is emarginated. The fins are characteristically very large and wide, extending from the anterior margin of mantle to the posterior end. Anteriorly at the beginning, the fins are narrow but gradually broaden behind, broadest at about the posterior third of the body beyond which they narrow down rapidly and unite with each other at the posterior end. The fins are very thick and muscular. The head is large, eyes prominent and greenish at the base, funnel is large and provided with prominent funnel valve. The arms are unequal in length in the order 3.4.2.1, the second and third pairs prominently keeled; suckers of all the arms are arranged in two alternating rows; the horny rings of the suckers are provided with blunt squarish teeth on the proximal margin and sharp conical teeth on the distal margin. There are about 20 such teeth on the smaller suckers and 23 teeth on large suckers of the arms.

The left ventral arm is hectocotylized in males. At the base upto 20 pairs the suckers are normal; in the next 6 pairs the pedicels are thick and prominent with minute suckers; in the remaining portion of the arm upto tip, only the pedicels are present. The pedicels on the dorsal margin are slightly larger than those on the ventral row.

The tentacles are moderate in length and the stalks are stout and slightly laterally compressed; clubs are

large and provided with trabeculate protective membranes on the sides. Suckers arranged in four rows transversely, those in the middle rows are larger than the lateral ones; horny rings of large club suckers have 14 to 23 teeth as in arm suckers.

The gladius is lanceolate and colourless in fresh condition.

The largest size recorded is 36 cm for males and 30 cm for females (Voss and Williamson, 1971).

The colour of the animal on dorsal side is darkish due to crowding of chromatophores, the ventral side is less pigmented. The general colouration in fresh specimens is pinkish brown, with whitish ventral side, the base of the eyes and the surroundings have a greenish tinge. On the dorsal surface of the mantle and fins greyish transverse streaks are found which are conspicuous in males.

Lololus investigatoris Goodrich, 1886

The body is conical in shape with the greatest width at about the middle. The adult females are always a little larger in size and relatively broader than males. The mantle is small and is rounded posteriorly. The anterior margin of mantle is produced into a small lobe middorsally as in other loliginids. The midrib of gladius is seen clearly through the skin middorsally in the anterior part of mantle. The fins are large and broad and extend along more than 70 per cent of the mantle length; their anterior and lateral margins are rounded and the two fin lobes together are heart shaped. The fins of females are broader than in males. The head is small, as long as wide but narrower than the mantle width.

The arms are rather short and subequal in length. The arms of males are slightly larger than those of females. The first and third pairs of arms are well-compressed laterally whereas the second and fourth pairs are less compressed. The arm suckers are globular and arranged in two series and the sucker rings are provided with 3 or 4 teeth. Those on the lateral arms are slightly larger than the suckers of other arms. In males, the suckers on the ventral row of the lateral arms are distinctly larger than the dorsal ones.

The left ventral arm is hectocotylized in males; the hectocotylization differs from that in *Loligo* spp. The distal portion of the modified arm is devoid of normal suckers and there are several ridges along the edge which gives it corrugated appearance. The protective membrane in the region is well developed.

On the dorsal margin, the membrane is very narrow and has several small papillae.

The tentacles are short and very thin and end in narrow clubs which have small, subequal suckers arranged in four rows. The median suckers of the manus are larger in size than the peripheral ones. The gladius is short and the vane is conspicuously broad at midlength.

The maximum mantle length of females is 55 mm.

The body is colourless and transparent when fresh. On preservation the mantle becomes somewhat whitish with diffused chromatophores pale brown in colour and distributed all over the body. The midrib of gladius on the anterior dorsal mantle is seen as a dark brown line.

Onychoteuthis banksii (Leach, 1817)

Body muscular, long, cylindrical and tapering gradually to an acuminate posterior tip; greatest width about one fourth the length of mantle. Head slightly flattened dorsoventrally; the nuchal area around the neck with 9 or 10 conspicuous elongate folds. Eyes are large with wide eye-opening, a large patch-like photophore present on the ventral surface of each eye. Fins thick and muscular, sagittate in shape and distinctly wider than long, fin length being about 60 per cent of mantle length; fin angle at the posterior end about 50°. Arms are moderately long, the lateral arms are longer and about half in mantle length; suckers are arranged in two rows.

Tentacles are about as long as mantle; clubs not expanded and possess a fixing apparatus consisting of about 20 small fleshy cup-like suckers and pads at the base; the rest of the portion is armed with 12-23 large and strong chitinous curved hooks arranged in two rows; the lateral rows of suckers are lacking; hooks of the manus portion on the ventral margin well developed and larger; other hooks reduced in size anteriorly and posteriorly. Lateral rows of suckers are lacking.

The rachidian ridge of gladius visible as a conspicuous dark-brown line through the skin along middorsal mantle surface. Two large oval-shaped light organs are present on the ventral side of intestine along its midline.

