

2. CHAMBERED NAUTILUSES

by Patrizia Jereb

Living nautilus are limited to a few species belonging to 1 family and 2 genera: the sole survivors of a once extremely specious subclass. They are unique among living cephalopods in possessing a coiled, pearly, external shell (Fig. 95). This is punctuated with chambers and the animal lives in the outermost chamber with its body attached to the sides of the chamber by the adductor muscles. This outermost chamber is connected to the innermost (apical) chamber by a tube (ectosiphuncle or siphuncular tube) which contains a core of tissue (endosiphuncle). Together, the tube and the internal tissue form the *siphuncle*, which serves as a wick to remove the fluid from the chambers. This enables the animal to regulate its buoyancy through control of fluid and gas in the chambers. Nautilus have up to 47 pairs of circumoral arm-like appendages, also called 'tentacles', arranged in 2 rings around the mouth and 2 pairs lateral to the eyes. These appendages lack suckers and have several different sensory functions. Above the tentacles is a large fleshy wedge, called the 'hood'. This is used as a trapdoor to seal the shell closed if the animal is attacked. On each side, between the hood and the tentacles, are the eyes, which are simple and lack lenses, so that seawater flows in and out. Below the tentacles is a rolled flap of skin which acts as a funnel, enabling jet propulsion powered by the large adductor muscles that contract, pulling the body into the shell like a piston.

Until recently, our knowledge of these 'living fossils' was limited. They were thought to be rare animals occurring at only a few remote Pacific island sites. Now they are known to occur through much of the tropical Indo-Pacific region, where they live close to the bottom, primarily over reef slopes, from near the surface to about 500 m depth. Scavengers and opportunistic predators, they seem to compete successfully with deep-water crustaceans and fishes.

