09 Cephalopod classification and Taxonomy

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Introduction

Chambered nautilus, cuttlefishes, squids and octopus are the four major groups of cephalopods, which belong to the highly evolved class of phylum Mollusca. Cephalopods are the third largest molluscan class after bivalves and gastropods and consist of more than 800 species (Lindgren et al. 2004). The fossil record contains about 17,000 named species of cephalopods. Although the diversity of cephalopods is very much reduced in the modern era, cephalopods are found to occur in all the oceans of the world from the tropics to the polar seas and at all depths ranging from the surface to below 5000m. Cephalopods were dominant predators millions of years before fish appeared. The earliest cephalopods were primitive shelled nautiloids which evolved in the Late Cambrian period. The living cephalopods range in size from 25mm (Southern pygmy squid, *Idiosepius notoides*) to more than 12m (Colossal squid, *Mesonychoteuthis hamiltoni*) in length.

All cephalopods are dioecious and females are generally bigger than males. Males have one or two modified arms known as hectocotylus which are used for mating. Fertilization takes place in the female. Development is direct to the young ones as miniature of adult. Many species of deep-sea cephalopods occurring at depths of about 400 - 800m undergo vertical migrations during the day and then rise into the uppermost 200 m or so during the night. Cephalopods are carnivores and possess a radula and powerful beaks. They eat fish, crustaceans, shellfish etc. They are major food resources for many top predators such as dolphins, whales, seals, birds and large fish.

Classification

Higher-level classification of recent cephalopods is mostly unstable. Several authors have suggested highly varying classification. A conservative arrangement should be accepted that do not differ much from that of Naef (1921 - 23). Classification of species within subfamilies and /or genera have proved to be useful based on the morphological studies (Voss, 1988), but less significant in determining higher-level relationships. The following classification can be used until an alternative arrangement can be derived from cladistic analysis. Molecular or morphological based analysis must have to go considerable scrutiny before changed in classification should be adopted.

Cephalopods (Class Cephalopoda) are represented by two extant subclasses, Nautiloidea (Nautilus and Allonautilus) and Coleoidea and one extinct subclass, Ammonoidea. Members of the subclass Coleoidea includes two subdivisions, the Belemnoidea, which is the primitive form of cephalopod possessing ink sac and ten equally sized arms, became extinct during the cretaceous period and Neocoleoidea (cuttlefish, squid and octopus) where the shell has been internalized and reduced, completely lost. As a consequence, members of Neocoleoidea rarely fossilize and very few information pertaining to the origin and relationships of living coleoid cephalopods is available from the fossil record. The major division of Coleoidea is based upon the number of arms or tentacles and their structure.

Presently, living coleoids can be segregated into two superorders, Decapodiformes and Octopodiformes (Berthold and Engeser, 1987). The Decapodiformes has fourth arm pair modified into long tentacles. The Decapodiformes contains two orders; the order Teuthoidea, which includes two suborders [Myopsida(closed-eye squids) and Oeopsida (open-eye squids)] and the order Sepioidea which includes families like Idiosepiidae (pygmy squid), Sepiidae (cuttlefish), Sepiolidae (bobtail squids), Spirulidae (ram's horn squid), and Sepiadariidae (bottletail squids). The Octopodiformes includes the orders Octopoda (pelagic and benthic octopuses) and Vampyromorpha (vamphire squid). Octopodiformes has modifications to second arm pair; it is drastically reduced as a sensory filament in the Vampyromorphida, while Octopoda species have totally lost that arm pair. The Octopoda

contains two suborders; Cirrata (deep-sea finned octopuses) and Incirrata (pelagic and benthic octopuses including the argonautiods and blanket octopuses)

Squids posses elongate, cigar-shaped body with posteroexternal fins and eight cirumoral arms, not joined at the base with a web, with two or more rows of stalked suckers bearing chitinous rings (and/or hooks) extend the length of the mantle. They also posses two long tentacles with tentacular club of two or more rows of suckers (and or hooks) at the distal end. The cuttlefish posses a broad sac-like body with lateral fins that are either narrow and running over the entire length (Sepiidae) or are short, round and flap-like (Sepiolidae). In both cases the posterior ends of the fins are free (subterminal) and separated by the posterior end of the mantle; ten circumoral appendages, the longest (fourth) pair of tentacles are retractile into pockets at the ventrolateral sides of head. The eight arms frequently bear four rows of stalked suckers with chitinous rings. Both eyes are covered with a transparent membrane; shell is thick, chalky, calcareous (cuttlebone of sepia) or thin, chitinous (Sepiolidae). Octopus posses a short, sac-like body with either no lateral fins or with separate paddle-like fins in some deep sea forms, and eight circumoral arms with no tentacles, with the bases connected by a web and un-stalked suckers, without chitinous rings, along the length of the arms.