The bite of this squid is reported to be toxic and likened to the sting of a wasp in its effect (Roper *et al.*, 1984).

The maximum size recorded for this species is 30 cm (Roper *et al.*, 1984).

Ommastrephes bartrami Lesueur, 1821

Mantle nearly cylindrical and muscular; sides parallel upto origin of fins then tapers gradually to a posterior blunt point. Head is long, as wide as mantle opening and slightly tapering from base to the point of origin of oral arms. Funnel is short, heavy and muscular; funnel pit deeply excavated; faveola with six or seven longitudinal ridges and on either side of this three or four secondary pockets present. Mantle-funnel locking cartilages are free and not fused. An elliptical golden stripe present along the midventral line from mantle opening to the point of fin insertion. Fins transversely rhombic in shape with a fin angle of 55-60°; the anterior margins of fin lobes slightly convex and the posterior margins slightly concave; fins wider than long.

Arms are subequal in length, the first pair being always the shortest; ventro-lateral arms thickest with well developed swimming membrane. Protective membrane well developed with strong trabuculae on all arms; the dorsal membrane is wider than the ventral one. Large arm suckers bear several flattish teeth on their chitinous rings. In males either the left or right arm is hectocotylized in the distal half. Tentacles moderate and about as long as mantle in length. A fixing apparatus is present consisting of 2-4 knobs on the dorsal edge at the base of clubs; clubs elongate and slightly expanded in the middle; suckers are arranged in four rows; suckers on the median two rows in manus are larger than the lateral ones; the chitinous rings of these large suckers bear four sharp prominent teeth, one in each quadrant interspaced with five or more small teeth. Dentition on the rings similar to that of *Symplectoteuthis oualaniensis*. Ventral side of mantle with numerous closely packed small irregularly shaped and interconnected light organs; patches of such light organs are also present on the ventral surface of head.

Maximum size reported is about 50 cm in mantle length in females and 32 cm in males (Roper *et al.*, 1984).

Symplectoteuthis oualaniensis (Lesson, 1830)

(Plate IX; A and B)

The mantle is long, muscular and cylindrical upto the point of origin of fins and tapers abruptly to a narrow point at the posterior end. The dorsal margin is slightly produced in the middle. The fins are short, muscular and broad with convex anterior margin and from an angle of about 65° laterally. The head is large and as wide as mantle and bears comparatively short arms. The funnel is short, compact and set in a

deep pit present on the ventral side of the head ; faveola with 7 to 9 longitudinal folds in the central pocket and 3 to 5 lateral pockets on either side. Funnel locking apparatus is ' L ' shaped and fused in its middle portion with the mantle groove so that separating the funnel free from mantle-lock is difficult.

The arms are large, strong in the order 3.2.4.1 and compressed with the third pair strongly keeled. Arm suckers are biserial ; the protecting membranes have prominent trabeculae ; the larger arm suckers are provided with about 12 sharp teeth around the entire rim of the horny rings.

The left ventral arm in males is thicker and longer than the right ventral arm and hectocotylized. About one half of its distal part is devoid of suckers and papillae. In the basal portion of the hectocotylized arm 14 or 15 suckers are present in two rows protected by flap-like membranes. There is a series of pits in a single row along the base of the protective membranes (Voss and Williamson, 1971).

The tentacles are short and muscular and laterally compressed. The clubs are small and slightly expanded ; the suckers are quadriserial with the inner rows on the manus larger. The larger suckers of the club bear about 20 sharp teeth on the rims of which four are larger and located one in each quadrant. An oval photophoric patch is present on the anterodorsal surface of mantle ; there are also two photophores on the intestine.

This is a large species of oceanic squid attaining a size of 35 cm (Roper *et al.*, 1984).

The head, dorsal mantle, fins and arms are uniformly of chestnut brown colour.

***Thysanoteuthis rhombus* Troschel, 1857**

The epipelagic oceanic species is a very large and muscular bodied squid. Mantle is thick cylindrical, wide anteriorly and gradually tapering to a blunt end posteriorly. The fins are long and occupy the entire length of the mantle along the sides ; shape of the fin is characteristically rhombic being very broad at the middle. The head is short and nearly as long as wide. Eyes are prominent. The oral arms are long with broad cirrate trabeculate protective membranes. Suckers arranged in two rows ; sucker rings possess 20-26 sharp teeth. The funnel mantle locking apparatus is typical ; the funnel cartilage is ' -| ' shaped consisting of an elongate and narrow longitudinal groove and a short and broad transverse groove emerging from the middle part (Fig. 3).

The tentacles are rather weak and the clubs are slightly expanded in the middle. The suckers are small arranged in four rows, and carpus extended ; sucker rings with 15-20 fine teeth.

