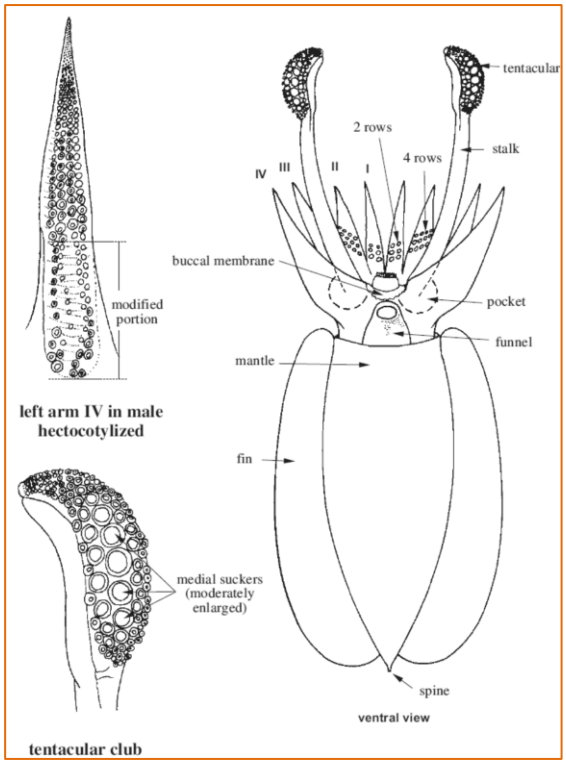
Cuttlefish biology

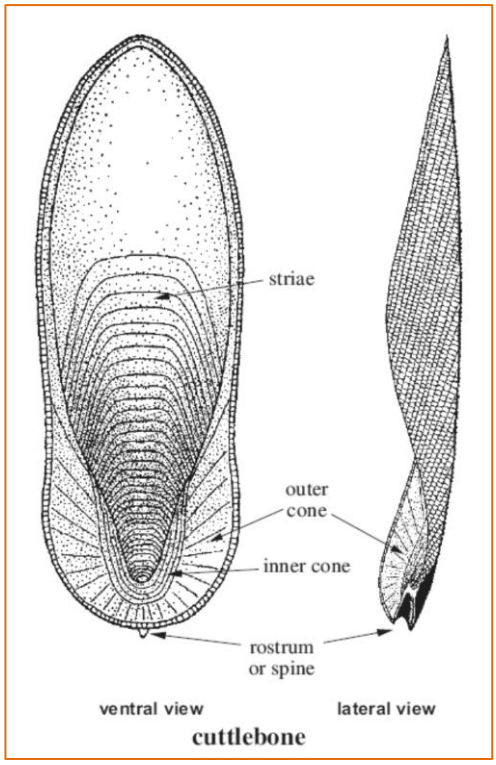
Geetha Sasikumar
Sr. Scientist, Molluscan Fisheries Division
CMFRI Research Centre, Mangalore
P.B. 244, Mangalore, Karnataka-575 001

The Class Cephalopoda comprising of squids, cuttlefishes and octopus includes the largest known living invertebrates within the animal Kingdom. Cephalopods have well developed head and a body consisting of a muscular mantle and mantle cavity. Head bears circumoral appendages (arms, tentacles), a feature that reflects the origin of the name 'Cephalopoda', which is derived from the union of the two Greek words: 'kefale', head, and 'pous', feet. These soft-bodied bilaterally symmetrical groups are commercially important fishery resources occurring in all marine habitats in depth ranging from intertidal to over 5,000 m. Salinity is considered as the limiting factor restricting their distribution between 27 and 37 psu, with few exceptions.

The cuttlefishes belonging to the family Sepiidae are of significant commercial value to artisanal and industrial fisheries. Cuttlefishes are primarily bottom-dwellers over a range of habitats, including rocky, sandy, and muddy substrates, seagrass, seaweed and coral reefs. They are slower swimmers than the more streamlined squids. Cuttlefishes are able to attain neutral buoyancy by regulating the relative amounts of gas and fluid in the chambers of the cuttlebone, and they are able to hover in midwater, with fins acting as stabilizers. Large species such as *Sepia latimanus*, *S. officinalis* and *S. pharaonis* are restricted to much shallower depths and show very different septal spacing and sutures than the deeper water species. Some species migrate seasonally in response to temperature changes and aggregate, usually in shallow water, at spawning time.

Cuttlefishes have broad sac-like bodies with lateral fins that are narrow and extend along the length of the mantle; posterior lobes of the fins free (subterminal) and separated by the posterior end of the mantle; 10 circumoral appendages, the longest 2 (tentacles) are retractile into pockets on the ventrolateral sides of the head; the 8 remaining arms frequently with 4 series of stalked suckers with chitinous rings; eyes are covered with a transparent membrane and eyelids are present. They are characterized by the presence of a dorsally placed internal calcareous shell known as the cuttlebone, which is a finely chambered shell, thick, and chalky.





