

**Class Cephalopoda** (Cuttlefishes, squids and octopuses)

**CHARACTERISTICS:** *Bilaterally symmetrical MOLLUSCA with well-developed head bearing 8 or 10 circumoral, mobile appendages provided with suckers and/or hooks. Pharynx with chitinous beak-like jaws and a radula. Shell mostly reduced, modified or absent, and enclosed by the mantle (except in Nautiloidea); gills as 1 (rarely 2: Nautiloidea) pair.* The size ranges from 2 cm to 20 m (!); Bermuda species are in the range of 5-100 cm. Under a shiny skin the body is surprisingly tough and muscular, and capable of considerable changes in shape in some species (e.g., *Octopus*). The coloration is variable, and rapid changes of color and patterns are an integral part of their behavior. Rapid locomotion is achieved by drawing water into the mantle cavity and then expelling it, jet-like, through the funnel; in addition, most benthic forms (many octopods and sepioids) can crawl along the bottom using arms and suckers, and pelagic forms use fins on the mantle for balance, steering and minor locomotion.

One of the 2 subclasses, the Nautiloidea, is found only in the Indo-Pacific Ocean. Of approximately 1,000 living species, about 12 are known to occur near Bermuda; the 9 included here are either regular near-shore inhabitants, or offshore species seen at the surface or stranded.

**OCCURRENCE:** All marine habitats of the world; benthic on coral reefs, grass flats, sand, mud, rocks; pelagic and epipelagic in bays, nearshore and open-ocean habitats. Depth range from 0 to over 5,000 m. Abundance varies depending on group, habitat and season, from isolated territorial individuals (primarily benthic octopods), to small schools with a few dozen individuals, to huge schools of oceanic species with millions of specimens.

Collecting techniques include small

traps (octopods), weirs, lures and jigs (some cuttlefishes and squids), encircling seine nets (nearshore squids) and midwater and otter trawls (squids and octopods). Certain species of squids are attracted to light, then jigged or seined. Occasionally cuttlefish and octopods are caught in hand nets or are speared, but it is nearly impossible to capture free-swimming squid in this manner. Caution: the bites of cephalopods, especially octopuses, can be painful at the least, or poisonous, or get secondarily infected.

Although cephalopods are extremely important worldwide as food for human consumption, they are not caught commercially in Bermuda. Cephalopods also are important experimental animals in biomedical research. Because of the highly developed brain and sensory organs, they have a great capacity to learn and remember, rendering them valuable in behavioral and comparative neuroanatomical studies. In addition, cephalopods possess the largest single nerve axons in the animal kingdom, and are therefore used extensively in neurophysiology.

**IDENTIFICATION:** Major groups as well as species are readily distinguished by external characteristics.

Note the shape of the body and color patterns, which are due to innervated chromatophores (pigment-filled sacs) and iridocytes (reflective cells that give sheen). Some deep-water species may have photophores (light-producing organs). Presence and shape of fins, and the presence (cuttlefish and squids) or absence (octopuses) of a pair of long tentacles in addition to the 8 arms distinguish major taxa. Tentacles consist of a stalk devoid of suckers, and a terminal club that bears suckers and/or hooks. Arms may be connected basally by a web (*Vampyromorpha* and *Octopoda*); they usually bear 2 (1-4) rows of suckers and/or hooks that may be stalked or unstalked. In squids, the structure of the locking apparatus (ridge and groove mechanism by which mantle and funnel are locked together during expulsion of water) may be diagnostic. Mature males possess a hectocotylus, i.e., 1 or more arms modified for transferring spermatophores (sperm packets) to the female. The length of the modified tip (ligula) of the octopod hec-

pallet dark brown, with a deep longitudinal furrow on the outer face.

*Teredora malleolus* (Turton) (= *Teredo thomsoni* Tryon) (Hammered shipworm): Genus with unsegmented oval pallets with a short stalk and a thin blade. Outer face of pallet with a thumbnail-like depression. Siphons united.—Species with shell and pallets to 10 mm. Auricle large, ovate. Pallets with short stalk and large blade. Straw-yellow periostracum on the pallets.