The maximum size reported is about 100 cm in mantle length (Roper *et al.*, 1984).

OCTOPODS

***Octopus dollfusi* Robson, 1928**

(Plate X ; D)

The mantle is elongately oval in shape, head small, eyes well developed but not conspicuous, there are no cirri over the eyes.

The arms are moderately long, subequal and stout at their base ; the first pair of arms are shortest. The interbrachial membrane is well developed between all the arms except in between the first pair where it is narrow. The arm suckers are cup-like and fleshy without chitinous rings and are directly set on the arms uniformly in two alternating rows. The normal suckers are large at the base, become smaller progressively along the length of arms and minute at the tips. There are a few slightly enlarged suckers at the base of the second and third arms in males.

In males the third right arm is hectocotylized. This arm is slightly shorter in length than the left third arm, the ventral margin of the web is rolled into the form of a deep groove which serves as the spermatophore groove and extends upto the ligula. The ligula and calamus are well developed and the former is about 8-10 per cent of the arm. There are eight or nine lamellae in each demibranch of the gills. One of the characteristic anatomical features of this species is that the male reproductive system consists of an elongate and slender penis and a large coiled diverticulum together forming a reverse 6-shaped structure. The spermatophores are moderately long and distinctly armed with a series of teeth-like cirri.

This is a moderate size octopod with a maximum mantle length of 9 cm (Voss and Williamson, 1971).

The body and arms are of light greyish brown colour with a reticulate pattern all over the body.

***Octopus aegina* Gray, 1849**

Mantle rounded to elongately oval in shape and closely covered with small tubercles or fine papillae and fine reticulate pattern on the dorsal surface. Head is small with a narrow neck region. Eyes are prominent