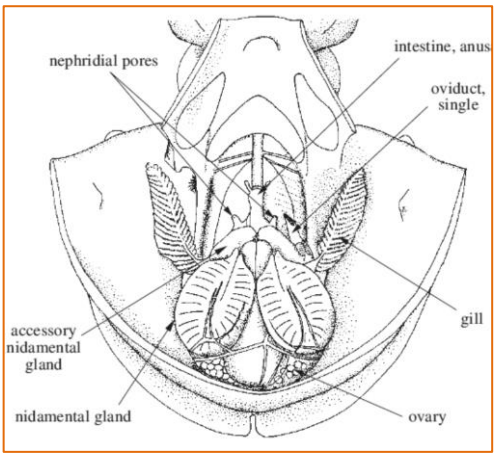
Basic cuttlefish features (Reid *et al*., 2005)

Mantle: The multifunctional mantle cavity is important for cuttlefish locomotion, giving the animal its characteristic jet propulsion ability. To move away from a predator, the cuttlefish sucks water into the mantle cavity and then uses its strong mantle muscles to expel water with great force, forcing the cuttlefish in the opposite direction. Water exits through a movable part called the funnel, which controls the angle of the spray. The mantle cavity also aids in respiration by bringing water to the animal's gills, which in turn filter oxygen into its bloodstream.

Fin: While the cuttlefish uses its mantle cavity for jet propulsion, it relies on its specialized fins for basic mobility and maintaining consistent speeds. The muscular fin can manoeuvre the cuttlefish in nearly any direction: backward, forward, even in circles, with such movement being more energetically efficient than jetting.

Gills, Hearts and Blood: The cuttlefish has three hearts, with two hearts pumping blood to its large gills and one circulating the oxygenated blood to the rest of its body. The blood itself is blue-green in colour because of hemocyanin, a copper-containing protein that transports oxygen throughout their bodies.

Reproduction: Gonads form a single mass at the posterior end of the mantle cavity. Reproductive systems are highly complex structures with ducts, glands and storage organs. In males, the sperms are produced in the testis located in the posterior end of the mantle, which are then picked by the ciliated funnel of the vas deferens that joins the multi-unit spermatophoric organ. While passing through this organ the sperm are formed into a spiral mass and coated with the various membranes and tunics to form the spermatophores (sperm packets). The vas efferens takes the fully mature spermatophores and transfer them one at a time into the spermatophoric sac or the Needham's sac and stored until copulation. Female reproductive system consist of a single



ovary, the single oviduct having thin walled as well as glandular portions, the paired nidamental glands and the paired accessory nidamental glands. Once shed, the ova pass into the funnel in the oviduct, where they are stored in the proximal thin walled portion of the oviduct until mating and egg laying. The ova in the more posterior-dorsal ovary are opaque when immature and less clear when still surrounded by the follicular epithelium. From the thin-walled lightly muscular, proximal portion of the oviduct, the eggs are passed during laying through an opaque glandular portion of the oviduct on the left side of the mantle, where they are coated with a layer of egg jelly. The oviducal gland is connected to two large nidamental glands, which contains thick white gelatinous material which is used to embed each ovum into an individual protective capsule. The cuttlefish ovary grows rapidly during sexual maturation. The eggs growing in the same string of germinal epithelium in ovary grow at different rates and vary considerably in size. All eggs in the ovary will not reach maturity at the same time due to the limitation in the physical capacity of the ovary. Therefore the mature eggs in cuttlefish are spawned in different batches.

During mating, the male uses a modified arm, the hectocotylized arm, to transfer the spermatophores into the female's buccal area. The spermatophores are stored in the buccal area until fertilization of the eggs. When the female is ready to deposit the eggs in protected areas under rocks or in discarded shells, the female uses the arms to wipe the stored spermatophores onto each egg.

Cuttlefish eggs are individually enclosed in a tough protective external coating, often pigmented black from the ink-sac secretions. These egg clusters are attached to rocky crevices and disguised among many encrusting organisms.

Food and Feeding: All cuttlefish are active carnivores feeding on live prey during their entire life cycle. They are opportunistic feeders, switching easily from one prey to another. Preferred diet of cuttlefish is crabs and fish; they feed on small shrimp soon after hatching. They use their camouflage to hunt their prey. They swim at the bottom, where shrimp and crabs are found and shoot out a jet of water to uncover the prey buried in the sand. Then when the prey are trying to get away, the cuttlefish open their eight arms and shoot out two long feeding tentacles to grab them. The tentacular club suckers grab the prey. The captured prey is brought to the mouth by the arms where it is killed. The dorsal beak or the ‘upper’ beak is inserted within the ‘lower’ (ventral) beak to tear tissue of the prey with a scissors-like cutting action. The gut has spontaneous peristaltic activity. The chopped food passes from the buccal cavity through the oesophagus to the stomach, where most of the digestion takes place. The digestive tract except for glandular area is chitin lined from the buccal mass to the stomach. The cuticular ridges in the stomach aid in grinding food. The food is broken down with enzymes in the stomach from the digestive gland. The stomach may be greatly expandable in size and serve as a storage area until food can be fully processed.