About 210 species of cephalopods have been reported from India. Among these, there are about 80 species of cephalopods of commercial and scientific interest distributed in the Indian seas.

Systematic position of potentially important cephalopods of India

Class	CEPHALOPODA	
Sub class	NAUTILOIDEA	
Family	Nautilidae	*Nautilus pompilius*
Subclass	COLEOIDEA	
Order	TEUTHOIDEA	
Suborder	Myopsida	
Family	Loliginidae	
Genus	*Uroteuthis*	*Uroteuthis (Photololigo) duvaucelii*
		U (P) sibogae
		U (P) singhalensis
		U (P) edulis
		U (P) chinensis
Genus	*Sepioteuthis*	*Sepioteuthis lessoniana*
Genus	*Loliolus*	*Loliolus (Loliolus) hardwickei*
		Loliolus (Nipponololigo) uyii
		L (N) sumatrensis
Suborder	Oegopsida	
Family	Onychoteuthidae	
Genus	*Onchoteuthis*	*Onchoteuthis banksii*
Family	Ommastrephidae	
Subfamily	Ommastrephinae	
Genus	*Sthenoteuthis*	*Sthenoteuthis oualaniensis*
Family	Thysanoteuthidae	
Genus	*Thysanoteuthis*	*Thysanoteuthis rhombus*
Order	SEPIODIDAE	
Family	Sepiidae	
Genus	*Sepia*	*Sepia pharaonis*
		Sepia aculeata
		Sepia prashadi
		Sepia elliptica
		Sepia trygonina
		Sepia brevimana
		Sepia arabica
		Sepia kobiensis
		Sepia prabahari
		Sepia ramani
		Sepia omani
Genus	*Sepiella*	*Sepiella inermis*
Family	Sepiolidae	
Genus	*Euprymna*	*Euprymna stenodactyla*
Order	OCTOPODA	
Suborder	Incirrata	
Family	Octopodidae	
Genus	*Amphioctopus*	*Amphioctopus aegina*
		Amphioctopus neglectus
		Amphioctopus marginatus
		Amphioctopus rex
Genus	*Cistopus*	*Cistopus indicus*
		Cistopus taiwanicus
Genus	*Haplochlaena*	*Haplochlaena maculosa*
Genus	*Callistoctopus*	*Callistoctopus luteus*
Genus	*Octopus*	*Octopus vulgaris*
Genus	*Pteroctopus*	*Pteroctopus keralensis*
Family	Argonautidae	
Genus	*Argonauta*	*Argonauta hians*
		Argonauta argo

Subclass Nautiloidea

Shell complete external, smooth, coiled and chambered, more than 10 (63 - 94) circumoral appendages without suckers, a funnel bilobed, two pairs of gills and the absence of an ink sac.

Family Nautilidae

The ''chambered or pearly nautiluses '' comprises single family and genus and six species. They have approximately 100 sucker-less tentacles, simple eye without lenses and thick rigid hood used to protect the animal when retracted within the shell.

Subclass Coleoidea

This subclass includes all living cephalopods - squids, cuttlefish and octopuses, other than chambered nautiluses. Key diagnostic characters are shell internal, calcareous, chitinous or cartilaginous, 8-10 circumoral appendages with suckers, only one pair of gills (dibranchiate) and funnel tube-like.

Order Teuthoidea

This order contains the squids, characterized by internal shell (gladius or pen) chitinous feather or rod shaped, eight arms; two contractile but not retractile, pocket absent, tentacles lost secondarily in some, fin on the mantle and stalked suckers with or without chitinous hooks, with horny rings and constricted necks; fin lobes fused posteriorly. Eyes either covered or open and without supplementary eyelid.