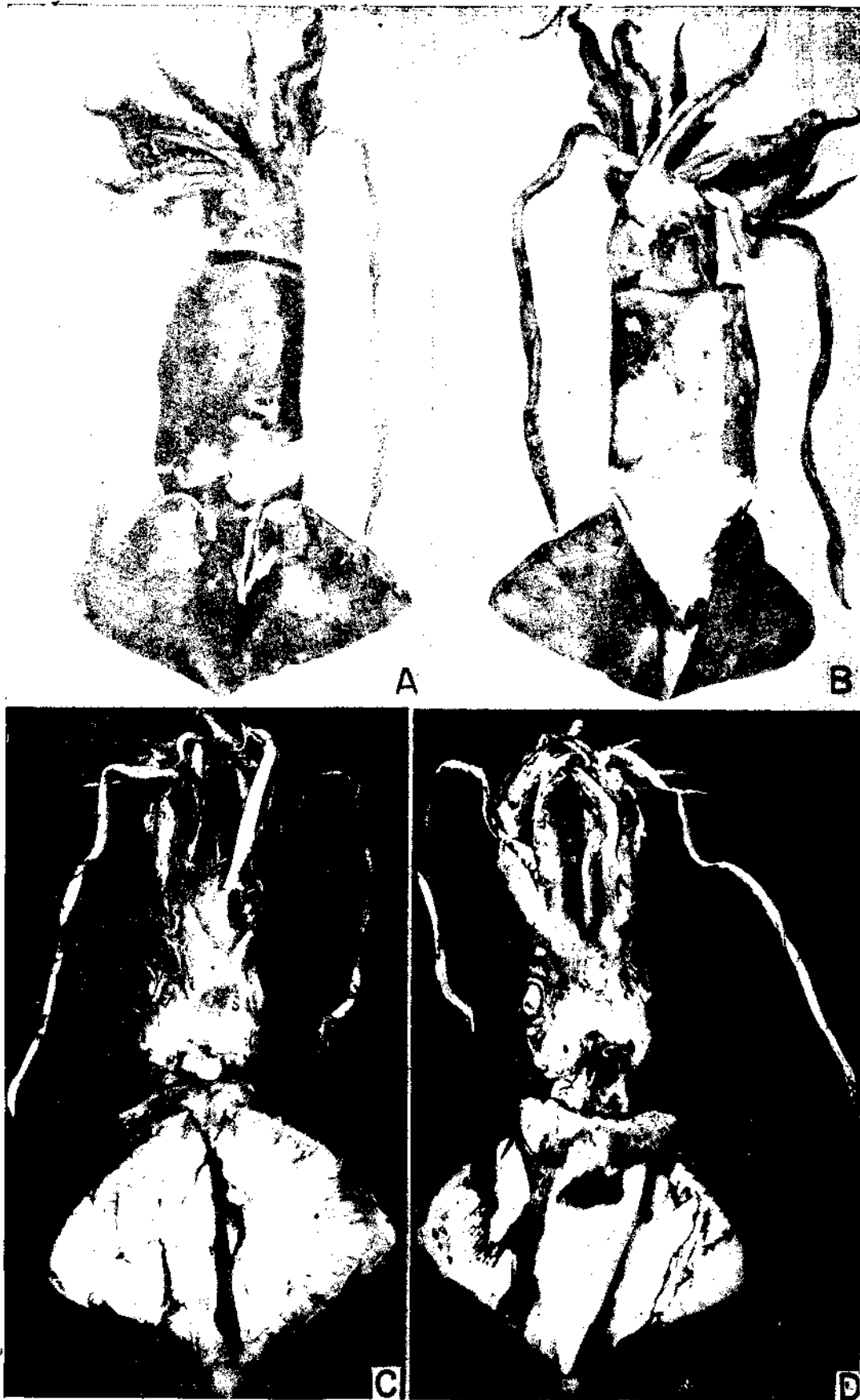


PLATE IX. *Symplectoteuthis oualaniensis*, caught off Rameswaram in drift gill net. A. Dorsal view of female. B. Ventral view of female. *Ancistrocheirus leueuri* caught by FORV SAGAR SAMPADA in pelagic trawl net at $13^{\circ}26,7'N$ $69^{\circ}28,2'E$ on 16th February 1985. : C. Dorsal view: D. Ventral view.

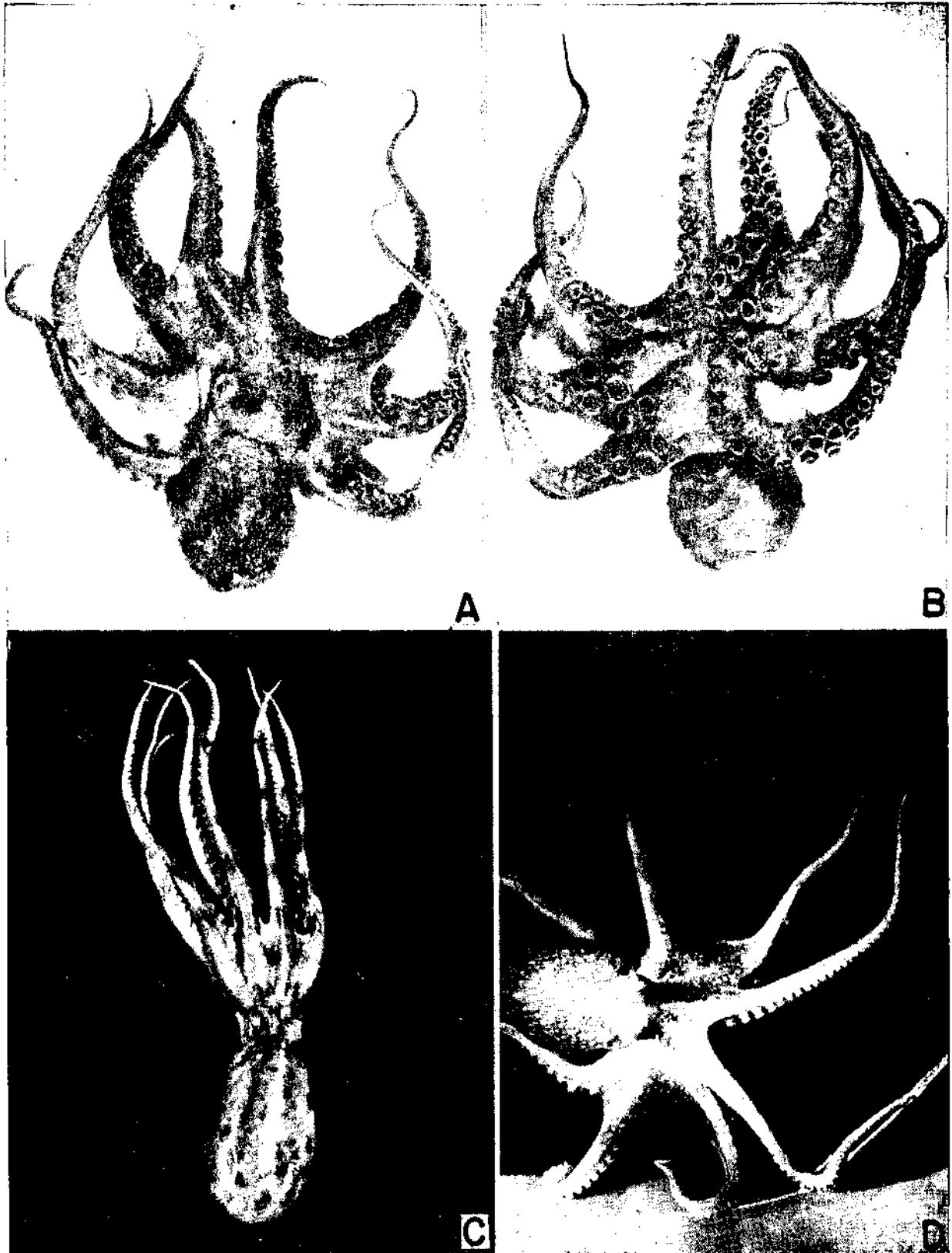


PLATE X. *Octopus globosus*. A. Dorsal view of male. B. Ventral view of male. *Hapalochlaena maculosa*. C. Dorsal view of female. *Octopus dollfusi*. D. Dorsal view of female.

