BANGKOK SEASHELL MUSEUM (ON SILOM 23rd STREET)

AN INTRODUCTION TO "SHELLS"

WHAT ARE SHELLS & PHYLUM MOLLUSCA?

Shells or seashells are the hard external coverings of soft-bodied organisms; mollusks, members in the Phylum Mollusca which includes clams, snails, slugs, octopuses, squids, and chitons. In some forms however, the shell has been lost in the course of evolution, as in slugs and octopuses, or greatly reduced in size and internalized, as in squids. Mollusca also includes some lesser known groups like the monoplacophorans, a group once thought to be extinct for millions of years until one was found in 1952 in the deep ocean off the coast of Costa Rica.

The word "mollusk" derives from the Latin mollis meaning "soft", just as the term "malacology", the study of mollusks, comes from the Greek word for soft, malakos. Mollusca is one of the most diverse groups of animals on our planet; there may be as many as 100,000 living species (and more likely to be around 200,000), second in number only to the Phylum Arthropoda (which includes insects, crabs, shrimps, etc.), many of them found in land or freshwater habitats, but most of them living in the world's seas.

These creatures have been important to humans throughout history as a source of food, jewelry, tools, and even as pets. A part of almost every ecosystem in the world, mollusks are extremely important members of many ecological communities. They range in distribution from terrestrial mountain tops to the hot vents and cold seeps of the deep sea, and range in size from 20-meter-long giant squid to microscopic aplacophorans, a millimeter or less in length, that live between sand grains.

They also have a very long and rich fossil record going back more than 550 million years (in the Cambrian period), making them one of the most common types of organism used by paleontologists to study the history of life.

Most mollusks are "nocturnal animals", meaning they are more active at night than during the day. While sting during the day. Sea snails generally burrow in sandy bottoms to hide themselves from hunter animals and terrestrial & desert snails may hide underneath leaf litter or fallen trees in order to escape extreme daytime heat and preserve the humidity within their shells.

SYSTEMATICS

Most authorities now place living mollusks in seven classes as shown in the cladogram below.

Class Bivalvia (cockles, mussels, oysters and other bivalves): laterally compressed mollusks contained within a two-piece (or bivalve) shell, the valves being hinged, and joined by the elastic ligament. One or two adductor muscles open and close the valves. Most bivalves have a large foot, a pair of siphons, and a fleshy, shell-forming mantle lining each valve. Found in sea, terrestrial and freshwater habitats.

Class Monoplacophora (segmented limpets, or gastroverms): meaning "bearing one plate", limpetlike mollusks with internal segmentation and a thin, almost circular, caplike shell. Up to 2008, about 31 species of these "living fossils" are known, all from deep seas. They have a single, flat, rounded bilateral shell that is often thin and fragile; it ranges in size from 3 to 30 millimetres.

Class Gastropoda (snails, whelks, slugs, limpets, cowries, etc.): single-shelled mollusks usually with tentacles and eyes, a broad foot, and a visceral hump contained within a shell that may be coiled. Within the mouth of these univalves there may be many or few teeth, arranged in rows on a ribbonlike structure (the radula) the mollusks typically used for scraping, cutting and chewing food before it enters the esophagus, unique. Some have a operculum, a horny or calcareous structure attached to the foot, seals or partially seals, the aperture when the animal withdraws into its shell. Found in both sea and freshwater habitats.

Class Cephalopoda (nautiluses, cuttlefish, octopuses, squids): Cephalopoda derived from Greek plural Κεφαλόποδα (kephalópoda); "head-feet". Equipped with large eyes, a powerful beak, and sucker-studded tentacles, a cephalopod seems to have little in common with other mollusks, although the possession of a radula and, occasionally, a shell indicates that it may be more closely related to them than outward appearances and habits suggest. There may be as many as 1,000 different species of cephalopods living in the world's seas.

Class Scaphopoda (tusk shells, or tooth shells): meaning "shovel-footed", bilaterally symmetrical mollusks with a tusklike shell, open at each end, the anterior end being the larger. The posterior end commonly protrudes above the sand in which tusk shells live. There is a large foot and a radula, but it looks head, eyes, and gills. All of the roughly 1,000 species are marine species, many requiring a hand lens to identify.