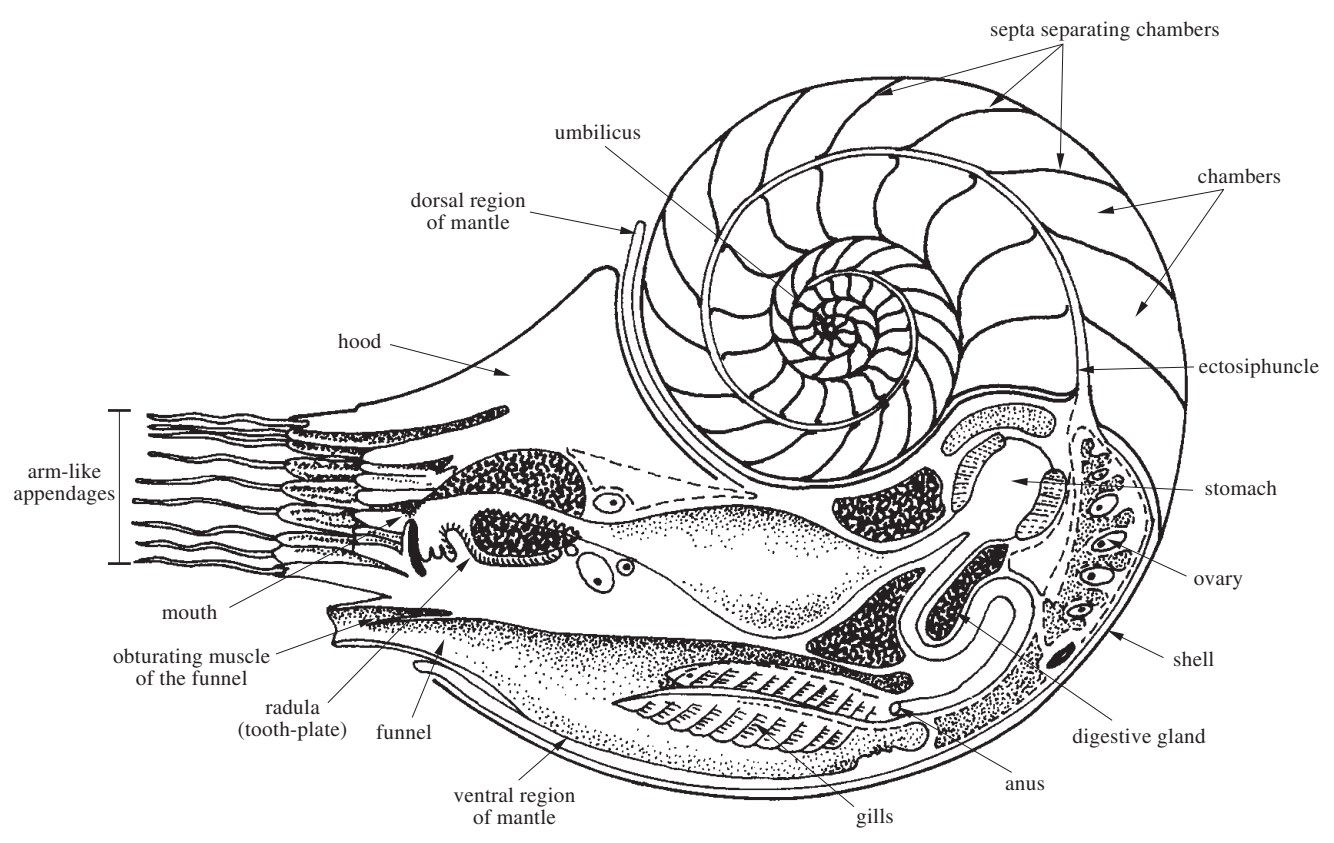


Fig. 95 Schematic cross-section of a *Nautilus*

2.1 Family NAUTILIDAE de Blainville, 1825

Nautilidae de Blainville, 1825, *Manuel de Malacologie et de Conchologie*, 647 pages, Paris, 386.

FAO Names: En – Chambered nautilus; Fr – Nautilus; Sp – Nautilus.

Diagnostic Features: Coiled, pearly, external shell punctuated with chambers; 2 pairs of gills; up to 47 pairs of arm-like appendages around mouth; suckers and hooks lacking; eyes simple, without lenses; funnel (or infundibulum) consisting of 2 lobes which fold together to form a tube-like structure. Chromatophores and ink sac absent. Shell compressed and involute to umbilicate and even perforate. An umbilical callus may be present. Shell sculpture of sinuous growth lines and possibly fine spiral ridges in some species. Shell coloration variable by species. Irregular red to yellow-brown stripes typically radiate from the umbilicus; they cover the entire shell in juveniles, but are restricted to the dorsal, chambered, portion of shell in adults. Shell broader and larger in mature males than in mature females. Radula with 13 elements, including 2 lateral teeth and 2 inner marginal support plates not seen in coleoids; jaws with calcite denticulation. Four tentacles in males fused to form the spadix, used to transfer spermatophores to females during copulation. Males are larger than females.

Size: Shell up to 229 mm in diameter, average animal weight up to 1 675 g. Shell size varies depending on species and geography.

Habitat and Biology: Nautilus are primarily mobile benthic bottom dwellers, associated with coral reefs, ranging from near the surface to about 500 m depth, but their optimal range seems to be from 150 to 300 m. Factors controlling the upper limits include predation by fishes and temperature: temperatures exceeding 25°C may be lethal for these animals. This explains why most shallow water sightings of nautilus occur at night and during cold seasons. Maximum depth limits are determined by shell implosion (about 800 m) and chamber flooding (about 300 to 400 m). Males outnumber females and both live for many years after maturity is reached at an estimated age of 5 to 15 years. Recent mark-recapture studies indicate that nautilus may live for more than 20 years. Growth is slow and no more somatic growth occurs after the animals reach sexual maturity. Egg capsules have not been seen in natural habitats, but in captivity eggs are laid singly, attached to hard substrates and take up to 14 months to hatch in warm water (21° to 24°C). It is hypothesized that in nature they are laid in relatively shallow water (80 to 100 m) and that after hatching the young move to deeper, colder waters. The egg, similar in shape and size to a whole garlic, is equipped with 1 or 2 capsules, separated by a narrow space full of seawater. The outer shell is white, tough but flexible, and provided with a series of small holes that allow seawater to circulate between the 2 capsules. In aquaria, young hatchlings feed almost immediately on shrimp or other food items. Decapod crustaceans seem to be a standard food for adults, but echinoid fragments, fish bones, coleoid beaks and nautilus tentacles have also been observed in the crops of examined animals. Nautilus are highly mobile; tagged animals have been seen to move over 150 km in one year. They also move to shallow waters at night and return to deeper waters during the day, where, however, they remain active.