**S.CL. ANOMALODESMATA:** Bivalvia with prismatic nacreous, short to elongate, inequivalve to sub-equivalve shells. Isomyarian. Hinge plate and teeth weak or lacking. Primitive forms with resilium and lithodesma. Mantle margins ventrally fused. Eulamellibranchiate or septibranchiate. Most are hermaphroditic. Siphonate burrowers. (Only order: Pholadomyoidea.)

**SUP.F. PANDORACEA:** Pholadomyoidea with thin, inequivalve, gaping shell. Endostracum nacreous. Ligament and resilium present, sheathed with calcareous layer (lithodesma). Hinge lacks regular heterodont teeth, but may have denticles or buttresses.

**F. LYONSIIDAE:** Pandoracea with a thin shell with a slight posterior gape. Pallial sinus distinct. (1 sp. from Bda.)

*Entodesma beana* (Orbigny) (= *Lyonsia beau* (Orbigny); *Mytilimeria plicata* of authors) (Pearly

Lyonsia): Genus with elongate, nacreous shell. Periostracum yellow. Posterior end attenuate, slightly gaping. Some species attach sand grains to the outside to the valves.—Species to 40 mm. Shell white, irregular, roughly ovate, gaping slightly at both ends. Umbones at anterior end. Sculpture of fine, concentric lines. Periostracum with brown radial rays on the posterior portion of the shell. Uncommon; within sponges in shallow water.

**SUP.F. POROMYACEA:** Pholadomyoidea with round to ovate, non-gaping shells. Isomyarian. Pallial sinus shallow. Somewhat developed cardinal and lateral teeth. Gills may be reduced or absent. The mantle margins are fused.

**F. VERTICORDIIDAE:** Poromyacea with small, nacreous, radially ribbed shells. Carnivorous, capturing small animals in sticky threads secreted by pallial tentacles. Muscular stomach lined with a chitinous sheath which serves as a crushing gizzard. (1 sp. from Bda.)

*Verticordia ornata* (Orbigny) (Ornate Verticordia): Genus with shell that is small to minute, nacreous, well ribbed externally. Pallial line simple. Ligament external.—Species to 4 mm. Shell oval, with 10-12 widely spaced, curved radial ribs on anterior 3/4 of shell. Margin strongly crenulate anteriorly. Exterior white; interior silvery nacreous. Rarely dredged, in 800 m.

tocotylized arm, expressed as a percentage of total arm length (ligula index) may be species-distinctive. In squids, determine whether the eye is covered with a corneal membrane or open. Most species have an ink gland that opens into the rectum and releases a black fluid used to confuse predators.

Fixation for study or display specimens of squids requires an initial period (a few days) in 8-10% seawater-formalin buffered with borax or other buffering agent. Specimens should be laid out straight in deep trays so the arms and tentacles can be fixed in an untwisted state. Large, thick-mantled specimens should be thoroughly injected or cut open along the midregion of the ventral surface of the mantle with a 5-10 cm incision to ensure fixation of the viscera and reproductive organs. After fixation transfer specimens to 70% ethyl alcohol or 50% isopropyl alcohol for permanent preservation. Squids die very soon after capture and fixation should begin immediately. (Caution should be exercised if live or moribund specimens are placed in formalin in an uncovered container, for several strong pumps of the mantle may occur before death and formalin can be jetted for several feet in any direction.)

Octopuses commonly survive capture by gentle techniques, and if specimens must be preserved, they must be killed carefully to avoid strong contractions and tight coiling of the arms (which render the specimen extremely difficult to work on). Narcotize the specimen by diluting the seawater with 25% by volume of fresh water, then 50%. The process may be hastened somewhat with small amounts of ethyl alcohol (0.5-1%) or other narcotizing agent, but patience is required if coiling is to be prevented. When the specimen is completely narcotized (or dead!) dip the tips of the arms into 8-10% formalin (formulated as above), then massage the arms straight. Repeat the dipping and massaging process on increasingly longer sections of arms until entire lengths are treated. Place entire specimen in the deep tray, as with squid. Occasional arm-straightening

may still be required. Fixation and preservation follow as for squid.