Cuttlefishes along Indian coast

Species	Common name	Distribution
Sepia pharaonis	Pharaoh cuttlefish	Indian coast
Sepia aculeata	Needle cuttlefish	Indian coast
Sepia elliptica	Golden cuttlefish	Indian coast
Sepia prashadi	Hooded cuttlefish	Indian coast
Sepia brevimana	Short-club cuttlefish	East coast
Sepiella inermis	Spineless cuttlefish	Indian coast

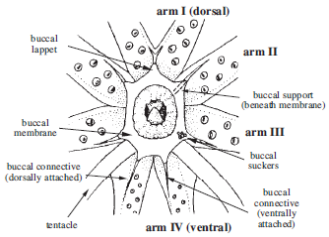
Technical terms

Accessory nidamental glands : Glands consisting of tubules containing symbiotic bacteria.

Beak : Two chitinous jaws of cephalopods, bound in powerful muscles.

Buccal : Pertaining to the mouth.

Buccal connective : Thin muscular band that attaches the buccal support of the buccal membrane to the base of the adjacent arm. The position of attachment of the connective on the fourth arms was recognized in the early twentieth century as an important character for phylogenetic relationships among decapodiformes.



Buccal membrane : The muscular membrane that encircles the mouth like an umbrella. It connects to the buccal supports to form the buccal crown. The pigmentation of the buccal membrane often differs from that of the adjacent oral surfaces of the arms.

Hectocotylus : One (or more) modified arm in male cephalopods used to transfer spermatophores to the female; modifications may involve suckers, sucker stalks, protective membranes, trabeculae .

Ink sac : The structure that manufactures and stores the ink of cephalopods; it lies parallel with the intestine and empties via a duct into the rectum.

Mantle cavity : Space enclosed by the mantle. In cephalopods the mantle cavity contains the visceral sac, gills, anus, openings of the gonoducts, nephridial pores and various muscles and septa.

Needham's sac (spermatophore/ spermatophoric sac) – : The elongate, membranous organ of males where completed, functional spermatophores are stored. It opens into the mantle cavity or directly into the water through the penis.

Nidamental glands : Large glandular structures in females of most decapods and nautiluses that lie in and open directly into the mantle cavity. The glands are composed of numerous lamellae that are involved in secretion of egg cases or the jelly of egg masses.

Oviduct : Female gonoduct(s). The oviduct conducts eggs from the visceropericardial coelom, which encompasses the ovary, to the mantle cavity and often is used to store eggs. In some argonautid octopods eggs are fertilized and undergo either partial (*Argonauta*) or complete (*Ocythoe*) embryonic development within the oviduct.

Oviducal gland : Glandular structure that surrounds the anterior end of the primary oviduct and secrets some of the external coatings around spawned eggs.

Sperm duct (=**seminal duct**)	:	The duct of males which joins the testis with the spermatophoric organ
Sperm mass	:	The mass of sperm held within the spermatangia of everted spermatophores.
Sperm receptacle	:	A bulbous structure in the buccal region or at the openings of the oviducts in females of certain cephalopods for deposition of spermatangia.
Spermatangium (pl. **spermatangia**)	:	Extruded, exploded, evaginated spermatophore/s, often in the form of a round bulb.
Spermathecae	:	Specialized sperm-storage structures found in the skin of some female decapodiformes or as pockets of the oviducal gland in octopods.
Spermatophore	:	A tubular structure manufactured by male cephalopods for packaging sperm; capable of holding millions of sperm, it is transferred and attached to the female until fertilization begins. It forms a spermatangium after the spermatophoric reaction occurs and the spermatophore has everted.
Spermatophoric complex	:	The unit formed by the sperm duct, the spermatophoric organ, the spermatophoric sac, the spermatophoric duct and the penis.
Spermatophoric duct	:	The duct of males through which the spermatophores, once formed, pass from the spermatophoric organ to the spermatophoric sac.
Spermatophoric organ	:	Male organ where the spermatophores are formed.
Spermatophoric reaction	:	The evagination of a spermatophore with the extrusion of the sperm mass, caused by the penetration of water inside the spermatophoric cavity, where the osmotic pressure is higher.

Pharaoh cuttlefish (*Sepia pharaonis)* catch – Mangalore FH