Interest to Fisheries: At least 2 of these species are of commercial value as food, largely at the artisanal and subsistence levels, and nautilus shells are sold commercially in the shell trade (e.g. in Indonesia, Fiji, New Caledonia, and the Philippines). Nautilus are also collected alive for public display and home aquaria and for research. They are caught using baited fish traps.

Remarks: Although 11 species have been named within the genus *Nautilus*, only 4 are well established and can be distinguished by differences in shell and (in some instances) soft part morphology: *Nautilus belauensis*, *N. macromphalus*, *N. pompilius* and *N. stenomphalus*. One species, *N. repertus*, has questionable status. Recently, Ward and Saunders (1997) erected a new genus, *Allonautilus*, for the most unusual member of the group, *A. scrobiculatus*, and one morphologically similar, but extremely rare, and not well known form, *A. perforatus*.

Literature: Flower (1964), Solem and Roper (1975), Saunders (1981a), Roper *et al.* (1984), Saunders (1987), Saunders and Landman (1987), Saunders (1998), Ward and Saunders (1997), Norman (2000).

Key to genera in the family Nautilidae

- 1a. Umbilicus small, or moderate, i.e. from 5 to about 16% of shell diameter; whorl cross-section oval (Fig. 96) . . . *Nautilus*
 1b. Umbilicus larger, approximately 20% of shell diameter; whorl cross-section quadrate (Fig. 97) *Allonautilus*

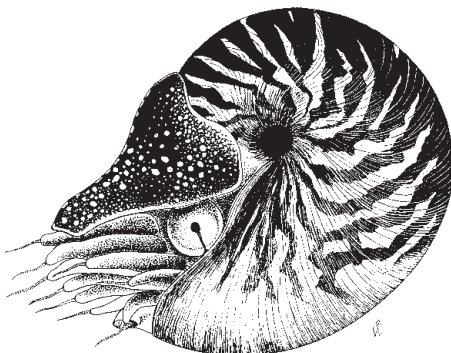


Fig. 96 *Nautilus*



cross-section

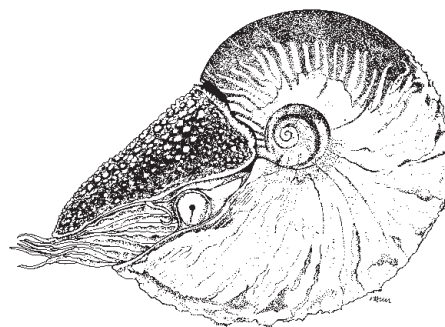
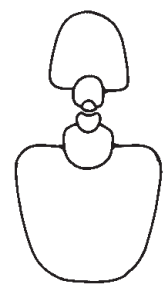


Fig. 97 *Allonautilus*



cross-section

Nautilus macromphalus* Sowerby, 1849*Fig. 98**

Nautilus macromphalus Sowerby, 1849. Monograph of the genus *Nautilus*. In: *Thesaurus Conchyliorum*, 2: 463–465 [type locality: unknown].

Frequent Synonyms: None.

Misidentifications: None.

FAO Names: En – Bellybutton nautilus; Fr – Nautilé bouton; Sp – Nautilo ombligo.

Diagnostic Features: Umbilicus open, a deep, round shouldered concavity, approximately 15 to 16% of shell diameter at its widest point; inner coils of the shell visible. No thickened layer (callus) present.

Size: Maximum shell diameter around 160 mm.

Geographic Distribution: Southwestern Pacific Ocean; live animals known only from off northeastern Australia, New Caledonia and Loyalty Islands, while drift shells have been recorded as far south as Lizard Island, Queensland (eastern Australia) (Fig. 99).

Habitat and Biology: *Nautilus macromphalus* inhabits continental shelf and slope waters associated with coral reefs, from the surface to a depth of about 500 m. In some areas of southern New Caledonia, this species rises to very shallow waters at night (i.e. less than 20 m depth), so divers can observe animals foraging.