**BIOLOGY:** All cephalopods are dioecious and many, though not all, exhibit external sexual dimorphism, either in structural or size differences. Females generally are larger than males. Males of many forms possess 1 or 2 modified arms (hectocotyli) for mating. The hectocotylus may consist of modified suckers, papillae, membranes, ridges and grooves, flaps, etc., but in any case functions to transfer spermatophores from the male's mantle cavity to a locus of implantation on the female, which may occur inside the mantle cavity, around the mantle opening on the neck or head, in a pocket under the eye, around the mouth, etc. Fertilization takes place in the female as the eggs are laid. Eggs of squid generally are encased in a gelatinous matrix secreted by the nidamental glands and are laid as multi-finger-like masses (sometimes called "sea mops") attached to rocks, shells or other hard substrate on the bottom in shallow waters (inshore squids), or they are extruded as large, singular, sausage-shaped masses that drift in the open sea (oceanic squids). The fingers may contain from a few to several hundred eggs, whereas the sausages contain tens or even hundreds of thousands of eggs. The mode of reproduction and egg laying is unknown for many forms, especially oceanic and deep-sea species. Benthic octopuses lay their eggs in great, grape-like clusters and strands in lairs, under rocks and in abandoned mollusk shells, where they brood the eggs until hatching. The eggs are attached to each other, but they are not encased in a gelatinous matrix. The female of the pelagic octopus *Argonauta* constructs a thin, shell-like egg case in which she resides and lays festoons of eggs, fertilization having taken place from sperm contained in the highly modified hectocotylus that was autotomized from the male and deposited in the egg case. The

life expectancy is about 1 yr in most forms, but larger species of squids and octopus must live for several years. Many species die after spawning. Many oceanic cephalopods undergo diel vertical migrations, wherein they occur at depths of about 400-800 m during the day, then ascend into the uppermost 200 m or so during the night. Whereas shallow-living cephalopods are able to conceal themselves by chromatophore-produced color patterns and chameleon-like color changes, many deep-sea forms camouflage themselves by producing bioluminescence from photophores (light-producing organs), which eliminates their silhouettes against the downwelling light in the dimly lit mid-depths. Cephalopods are active predators upon crustaceans, fishes, other cephalopods and, in the case of octopuses, bivalved mollusks. In turn, cephalopods are major food items in the diets of toothed whales, seals, pelagic birds (penguins, petrels, albatrosses, etc.) and both benthic and pelagic fishes (e.g., sea basses, tunas, billfishes). The parasites on cephalopods include dicyemid Mesozoa in the kidneys of octopods as well as digeneid Trematoda and apostomeid Ciliophora. Cestoda and Nematoda may parasitize the intestinal tracts of oceanic squids.

### Plate 129

**DEVELOPMENT:** Cephalopod eggs are very yolky (telolecithal) and cleavage is thus incomplete, or meroblastic, so that typical molluscan spiral cleavage is absent. Development is direct and babies hatch as miniatures of the adult (to a greater or lesser extent depending on the species). Cephalopod eggs may vary in size from about 13 mm (in some octopods) to 0.8 mm (in *Argonauta*) (ARNOLD 1971). Time of embryonic development also varies widely from a few weeks to several