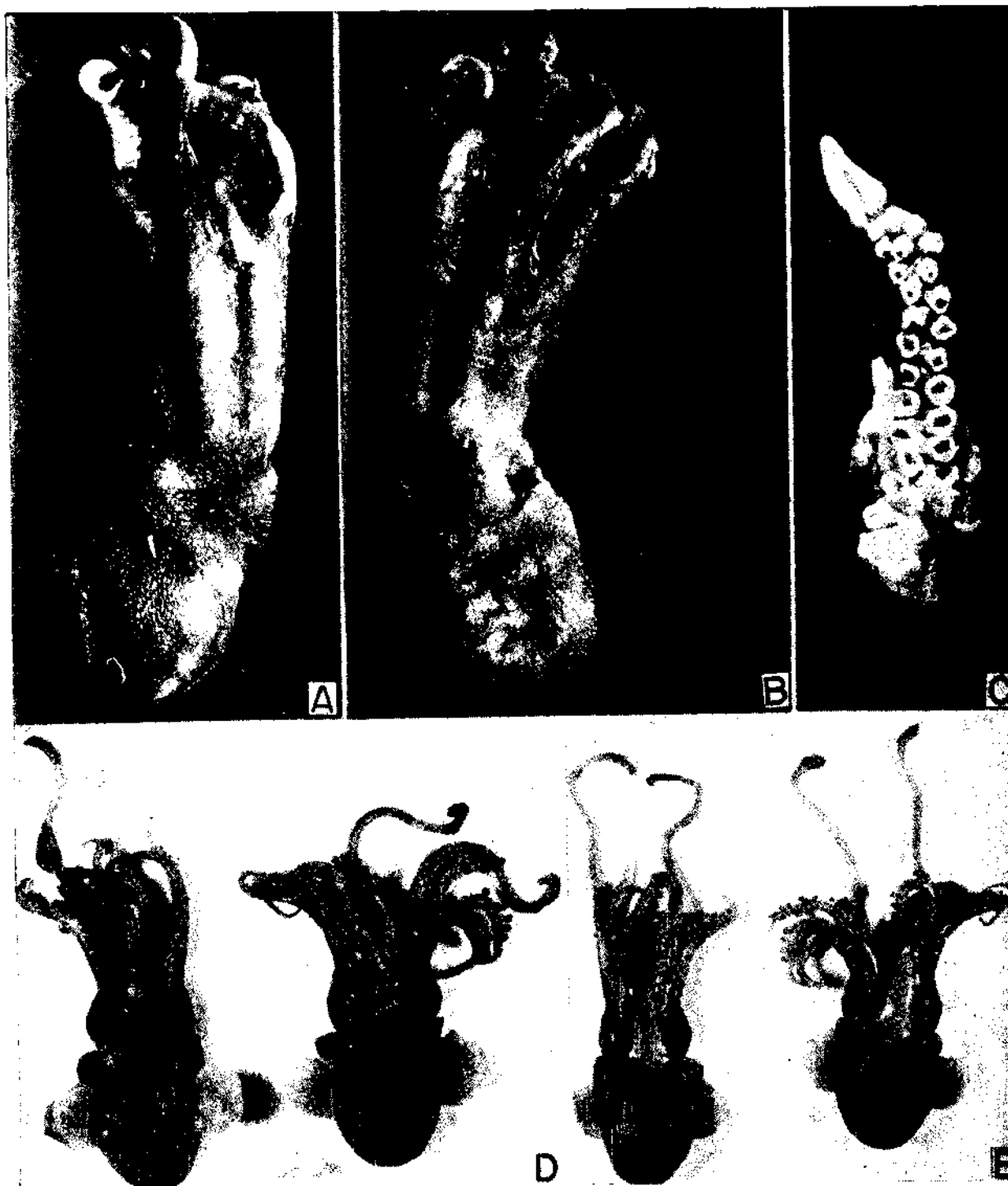


PLATE XI. *Berrya keralensis*. A Dorsal view of male. : B. Ventral view of male : C. Hectocotylized arm. *Euprymna stenodactyla*. D. Dorsal view of female and male. E, Ventral view of female and male.