Suborder Myopsida

Myopsid squids are characterized by eyes entirely covered by a transparent corneal membrane. Eye cavity communicates with the exterior through a tiny hole. Arms and tentacles have suckers only, no hooks. Mante locking apparatus is simple (linear) and the gladius is pen-like.

Suborder Oegopsida

Oegopsid squids (Oceanic squid or Open-eyed squids) are characterized by eyes not covered with a corneal membrane and open to the surrounding medium, arms and tentacles bear suckers and / or hooks. Mantle locking apparatus ranges from simple to complex to fused.

Family Loliginidae

Sepioteuthis lessoniana Ferussac *in* Lesson, 1831

Body elongate, cylindrical in outline; fins marginal, wide and muscular, very long almost running along entire length of mantle; elliptical in shape

Uroteuthis (Photololigo) duvaucelii (Orbigny, 1835)

Body elongate, mid-rib of gladius clearly visible through mantle skin; fin length in adults upto 60 per cent of mantle length; tentacular clubs large median manal sucker ring with 14 - 17 teeth; Arm sucker rings with broad, large, square teeth (5 to 9) on the distal margin; in males, more than half the length (up to75 %) of the left ventral arm hectocotylized, papillae not fused.

U (P) sibogae (Adam, 1954)

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 accumulate posteriorly.

U (P) singhalensis (Ortmann, 1891)

Mantle is long, slender, cylindrical, and it tapers posteriorly into as sharply-pointed tip. Mantle bout 4-7 times as long as wide. Mantle with a ridge along midline in males; The tentacles are short and slender. Clubs are rather short. Left ventral arm IV is hectocotylized distally in mature males for 40 - 45% of its length. The chitinous sucker rings are smooth or wavy proximally, while the distal margin bears 6-11 (most commonly 9) plate-like, truncate, squared teeth.

U (P) edulis (Hoyle, 1885)

Mantle more or less stout, elongate and slender. Fins large, rhombic with the anterior margin slightly convex, the posterior margin gently concave and the lateral angles rounded. Fins become slightly longer than wide in adult specimens (up to 70% of mantle length), gladius long, somewhat narrow, arms somewhat long (25- 45% of mantle). More than half of left ventral arm hectocotylized distally in males.

U (P) chinensis Gray, 1849

Fin length in adults greater than 60% of mantle length. Hectocotylized portion of the left arm IV from 33% to 50% of total arm length. Arm sucker rings with 10-15 stout, pointed, conical teeth distally, the proximal margin smooth; occasionally with rudimentary teeth only. Although the record of this species along the Indian east coast is available in the literature, this species is not recorded in the cephalopod samples of Institute.

Loliolus (Loliolus) hardwickei (Gray, 1849)

Small squids. Mantle length of adults less than 60 mm; fins heart shaped; vane of gladius conspicuously broad at midlength

Loliolus (Nipponololigo) uyii (Wakiya and Ishikawa, 1921)

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 have median manal suckers with smooth rings; in males left ventral arm hectocotylized almost the entire arm; papillae on ventral margin fused with membrane.

L (N) sumatrensis (D'Orbigny, 1835)

Body short, sub-cylindrical, gradually decrease in width posteriorly to blunt point. Head small with large eyes; fins 60-65% of mantle length; fin rhomboidal in shape; arm sucker ring with 6-9 broad, squared teeth; in male left ventral arm hectocotylized upto 87%.

Onychoteuthidae

Onchoteuthis banksii (Leach, 1817)

Oceanic squids with muscular body; head with nuchal folds on the 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.

Thysanoteuthidae

Thysanoteuthis rhombus Troschel, 1857

Funnel locking cartilage shaped consisting of a narrow longitudinal groove and a short transverse groove branching from it medially. Fins broad and rhombus-shaped occupying nearly entire length of mantle.

Ommastrephidae

Sthenoteuthis oualaniensis (Lesson, 1830)

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.

Order Sepioidea

This order includes the cuttlefishes, characterized by an oval body shape, compressed dorsoventrally and framed along both sides of the body by narrow fins that do not attach at the posterior end. The arms bear 2 to 4 rows of suckers. The tentacles are totally retractile into pockets. The internal shell, cuttlebone (calcareous) lies dorsally in the body below the skin. The shell is an oval in shape, thick, containing several gas and /or water filled chambers for buoyancy control.