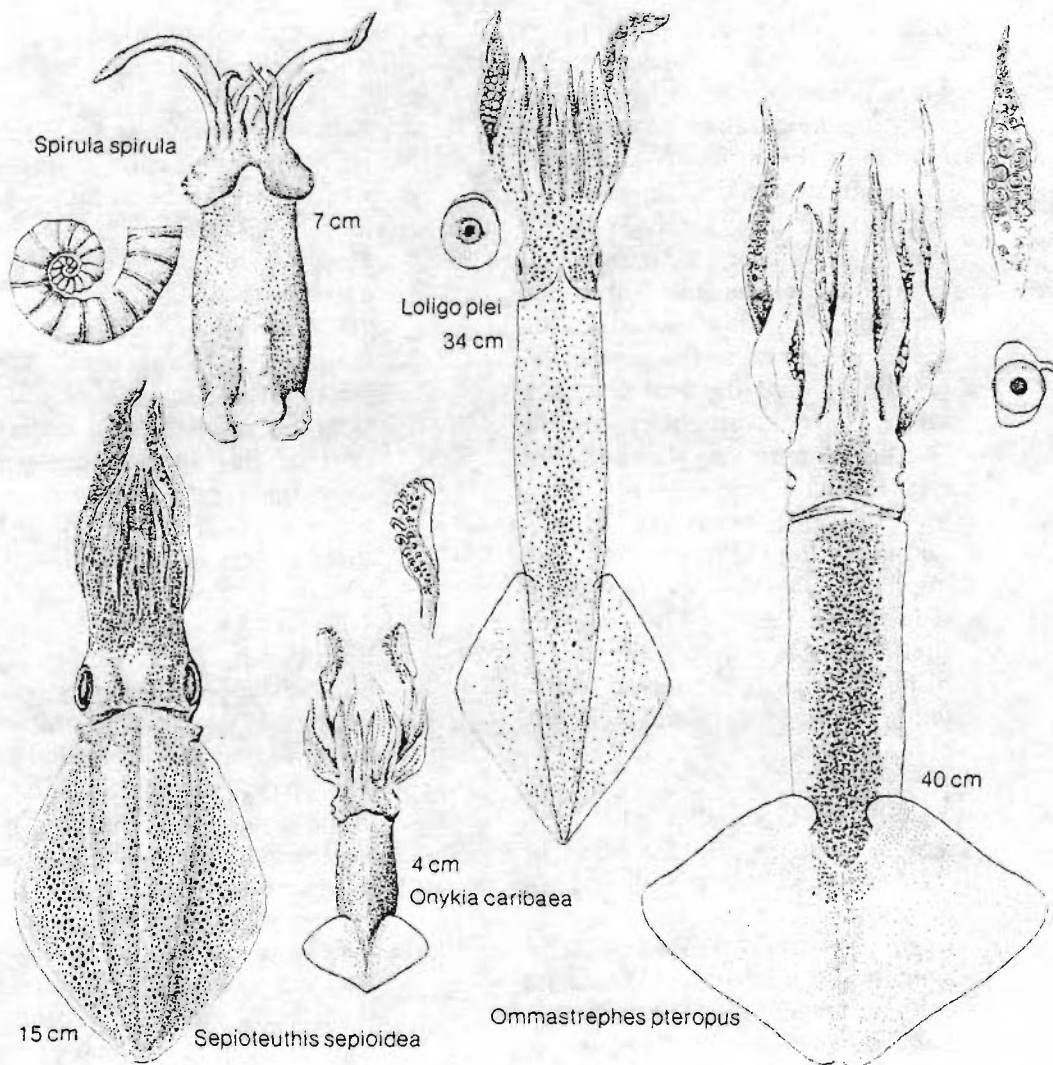
months, depending on the species and temperature conditions. Hatching may occur rapidly from a single clutch or be extended over a period of 2-3 weeks. Young animals often occupy different habitats from the adults. For example, the young of some species of benthic octopuses spend periods of time as planktonic organisms, and the juveniles of many deep-sea forms occur in the upper 100 m of the open ocean, then gradually move to greater depths with increasing size.

Juveniles are obtained by collecting the egg masses of nearshore squids and octopuses and letting them hatch out. Planktonic juveniles of benthic and oceanic forms can be collected by a medium mesh plankton net, but there has been little success in keeping them alive.

**REFERENCES:** A systematic overview of the class is given in BOSS (1982). An illustrated key to the families of Teuthoidea is by ROPER et al. (1969). Vampyromorpha were dealt with by PICKFORD (1946, 1949), and oceanic squids were reviewed by CLARKE (1966) and ROPER & YOUNG (1975; vertical distribution). Littoral Octopoda were studied by PICKFORD (1945) and VOSS & PHILLIPS (1958). Field guides to the potentially commercial species are by VOSS et al. (1973; tropical West Atlantic); ROPER & SWEENEY (1981; central Western Atlantic), and ROPER et al. (1984; worldwide). The nervous system and behavior of cephalopods are described by WELLS (1962, 1978) and YOUNG (1971).

Observations on species occurring in Bermuda were reported for *Spirula* by BRUN (1943) and DENTON et al. (1967); for *Loligo* by LaROE (1971), ROPER (1965) and WALLER & WIKLUND (1968); for *Sepioteuthis* by ARNOLD (1965) and LaROE (1971); and for *Argonauta* by ILIFFE (1982). A review of Bermuda's inshore and oceanic species is given in VOSS (1960), and important early records include VERRILL (1881, 1901a, 1902a), HOYLE (1885a, b), HEILPRIN (1888), and VERRILL & BUSH (1900). COHEN (1976) verified the identity of *Loligo plei*.