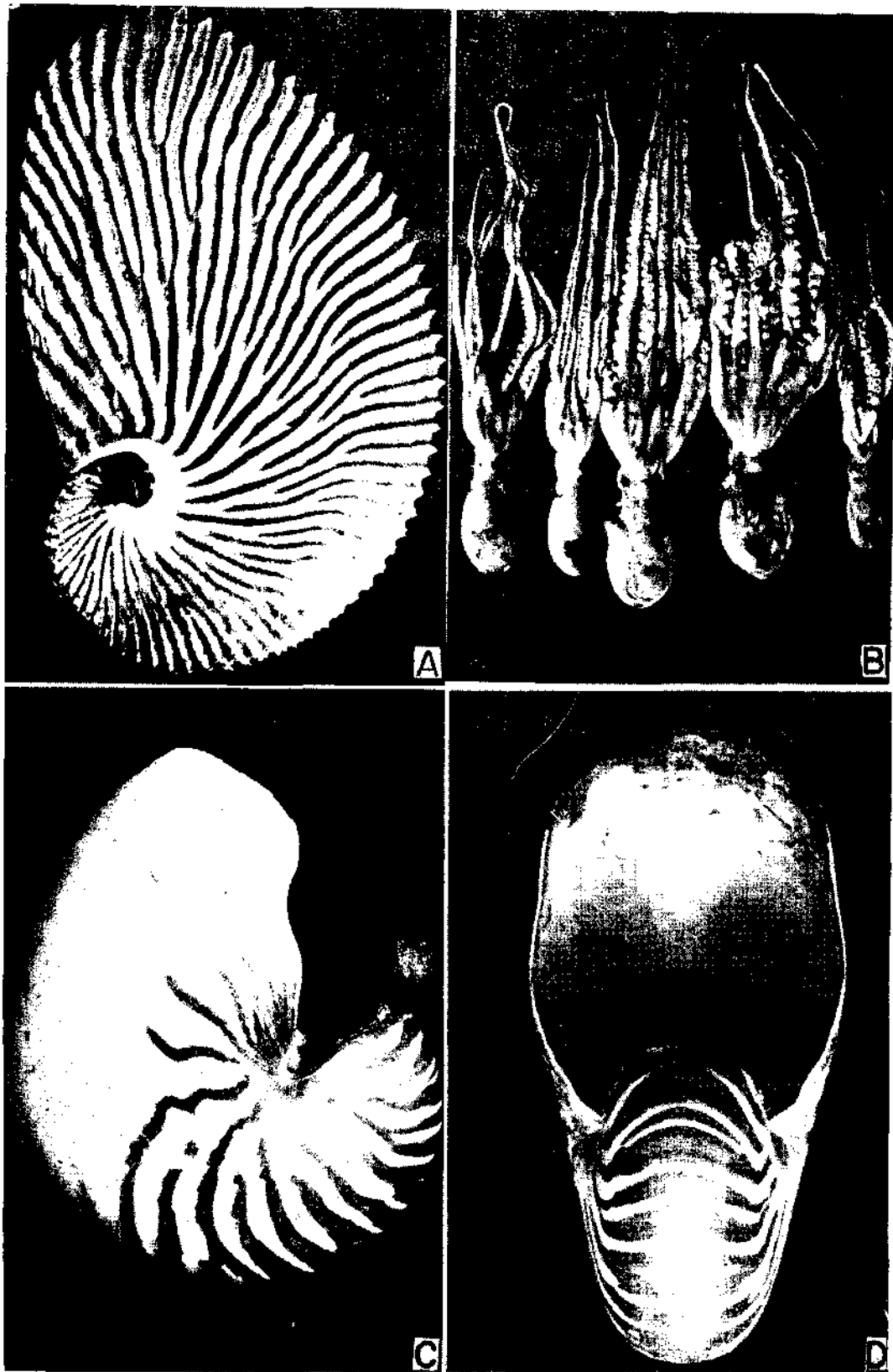


PLATE XII. A. Shell of *Argonauta argo* (from Dell, 1952). B. *Cistopus indicus*. C. and D. Shell of *Nautilus pompilius*.

and have a single large cirrus near the base of each eye; fresh specimens with a narrow distinct white band across the base of head between eyes. Arms are long and stout, the dorsal pair distinctly shorter than others. The web between dorsal arms is very shallow; depth between other arms moderate; on the dorsal side of each arm a cluster of dark chromatophores present at the base of each sucker. The right third arm in males is long, slender and hectocotylized; ligula is short and about 5 to 8 per cent of the hectocotylized arm; groove very shallow and without ridges; calamus very small and distinct. In males abruptly enlarged suckers may or may not be present. Male genital organ consist of a characteristic long, slender penis and a long diverticulum together forming a 'U' shaped structure terminating in an additional secondary loop. Spermatophores are long and unarmed.

The maximum size recorded is about 10 cm (Roper *et al.*, 1984).