Interest to Fisheries: Consumed locally, it is object of artisanal fishery. It also supports a small fishery for public and private aquaria and research trade. Collected alive at a depth of about 65 m on the outer slope of the barrier reef in New Caledonia; in the Coral Sea it is caught by traps, at depths between 300 and 400 m.

Literature: Dunning (1998), Saunders (1987), Norman (2000).

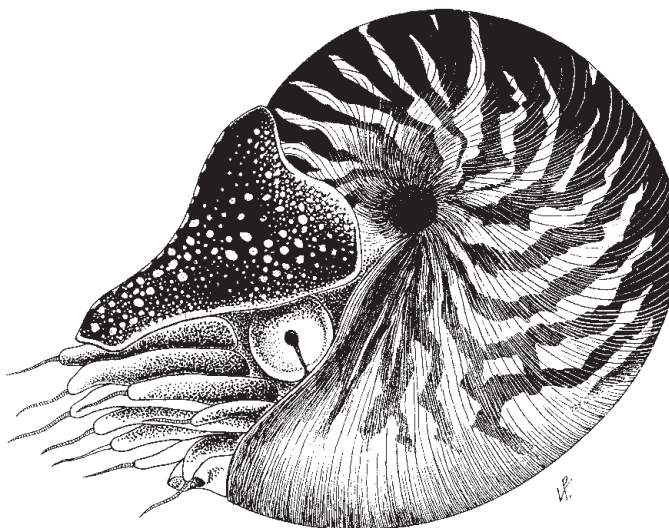


Fig. 98 *Nautilus macromphalus*

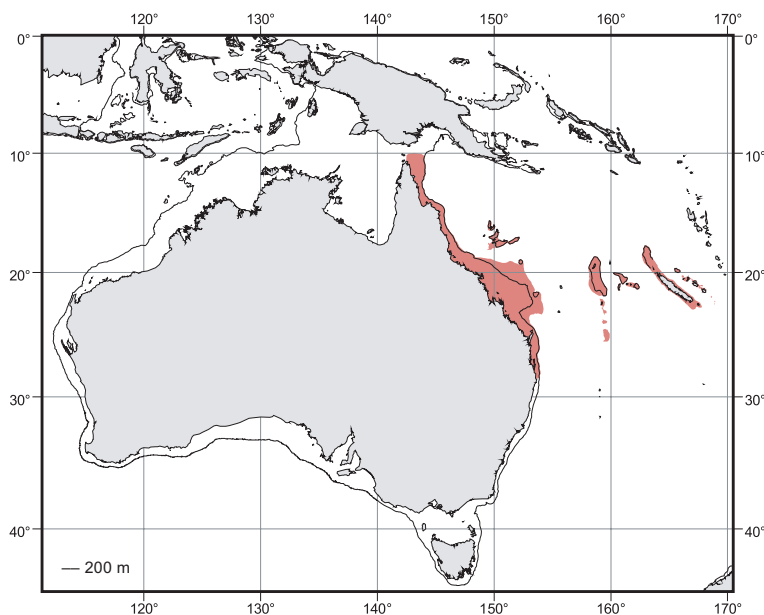


Fig. 99 *Nautilus macromphalus*
■ Known distribution

Nautilus pompilius Linnaeus, 1758

Fig. 100; Plate I, 1–5

Nautilus pompilius Linnaeus, (1758). 'Systema Naturae.' 10 (1): 709. (Holmiae.) [=Stockholm] [Reprint Leipzig, 1894] [type locality: Ambon, Indonesia].

Frequent Synonyms: None.

Misidentifications: None.

FAO Names: En – Emperor nautilus; Fr – Nautille flammé; Sp – Nautilo común.

Diagnostic Features: Umbilicus small, visible as shiny silver and black patch, closed; callus usually present (with rare exceptions). No inner coils visible. Shell colour patterns variable: irregular brown to reddish brown stripes radiate from the umbilicus to venter in the usual coloration, but this striping can be reduced to various degrees, leaving the umbilicus and even much of the flanks white.

Size: Shell diameters typically between 170 and 180 mm around Fiji and the Philippines, larger in the Western Australian population (i.e. mean diameter up to 222 mm).