**S.CL. COLEOIDEA** (=DIBRANCHIATA): Shell, internal, enveloped by mantle, in various degrees of reduction. With a single pair of gills, 10 (secondarily 8) cir-



163 SEPIOIDEA, TEUTHOIDEA (Squids)

cumoral appendages, and a tube-like funnel (siphon). (All 4 orders represented in Bda.)

Posterior fin lobes free. Each tooth of radula, including rachidian, with only 1 projection. No branchial canal between afferent and efferent branchial blood vessels. Digestive gland divided or bilobed; pancreas separate. (1 sp. from around Bda.)

Plate 163

O. **SEPIOIDEA** (Cuttlefishes): Coleoidea with a calcareous or chitinous shell and 10 circumoral appendages. Tentacles (4th pair of appendages) retractile into pockets.

*Spirula spirula* (L.) (Ram's horn shell): Internal shell open-coiled; chambers connected by a tube. Fins terminal, transversely sit-

uated. A single large photophore ("terminal disc") occurs at the blunt posterior end of the mantle. Four to 8 longitudinal rows of suckers along the arms. Whole specimens (maximum total length about 7.5 cm) are very rarely seen, for they inhabit the mid-waters off Bermuda, but the small (up to 2.5 cm diameter), white, coiled, chambered shells rise to the surface after the animals die and are commonly found washed up on the beaches after stormy weather. The species exhibits a vertical migratory behavior, occurring at 500-700 m during the day and ascending to 100-300 m at night (CLARKE 1969). The internal shell serves as a buoyancy mechanism to assist the animal in maintaining desired depths (DENTON et al. 1967).

**O. TEUTHOIDEA** (Squids): Coleoidea with a simple, rod- or feather-like, chitinous shell (pen or gladius). Ten circumoral appendages; 4th pair (tentacles) occasionally secondarily lost. Tentacles contractile, but not retractile into pockets. Posterior fin lobes fused, occasionally free. Rachidian and first lateral teeth of radula with secondary cusps. Branchial canal present between afferent and efferent branchial blood vessels. Digestive gland a single, undivided structure; pancreas separate.

**S.O. MYOPSIDA** (Inshore squids): Teuthoidea with eyes covered with corneal membrane; eye pore present. ♀ gonoducts single. Accessory nidamental glands present. Suckers present on buccal lappets. Suckers only (never hooks), on

arms and tentacular clubs. (2 spp. from around Bda.)

*Loligo plei* Blainville (= *Doryteuthis plei*) (Arrow squid): Body long, slender especially in adult ♂. Fin length 35-58% of mantle length. Hectocotylus on left ventral arm extends to arm tip and occupies 26-50% of arm length. Maximum mantle lengths approach 35-40 cm but mature specimens may be considerably smaller. Most earlier records of this species in Bermuda were incorrectly attributed to *L. pealei* (see COHEN 1976). In all inshore waters as well as the backwaters of the reefs. COHEN (1976) described several abnormalities in Bermudian specimens (missing buccal lappets) and suggested these may be due to the small, isolated population at Bermuda. The spawning season of the Bermuda population is unknown, but mature adults in spawning condition have been recorded throughout the year across the range of *L. plei*. Eggs are laid on the bottom, attached to a hard substrate (rock, shell, coral rubble), in gelatinous strands or fingers; many strands are laid at once on the same object resulting in a large mass or "sea mop".

*Sepioteuthis sepioidea* (Blainville) (Caribbean reef squid): Mantle stout, bluntly rounded posteriorly. Fins extend nearly entire length of mantle (except in smallest young). Hectocotylus occupies distal 26-30% of left ventral arm (4th), characterized by complete loss of suckers and greatly enlarged fleshy papillae. The species reaches a maximum mantle length of about