Family Sepiidae

Small to medium- sized animals characterized by an oval body; flattened dorsoventrally, calcareous internal shell, head free from dorsal mantle, fins marginal and narrow, light organ absent.

Family Sepiolidae

Small animals characterized by saccular body, 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.

Genus Sepia

Body without a glandular pore at posterior extremity; cuttlebone mostly with a spine (rostrum) at posterior end.

Sepiella inermis Van Hasselt, 1835 (in Ferussac and d' Orbigny, 1834 - 1848)

Body with a district glandular pore at posterior extremely on ventral side; with brownish fluid oozing out; cuttlebone devoid of spine.

Sepia pharaonis Ehrenberg, 1831

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 flattening anteriorly in striated area; striae ' Λ' shaped; inner cone forms a conspicuous yellow flat ledge; a sharp thick spine present; when alive, body brownish, tiger-stripe pattern prominent.

Sepia aculeata Van Hasselt, 1835 (in *Ferussac* and d' Orbigny, 1834 - 1848)

Tentacular clubs very long, with 10-14 rows of minute sub-equal suckers. Cuttlebone broad and thick with a median longitudinal edge with a faint groove running medially on striated area; inner cone forms a ledge-like callosity.

Sepia prashadi Winckworth, 1936

Body not robust, fin 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 alive, dusty brownish, transverse stripes less distinct.

Sepia elliptica Hoyle, 1885

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 anteriorly resulting in three longitudinal furrows in striated area; spine thick, sharp, long and well curved.

Sepia trygonina (Rochebrune, 1884)

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 lanceolite with acuminate anterior tip with edges of outer cone winged giving an arrow head appearance; spine small.

Sepia brevimana Steenstrup, 1875

Tentacular club 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 'Λ' shaped with a median shallow groove broadening anteriorly; inner cone and its limbs pinkish in colour; spine small, sharp and slightly curved.

Onychoteuthidae

Onchoteuthis banksii (Leach, 1817)

Oceanic squids with muscular body; head with nuchal folds on the 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.

Thysanoteuthidae

Thysanoteuthis rhombus Troschel, 1857

Funnel locking cartilage shaped consisting of a narrow longitudinal groove and a short transverse groove branching from it medially. Fins broad and rhombus-shaped occupying nearly entire length of mantle.

Ommastrephidae

Sthenoteuthis oualaniensis (Lesson, 1830)

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.

Order Octopoda

This order includes all octopuses, described by eight arms with 1 or 2 rows of suckers. Most species have web sectors between the arms.

Sub-order Cirrata

Finned or cirrate octopods are deep sea octopuses characterized by round to tongue- like fins on the mantle and single rows of suckers interspersed by cirri. Mantle aperture is very narrow. Only the left oviduct is developed

Sub-order Incirrata

Incirrate octopuses are characterize by fins lacking, and have 1 or 2 rows of suckers and no cirri.

Family Argonautidae

This family of pelagic octopuses is known as paper nautiluses or Argonauts, the females of which secrete an external shell. This calcareous external shell is brittle and white in colour with fine corrugations. The male is much smaller than the female. Male lacks the external shell and possesses a large modified third left arm which is detached during mating.

Family Octopodidae

This family includes tiny to very large benthic octopuses characterized by eight arms with 1 or 2 rows of sessile suckers and modified third right arm in males, without an external shell; internal shell either vestigial or lacking; no great disparity between males and females in size.

Cistopus indicus Rapp, 1835 (*in* Ferussac and d' Orbigny, 1834 - 1848)

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

Amphioctopus aegina (Gray, 1849)

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.

Amphioctopus neglectus (Nateewathana and Norman, 1999)

Medium-sized species characterized by elongate and ovoid body, U-shaped iridescent transverse bar on the head between the eyes, Dark ocellus including blue ring present at base of 2nd and 3rd arm pair, Head relatively wider in males than in female, 1 or 2 papillae present over each eye. Ligula long and slender.

Haplochlaena maculosa (Hoyle, 1883)

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

Suggested reading

Jerep, P and Roper, C.F.E. 2005. Cephalopods of the world. An annotated and illustrated catalogue of cephalopod species known to date. Volume 1. Chambered nautilus, and sepioids. FAO Species Catalogue for Fishery Purposes. No. 4, Vol. 1. Rome, FAO. 262p.

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