Geographical Distribution: Indo-West Pacific; Andaman Islands, Ambon, the Philippines, New Guinea to Fiji; northeastern and northwestern Australia. Absent from around New Caledonia, where it is replaced by *Nautilus macromphalus*. Sympatric with *Allonautilus scrobiculatus* off New Guinea and *Nautilus stenomphalus* off northeastern Australia. Replaced by *Nautilus belauensis* around Palau (Fig. 101).

Habitat and Biology: *Nautilus pompilius* is the most widely distributed and best known *Nautilus* species. It inhabits deeper continental shelf and slope waters around coral reefs, from near the surface to a depth of about 750 m. The species has been bred in captivity and animals are frequently kept in public aquaria.

Interest to Fisheries: This species supports a substantial shell trade, mostly from beach-drift specimens, and subsistence and artisanal fisheries. Captured in bamboo fish traps at depths from 60 to 240 m, the meat is sold in local markets and the shells go to the shell trade. The outer layers of the shells are sometimes removed, leaving the outer surface a silvery mother-of-pearl layer.

Remarks: The Western Australian population includes the largest specimens known, with a mean shell diameter of 222 mm and mean weight of 1 675 g. Here, shell striping varies from the typical form to reduced yellowish stripes that leave the umbilicus and flanks white. The questionable species *N. repertus* was described by Iredale (1944) on the basis of its large size (about 228 mm shell diameter) and the reduced orange-brown coloration observed on 2 drifted specimens from Western Australia. Historically, this has not generally been considered adequate to distinguish the species, given the considerable range in variation in both shell size and colour pattern in *N. pompilius*. However, increasing documented evidence of variation in shell colour pattern and dimensions between different regions, suggests that *Nautilus pompilius* populations are isolated from each other, and may, at least, represent distinct subspecies. The application of recently developed biochemical and genetic analysis may shed light on the validity of *N. repertus* and on the possible existence of *N. pompilius* subspecies. Northern Australian records of animals with shells up to 240 mm in diameter may represent an additional related species.

Literature: Saunders and Davis (1985), Saunders (1987), Saunders and Ward (1987a), Swan and Saunders (1987), Dunning (1998), Saunders (1998).

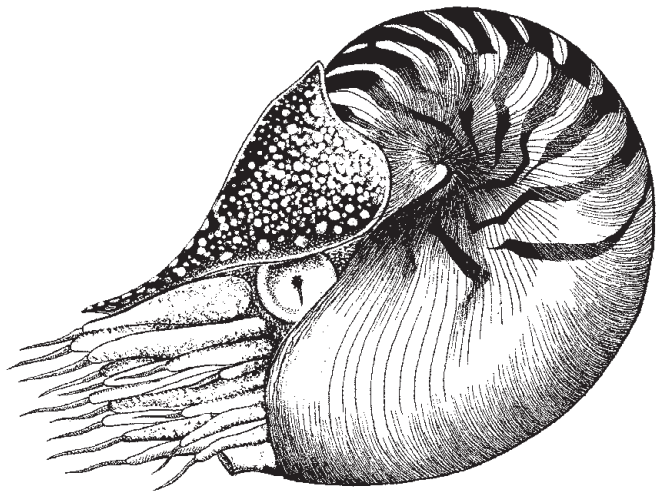
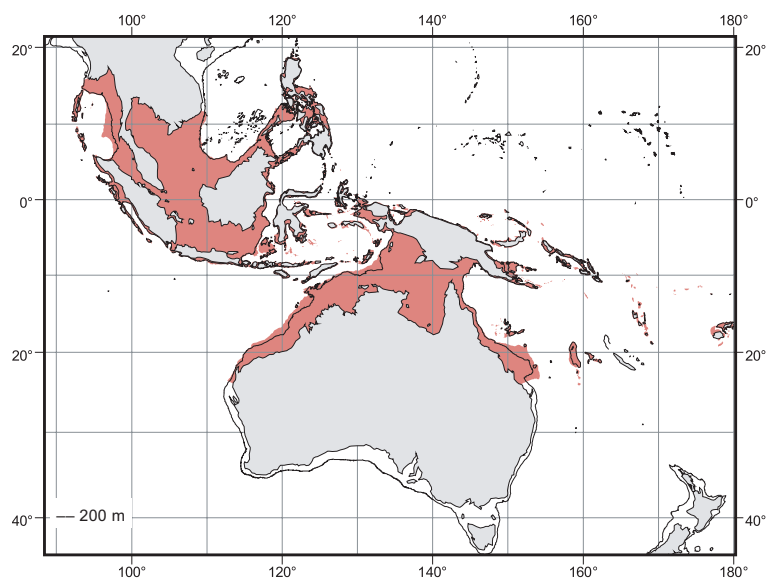
Fig. 100 *Nautilus pompilius*