Class Aplacophora (solenogasters): The Greek-derived name Aplacophora means "bearing no plate", wormlike, mostly very small mollusks covered with a calcareous spicules. Exclusively marine, they feed on bottom-dwelling animals, such as coelenterates, or on organic debris, and have been recorded at great depths. About 250 species have been described.

Class Polyplacophora (chitons, or coat-of-mail shells): The Greek-derived name Polyplacophora comes from the words poly- (many), plako- (tablet), and -phoros (bearing), a reference to the chiton's eight shell plates. Chitons are elongate-oval mollusks with a broad or narrow foot and a flattened visceral hump over which is situated an articulated, eight-piece shell, the outer edges of which are embedded in and surrounded by a flexible "girdle". About 650 species are known, mostly found clinging to in-shore rocks, though a few deep-water species have been recorded.

References

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FIRST FLOOR - Gastropods & Bivalves

Living Noble Volute or *Cymbiola nobilis* (Lightfoot, 1786)

Volutes - Family Volutidae

Volutes are often called the aristocrats of the shell world. The beautiful colors and striking patterns of the many species make this a popular family to collect or to study as a specialty. Most volutes are moderate in size, but a few rank among the largest of all shelled mollusks. The tropical species vary greatly in shell color and pattern from one locality to another.

Volutes lack the free-swimming larval stage of many other mollusks. Their large egg capsules contain albumen, enabling the embryos to survive a prolonged period of development that might last several months. Tiny, fully formed shells emerge from the capsules and crawl away on the bottom to start life close to the place where they were hatched. Without a planktonic larval form that can be carried great distances by ocean currents, volute species are not widely dispersed. They tend to be colonial and restricted to small ranges.

Living Indian Volute or *Melo melo* (Lightfoot, 1786)

The large, West African elephant-snout volutes (*Cymbium* spp.) are among the few mollusks that bear their young alive. Actually, the eggs are brooded inside a modified pouch, or marsupium, in the mother's foot. The young shells may grow to two inches in some species before being expelled.

Most volutes live in sandy habitats where they burrow into the sand and remain buried until night. They are carnivores, feeding on other mollusks & small marine invertebrate animals that they detect by

smell. They use their large and powerful foot to engulf their prey, usually a bivalve or another snail, after which a toxic saliva is secreted to paralyze the victim.

Most of them inhabit deep seas and are abundant in warm, temperate waters, expecially around the coasts of Australia. Many of the 250 species of volutes are uncommon or rare, and prices are high for those that are difficult to obtain.

Tritons - Family Ranellidae

The tritons are a large family of solid, highly sculptured shells. When alive, many species have a thick outer skin called the periostracum. In some species, the periostracum is extremely "hairy," with tiny bristles or leafy folds which help the shell blend into its surroundings.

Tritons are famous for having many cosmopolitan species, species which have a worldwide distribution. For example, the famous Hairy Triton, *Cymatium pileare*, is found in Florida, South Africa, the Philippines, and Brazil, yet it looks identical throughout this enormous range, Other cosmopolitan tritons may show some geographical variation. The reason for the wide distributions is that the lightweight, free-swimming larvae may live for up to a year as part of the plankton that is carried along with ocean currents for long distances. When the larvae begin to develop shells, they become heavier and sink, after which they continue their lives as bottom dwellers.

Tritons are voracious carnivores, feeding on a variety of mollusks, sea urchins, starfish, crabs, and other marine invertebrates. They produce a paralyzing fluid that is injected by the proboscis into prey animals to prevent them from escaping.

Distorsios - Family Personidae

Distorsio shells were formerly classified with members of the present Ranellidae (Cymatiidae) family. Alan J. Beu, 1988, states that they belong to a distinctly separate family, the Personidae, for the following reasons: 1) Paleontologically, the shells have evolved along a parallel lineage distinct from most Ranellidae,