The species is of dull brown colour with a fine reticulate pattern on the dorsal surface of mantle, head, arms and web. The oral surface of arms is whitish. At the base of each sucker on all arms there is dark pigmentation.

***Cistopus indicus* Orbigny, 1940**

(Plate XII ; B)

The body is large and somewhat loose in consistency when compared with other species. The mantle skin is smooth. The head is small and united with the mantle by a narrow nuchal region. The eyes are very small.

The arms are very long and tapering to attenuate tips, the dorsal ones are always the longest; arm formula usually 1.2.3.4. The web between the arms is well developed; the suckers are fleshy and without any chitinous rings and are arranged in alternating double rows on all the arms. The basal suckers are large and the distal ones very minute. There are eight water pores, each located in between the interbrachial membrane near the base of the arms, each pore leading to a small oval shaped pouch embedded in the oral side of the muscular web. The pouches can be easily seen by gently teasing out the superficial layer of skin in fresh animals.

In males, the third arm on the right side is hectocotylized and the ligula is small, smooth, poorly developed and not easily discernible; it forms only about 3 per cent of the arm.

This is a large octopod with a maximum total length of 60 cm, mantle length of 18 cm and weight of 2 kg (Roper *et al.*, 1984).

The species is of dull greyish or ash colour and has smooth mantle surface. The posterodorsal and posteroventral surfaces of the body have greenish iridescence.

***Hapalochlaena maculosa* Hoyle, 1886**

(Plate X ; C and front cover)

The mantle is small, globular to elongate and smooth. The head is small, slightly narrower than the mantle, the pallial aperture is not more than the width of the head. Eyes are very small and not prominent. The funnel is small and narrow, the anterior free portion is about half the length of the funnel. The arms are moderately long, subequal in length in the order 4.3.2.1, slightly stout at the base and have attenuated tips. The web is well developed between the arms and continues along the margin of the arms for some distance forming a wide membrane. The web between the third and fourth arms is wider than that between other arms. The third right arm in the male is hectocotylized and the modification is simple; the ligula is very small and rounded at the tip, having only a shallow groove in the middle with faint transverse ridges. The calamus is well developed and the spermatophore groove is broad.

The maximum size for this species is a mantle length of 47 mm and total size of 147 mm.

The external colouration is very characteristic. In live condition the whole body is dusty brown in colour with a number of blue to violet coloured small rings over the mantle, head and arms. Hence this venomous octopus is popularly known as blue-ringed octopus; the colouration of the rings is very intense and bright; sometimes dark bands appear on the body. The coloured rings are very conspicuous against the general dusty brown colour of the body. The somewhat wide circular rings assume the form of small speckles and the dusty brown colour of the body is lost on preservation.

***Berrya keralensis* Oommen, 1966**

(Plate XI ; A-C)

The body is short and stumpy and the posterior region is rounded. The head is somewhat narrower than the body and is demarcated from it by a slight constriction. Eyes with small external openings. The mantle is characteristically soft, loose and semigelatinous and has fine reticulations with minute papillae.

There are two distinct tubercles over the eyes. Smaller tubercles are present all over the dorsal surface of the mantle which is very distinct in males.

The mantle opening is very much reduced and is as broad as only the base of the funnel. The funnel is stout and compressed; it is fused with the head except for the extreme end portion near the opening.

Arms are very short, stout and tapering. The web between the arms is very wide except between the ventral arms where it is somewhat shallow. The fleshy suckers are arranged in two alternating rows but for the base where the first three suckers are in a single row. On preservation the suckers appear to be not globular in shape. Males do not possess any specially enlarged suckers.

The third right arm is hectocotylized and the hectocotylization is very characteristic in this species. The spermatophoric canal extends along the ventral margin of the arm from its base to the tip where it ends in the calamus. The latter is acutely conical in shape and the groove is very deep. The ligula is also somewhat conical in shape and forms about 11 to 15 per cent of the arm. The ink sac in this deep sea species is very much reduced.

Maximum mantle lengths of 55 mm and 39 mm have been recorded for males and females respectively (Oommen, 1966).

In preserved specimens the colour of the octopod is brownish red on the dorsal side with paler colouration on the ventral side. There are papillae on the mantle and they are surrounded by a circle of very minute reddish brown chromatophores.