Fig. 101 *Nautilus pompilius*
■ Known distribution

**SPECIES OF NO CURRENT INTEREST TO FISHERIES, OR RARE SPECIES FOR WHICH ONLY
FEW RECORDS EXIST TO DATE**

***Nautilus belauensis* Saunders, 1981**

Plates I, 6 and II, 7–9

Nautilus belauensis Saunders, 1981, A new species of *Nautilus* from Palau, *The Veliger*, 24(1): 1–7, 3 pls, 2 text figs [type locality: Palau, Western Caroline Islands].

Size: Shell diameter to 226 mm, animal weight to around 1308 g. The second largest species of *Nautilus*.

Geographical Distribution: Palau, Western Caroline Islands.

Remarks: The first species bred in aquaria.

Literature: Saunders, 1981b, Saunders and Spinosa (1978, 1979), Norman (2000).

***Nautilus repertus* Iredale, 1944**

Nautilus repertus Iredale, 1944, Australian pearly *Nautilus*. *Australian Zoologist*, 10(3): 294–298 [type locality: Rottneest Island and Pelsart Island, Western Australia].

Size: Shell diameter up to 228 mm.

Geographical Distribution: Type locality and General distribution: Rottneest Island and Pelsart Island, Western Australia.

Remarks: Doubtful species. See Remarks in *Nautilus pompilius*.

Literature: Dunning (1998), Saunders (1998), Norman (2000).

***Nautilus stenomphalus* Sowerby, 1849**

Plate II, 10

Nautilus stenomphalus Sowerby, 1849. Monograph of the genus *Nautilus*. In: *Thesaurus Conchyliorum*, 2: 463–465 [type locality: Great Barrier Reef, eastern Australia].

Size: Shell diameter to around 170 mm.

Geographical Distribution: Great Barrier Reef, eastern Australia.

Remarks: Very similar in size and weight to *Nautilus pompilius*, from which it can be distinguished by the absence of the callus and the reduced coloration, lacking in the umbilicus region. The hood is covered by elevated papillae, in a very characteristic pattern. The first live captures were reported by Saunders and Ward (1987b).

Literature: Saunders and Ward (1987b), Saunders (1998), Norman, 2000.

Allonautilus scrobiculatus (Lightfoot, 1786)**Plate I, 4–5**

Nautilus scrobiculatus Lightfoot, 1786, A catalogue of the Portland Museum, lately the property of the Duchess Dowager of Portland, Deceased. London, 194 p. [Type locality: Ndrova Island, Manus, Papua New Guinea].

Size: Shell diameter to around 180 mm.

Geographical Distribution: Tropical western Pacific: Papua New Guinea, Manus Province, Bismark Archipelago and Milne Bay. Drift shells are known as far south as the Solomon Islands.

Remarks: The rarest and most distinctive species among nautiluses. Other than for the larger umbilicus, *Allonautilus scrobiculatus* differs from the other nautiluses in the very peculiar features of the shell, including creases and encrusting layer on the periostracum (see Fig. 97). Gills and male reproductive system also differ from those of *Nautilus* species.

Literature: Ward and Saunders (1997), Norman (2000).

Allonautilus perforatus (Conrad, 1847)

Nautilus perforatus Conrad, 1847, Notes on shells, with description of new genera and species. *Journal of the Academy of Natural Sciences*, Philadelphia, *Second Series*, 1: 210–214 [type locality: unknown].

Size: Shell diameter to around 180 mm.

Geographical Distribution: Bali, Indonesia.

Remarks: Very rare form of questionable validity, only known from shells. Shell very similar to that of *Allonautilus scrobiculatus*.

Literature: Ward and Saunders (1997).