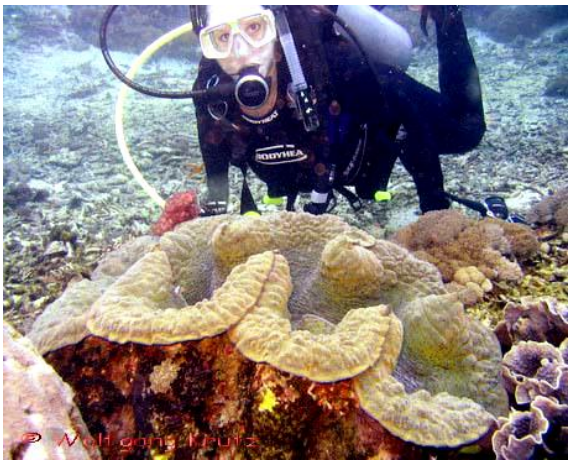
at least 15-30 million years earlier, and with no discernable common ancestor in the fossil record. 2) The mollusk shows anatomic details of the upper pharyngeal and gastric tract that are similar to those of the Ficidae. 3) The radula has teeth like spiny crescents rather than the ribboned teeth of most Ranellidae.

Distorsio shells are distinctive in showing a rather distorted coiling of the knobbed whorls, which are found even around the aperture. Soft tissue features are common to all three genera of the Personidae family. The Indo-Pacific species are found at moderate depths in warm waters. Distorsio anus is usually found under or among corals.

The former family, Cymatiidae, has been split into two new families: Ranellidae (tritons) and Personidae ("Distorsios"). "Cymatiidae" is now a synonym for the Ranellidae family.

Frog Shells - Family Bursidae

'Frog Shells' are worldwide tropical gastropods which live in shallow and deep water. A couple of species are extremely rare and represented in very few private collections. The thick, heavy shells are often covered with coralline encrustations from the coral habitats they inhabit. A deeply notched canal at the posterior end of the aperture is a common characteristic of the family. Some species have richly colored apertures with lavender, orange, or red coloration. Some species have striking columellar ornamented of white plications over a black coloration. The largest known Bursidae species, Tutufa (T.) bardeyi, as shown here. The smallest species grow to only an inch, or less.



Giant Clams - Family Tridacnidae

Family Tridacnidae (Fluted Giant Clam)

The delicate "frilly" appearance of the Fluted Giant Clam is produced by numerous rows of pronounced, overlapping scales. Shells are sometimes white but also come in pastel shades of pink, orange,

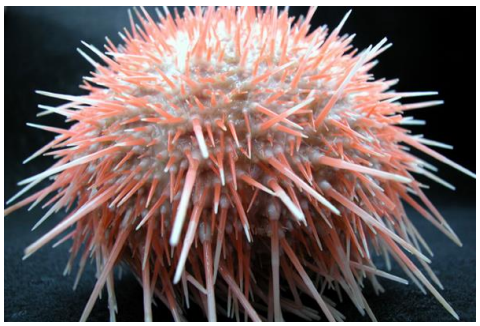
and yellow. This Indo-Pacific species lives a solitary life on shallow coral reefs. Living corals and sponges often grow around the shell, helping it blend in with the reef.

Although the Fluted Giant Clam is a filter feeder, it has also adapted to a symbiotic relationship with tiny algal cells (*Zooxanthellae*) which lived embedded in the upper surface of the soft mantle. The mantle is somewhat expanded, and the valves remain open most of the time, so the algae are exposed to maximum sunlight. The algae provide the clam with food and, in return, are protected from oceanic grazers. The mantle is marked in detailed patterns of blue, green and brown; no two animals are alike.

Giant Clams can reach lengths of 50 inches or more and weigh up to 500 pounds. They hold the record for producing fantastic quantities of eggs. They often discharge at one time as many as a billion eggs once a year. Giant clams reproduce sexually via broadcast spawning. They expel sperm and eggs into the sea. Fertilization takes place in open water and is followed by a planktonic larval stage. The larvae (veligers) must swim and feed in the water column until they are sufficiently developed to settle on a suitable substrate, usually sand or coral rubble, and begin their adult life as a sessile clam. This fertilization can go on for 30 to 40 years! Of course, only a few individuals, if any, will ever make it to maturity.

THE CENTER GLASS DISPLAY





SEA URCHINS are animals in Class Echinoidea in the Phylum Echinodermata with a somewhat round like orange or melon, having long and short outer spines. They are not mollusks but are animal in the group of starfishes and sea cucumbers, There are knobs all over the body, that connect their hard spines to their round shells and are able to move around like their legs.