Genus *Argonauta* Linnaeus, 1758

The systematics of the species of genus *Argonauta* are still unsettled. The taxonomy of this genus is primarily based on the external shell characteristics of the various species (Dell, 1952; Voss, 1963; Voss and Williamson, 1971; Roper *et al.*, 1984). *Argonauta* known commonly as the paper nautilus or the paper shelled nautilus are distributed throughout the warm and warm temperate waters of the world and about six species are recognised presently. They exhibit a remarkable degree of sexual dimorphism. Males are minute, scarcely exceeding 15 mm in total length. Their hectocotylized arm is coiled up in a large thin sac which is capable of self amputation (autotomy) at the time of mating and leaving it inside the mantle cavity of the female. The females are relatively quite

large, about fifteen times the size of the males. The external shell which is secreted by the membranous flaps of the dorsal arms, is used as an incubation chamber for the eggs as well as the females to reside. The shell is held by the flap of the dorsal arms spreading over the shell and adherence to the inner wall of the shell by suckers. The shells of *Argonauta* are more widely known and well described than the animals. Within the species the shells are highly variable in sculpture and form. There are two species *Argonauta argo* Linnaeus and *A. hians* Solander known from the Indian Seas (Robson, 1929; Silas, 1968 and Oommen, 1974).

Argonauta argo Linnaeus, 1758

(Plate XII; A)

Sexual dimorphism is marked; males are minute, 15 to 20 mm in total length. In the females the mantle is narrow to broadly oval in shape with blunt posterior end. The head is smaller than the mantle opening; the eyes are large. Arms are long and subequal in length, the dorsal arms quite thick at their base with large web-like membranous expansion along the entire length. The arm suckers are biserial.

The shell is large, thin and fragile; compressed well with a narrow keel; aperture narrow and 30 to 40 per cent of the diameter of shell. The narrow keel bears on either side numerous small and sharp nodules 10 to 12 numbers per 20 mm. The nodules are arranged in pairs in transverse rows on the keel, and each pair is united by a low ridge. The external sides of the shell bear a number of simple bifurcate ribs, most of which originate from the columella and extend to the carinal nodules; some of the outer ribs are separate and form the secondary ribs. The sides of the shell along the edge of the aperture are not turned widely outward unlike in *A. hians* (Voss and Williamson, 1971).

The main body of the shell is glistening marble white and the keel and the nodules are brownish black. In live condition the animal is predominantly bluish white in colour with the dorsal arms and webs iridescent white with tints of purple red chromatophores. Eyes are steel blue. Maximum length of shell is about 17 cm (Voss and Williamson, 1971).

Argonauta hians Solander, 1786

The shell is highly variable in sculpture. It is rather small, with widely inflated aperture, about 50 per cent of shell length. The keel is wide and bears the characteristic 15 to 23 prominent, large and blunt nodules

placed in pairs over the keel. Great variations exist in size and form of the nodules. The ribs on the sides of the shell extending from the crinal knobs are less numerous when compared to the other species with less bifurcation. There are two types of ribs present, the long and full sized ribs extending from the nodules to the nucleus which are in regular alternating series with the secondary ones ; the latter are short and extend upto half way from the nodules. The colour of the shells varies from white with brownish black tint on the nodules and adjacent ribs to light brown with sooty brown pigmentation over most of the surface of the shell (Voss and Williamson, 1971).

***Nautilus pompilius* Linnaeus, 1758**

(Plate XII ; C and D)

Nautilus popularly known as pearly nautilus or the chambered nautilus in contrast to the other interesting remarkable cephalopod the paper nautilus *Argonauta* is the only living representative of the Sub Class Nautiloidea. Species of *Nautilus* have been described by Owen (1832), Griffin (1900), Willy (1902), Saunders (1981) and others. The remarkable feature of the pearly nautilus is its beautiful coloured external shell which distinguishes this from other cephalopods.

Nautilus pompilius is extensively distributed in Indian Ocean, Western and Central Pacific Ocean, Phillippines to Australia and in Polynesia (Silas, 1968).

The body is enclosed in an external calcareous, spirally coiled and multichambered shell. The animal

occupies the last chamber which is the largest ; the inner surface of the chamber is pearly and the outer surface procellanous and pigmented with wavy reddish brown bands on whitish background. The colour markings on the shell are very conspicuous.

The successive chambers of the shell are separated by a system of concave septa which are perforated in the middle and a shelly tube is formed running through the chambers ; through this the vascular prolongations of the tip of the mantle, the siphuncle runs. Although the tubular siphuncle runs through the chambers to the apex of the shell, it does not open into the chambers. Except the outermost recently formed chamber in which the body is present, all the other chambers are filled with gas which gives buoyancy to the animal.

The body of the animal consists of head which bears eyes, a system of tentacles and a sac-like visceral mass. Arms are absent, funnel is bilobed. Mouth is situated at the end of the head and surrounded by foot with two sets of lappets forming an inner and an outer circle. The edges of the circles are beset with numerous, small, thin and annulated retractile tentacles. The tentacles are devoid of suckers and are adhesive in nature. A special fleshy hood used for closing the last chamber as an operculum is present above the head region. Arms and suckers are absent. Unlike other cephalopods *Nautilus* possesses two pairs of gills, two pairs of kidneys and two pairs of auricles. Sexes are separate. A portion of the tentacle crown which involves four tentacles of the lappets on the right side is modified to form the spadix.

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