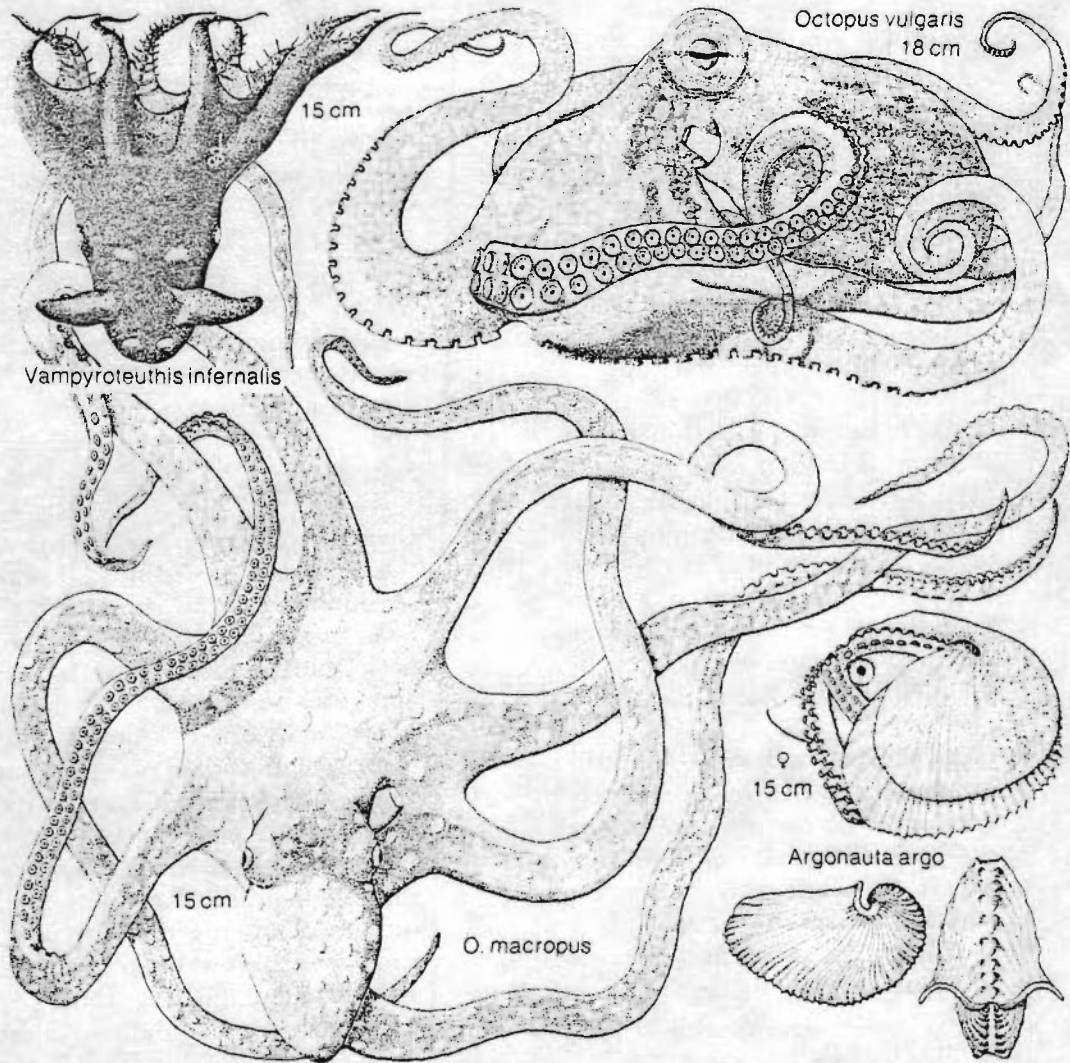
15 cm and a total length of about 30 cm. Around and behind coral reefs, over reef flats and turtle grass beds, surface to 20 m. The life-span is about 1 yr; sexual maturity is achieved in about 7 months. Where known, spawning occurs IX-III, possibly year round. The eggs are laid in shallow water in capsules or fingers, only 3-4 large (6 × 3 mm) eggs per capsule. Eggs are always laid in very cryptic spots, under flat rocks, in conch shells, well hidden from potential predators and bright light; about 130 eggs make up each "mop". After an incubation of about 36 days the hatchlings emerge at a relatively large size (10-12 mm total length), and reach sexual maturity 4-5 months after hatching.

**S.O. OEGOPSIDA** (Oceanic squids): Teuthoidea with eyes completely open, with no corneal covering or eye pore. Conoducts of ♀ paired. Accessory nidamental glands absent. Suckers on the buccal lappets usually absent. Arms and tentacular clubs with suckers and/or hooks. (About 50 spp. from around Bda.)

*Onykia caribaea* (Lesueur): Small, compact, plump body with broad rounded fins that extend somewhat posterior to mantle tip, especially in juveniles. No light organs known. The locking apparatus on the funnel is a straight, elongate groove. The tentacular club has a distinctive rounded wrist section (carpus) consisting of about 10 each of alternating suckers and knobs and a hand section (manus) with a row of suckers along each outer margin and 2 median rows

of hooks (about 10 hooks in each row). Chromatophores are dense and dark on the dorsal surface of the mantle, head and arms; in life they impart a deep bluish color characteristic of neuston species (HERRING 1967). A layer of iridophores gives a reflective sheen to the body. To about 7 cm in mantle length. An open-ocean, epipelagic species that can be caught at the surface, day or night, and is commonly associated with *Sargassum*.

*Ommastrephes pteropus* Steenstrup (Orange-back squid): Large, streamlined, thickly muscled body with broad angular fins. Strong neck folds present. The locking apparatus on the funnel is a deeply grooved, inverted T-shape. Tentacular club with a wrist section (carpus) consisting of a single row of 3-5 alternating, small suckers and knobs; hand section (manus) with 2 longitudinal rows of small suckers along the outer margins and 2 median rows of large suckers with prominent sharp teeth. An oval patch of very tightly packed photophores lies just under the skin on the anterior end of the dorsal surface of the mantle. Similar cream-colored, individual photophores, like small grains of rice, are embedded in the muscle of the mantle ventrally. Animals are a brick-red to a deep maroon color; mantle length to 40 cm. An oceanic species living primarily in the upper few hundred meters. This powerful swimmer is often attracted in great schools to the night light of a ship, where it can be dipnetted. Little is known of its biology, but it is assumed to lay the



### 164 VAMPYROMORPHA, OCTOPODA (Octopuses)

large, gelatinous, sausage-shaped egg masses, containing thousands of eggs, that have been observed on occasion offshore.

arms with unstalked suckers and paired cirri, and 2 are retractable coiled filaments embedded in the extensive interbranchial membrane. With 1 pair of reduced, dorsal fins. Radula well developed; median rachidian with 1 denticle. (Only species of the order:)

#### Plate 164

**O. VAMPYROMORPHA** (Vampire squids): Coleoidea with thin, uncalcified shell, and 10 appendages of which 8 are circumoral

*Vampyroteuthis infernalis* Chun (Vampire squid): Body plump, to 28 cm (including arms), dark purple-black. Eyes large, deep red.



Highly differentiated photophores on and near the eyes, and near fins. Bathypelagic (300-3,000 m); rare.

O. **OCTOPODA** (Octopuses):

Coleoidea with reduced, vestigial, "cartilaginous" shell and 8 circumoral appendages (arms) with unstalked suckers. Fins absent, or 1 pair of separated, paddle-shaped fins. Radula absent, or rachidian with 1 large median projection and 2 or more small lateral cusps; 1st and 2nd lateral teeth multicuspid. Branchial canal present between down-folded filaments. Digestive gland a single undivided structure with the pancreas incorporated. (5 spp. from Bda.)

*Octopus vulgaris* Cuvier (= *O. rugosus* Verrill, 1902; Peile, 1926; Robson 1929) (Common octopus; B Rock scuttle): Genus with firm, muscular body; fins on mantle and cirri on arms lacking. Hectocotylus generally external on tip of uncoiled right 3rd arm.—Species with arms not conspicuously long and slender, but stout; 1st pair always shortest; 2nd and 3rd pairs longer. Body chunky, with variably colors, commonly mottled brown, white and tan. Outer half of gills with 7-11 lamellae. Hectocotylized tip very small on the shortened 3rd right arm (ligula index less than 2.5). Maximum mantle length about 18.5 cm, total length about 1.3 m. From less than 1 m depth to 200 m; prefers a rocky, rubble, or reef habitat. Life expectancy is 1-2 yr. Males generally die after mating and females die after their eggs have hatched. Spawning generally takes place III-X. The eggs, about 3 mm long, are laid in holes in the

rocks, as many as 150,000 in long strands and clusters. The mother broods the eggs, without feeding, for the 30-50 day incubation period.

*O. macropus* Risso (= *O. bermudensis* Hoyle, 1885; 1886; Verrill & Bush, 1900; Peile, 1926; *O. chromatus* Heilprin, 1888) (White-spotted octopus; B Grass scuttle): Genus as above.—Species with very long arms, 1st pair always the largest and usually the longest and the stoutest or co-equally the stoutest with the 2nd pair. Body stout; mantle lengths reach about 15 cm but the long arms give a total length of at least 1.5 m. Animal covered with large, conspicuous white spots over mantle, head and arms against a blue-green to olive background color. When disturbed, animals flush a brick-red and spots become even more prominent. Outer half of gills with 9-13 lamellae. Hectocotylized tip of 3rd right arm very long and slender (ligula index up to 14). Depth range narrow, from less than 1 m to about 17 m. The Bermudian common name implies a grass bed habitat in the flats behind the reefs and in enclosed water with grassy bottoms, but it apparently has been recorded from rocky, sandy and grassy bottoms. Relatively little is known of the biology; spawning probably occurs in winter and early spring. The eggs are extremely small and hatchlings are planktonic before settling to the bottom.

*Argonauta argo* L. (Common paper nautilus, Greater argonaut): ♀ relatively large (to 30 cm), with dorsal arms greatly ex-

panded into glandular membranes that secrete and hold a delicate calcareous shell containing the eggs. This secondary shell is spiral, transversely wrinkled and unchambered. ♂ small (to 1.5 cm), shell-less; its relatively long (to 3 cm) hectocotylus separates at maturation and actively enters the ♀ mantle cavity at copulation. A pelagic, surface-living species that is occasionally washed ashore.

C. F. E. ROPER

## SUPERPHYLUM LOPHOPHORATA (=Tentaculata)

**CHARACTERISTICS:** *Solitary or colonial free-living BILATERIA with a circular or horse-shoe-shaped food-catching organ (lophophore); body and coelom more or less in 3 divisions. Mostly sessile, and with some form of protective covering (tube, shell or external skeleton).*

This assemblage consists of 3 phyla (or classes according to EMIG 1982) whose relationship to each other and position within Bilateria continue to be debated (NIELSEN 1977). All 3 are represented in Bermuda: Bryozoa (p. 500), Phoronida (p. 516) and Brachiopoda (p. 518).

### Phylum Bryozoa (Sea mats, moss animals)

**CHARACTERISTICS:** *Small, mostly colonial, mostly sessile LOPHOPHORATA; body covered by a cuticle or permanently fastened in an exoskeleton, digestive tract U-shaped. Although individuals (zooids) are usually less than 1 mm in size, some colonies may reach 0.5 m or more in diameter (encrusting forms) or height (bushy forms). They are colorless-transparent, or shades of yellow to red to purple. Bushy*

forms are soft-flaccid, flexible or rigid; encrusting forms are generally hard and brittle. The lophophore can be rapidly retracted when disturbed.

Many systematists consider Entoprocta (here treated as a subphylum) a separate phylum within the lower worms. Of some 4,000 extant bryozoan species, 87 are known from Bermuda, of which 45 are included here.

**OCCURRENCE:** Mostly marine and in shelf waters (rarely into oceanic depths); from tropical to polar seas. In Bermuda, they occur underneath corals, rocks, shells and larger algae, both inshore and on various reefs—outer or ledge flats, lagoon and barrier reefs—from the surface down to at least as far as examined (50 m). Many colonies add calcareous encrustations to reef frameworks or inshore rocks, but bryozoan fragments in Bermuda seldom survive abrasion to appear as recognizable grains in the loose sands accumulating across the platform.

As rapid colonizers and vigorous growers, bryozoans (together with other fouling organisms) cover ships' hulls, causing considerable loss in efficiency.

Collecting is best done by SCUBA, snorkeling or wading; some can also be obtained by dredge. Corals, rocks and shells should be turned over, and their undersides closely inspected for inconspicuous colonies.

**IDENTIFICATION:** Colony form is so variable that it is seldom diagnostic; consequently, attention must be concentrated upon microscopic (20-100×) inspection of the individual zooids. A wide variety of externally visible features of the zoecia suffice to distinguish Bermuda species; for many comparative studies, oriented thin sections will often be necessary as well.

Bryozoan colonies tend to be small (a few millimeters or centimeters) or inconspicuous, their form