Sea urchins feed on many kinds of sea life dead or alive including shells (mollusks). As well they become food for many groups of mollusks. The Bangkok Seashell Museum added this special display to show their similar beauty when compared with mollusks. Although they live together and looked much alike, they are not in the same group of animal!

Japanese Spiny Turbans served in Japanese Restaurants.

Turbo cornutus (Japanese Spiny Turbans) can be found in NE China, Korea, and Japan. Mainly these long-spined specimens are only found from Hokkaido in the northernmost part of Japan, in cold waters. They are quite common locally and are eaten as Japanese seafood. For decades they have been very common in worldwide seashell collections, but due to their higher value as a food fish, it's hard for collectors these days to fight with higher prices in fish markets to get few neat ones into their collections.

Turbo marmoratus are used widely in the past in Thai and Korean Royal handicrafts for pearl-inlay arts. They have been very common and could be collected anywhere in Thai coastal areas, shallow rocks with algae (their food), but for the past several years, their natural population has been reduced due to over-collecting for the use of pearl-inlay arts. More recently scientists hard to study the possibility of farming them and returning them into their natural habitats, and due to higher value, artists have turned to using natural pearly mussels from freshwater rivers, which are more abundant and much cheaper in cost.

Family Cassidae (Helmet Shells, Bonnets, and False Tuns)

The Family Cassidae is a relatively small group of marine mollusks, but includes some of the largest molluscan species. *Cassis cornuta*, one species of the genus, is probably the largest; specimen measuring over 16 inches in length.

No. 61 

Horned Helmet or *Cassis cornuta* (L., 1758)

Commonly known as Helmet Shells, including bonnets & false tuns, the Cassidae inhabit tropical and temperate oceans from intertidal to subtidal depths; a few as deep as 1000 meters of water. Many species surface as a by product of the fishing industry in trawling nets, and by dredging. Many of the largest species can also be collected by divers and snorkelers. The large species of Cassis are a food source in certain parts of the world. The Indo-Pacific *Cypraecassis rufa* is commonly used for carving cameos. Other large species have also been used for this ancient art, but the thick shell of *Cypraecassis rufa* is preferred by artisans for producing the bas-relief carving.

No.62 

Bullmouth Helmet or *Cypraecassis rufa* (L., 1758)

Helmets feed primarily on sea urchins and sand dollars. The helmet animal accomplishes this by using its radular teeth and acidic secretions to drill a hole into the “test” or shell of the urchin, digesting the soft parts within. Some long-spined sea urchins have been observed to shed their spines when penetrated by a helmet, supposedly the result of a toxic injection from the helmet’s proboscis. Some helmets, mostly bonnet shells, lay their egg capsules in layered towers.

No.71 -72

Family Ficidae (Fig Shells)

Ficidae or the fig shells are a taxonomic family of medium to large sea snails, marine gastropod molluscs in the clade Littorinimorpha. The shells of these snails are shaped rather like figs or pears. The family is found worldwide, mostly in tropical and warm ocean waters. Fig shells are found on fine sand and mud bottoms offshore. Ficidae shells are thin but strong. They have a large aperture and a long siphonal canal, but an extremely low spire which does not protrude above the outline of the body whorl.

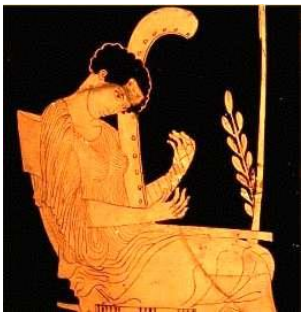
Fig shells very often have subdued spiral ribbing, and are subtly patterned in shades of very pale brown and beige. Some studies found that Fig shells feed mainly on sea cucumbers.

No.73-78-77

Family Tonnidae (Tun Shells)

The family Tonnidae is represented by the genera Tonna and Eudolium. Species of Tonna are large, globular lightweight shells, mainly tropical in distribution, that live from the shallow subtidal down to several hundred metres. They live mainly in sandy areas, where they can burrow beneath the sand and leave just the tip of their siphon exposed. They feed on sea cucumbers (holothurians).

The family Tonnidae includes a small number of species with medium-sized to large shells which are thin for their size, and nearly spherical. The spire is small, while the body whorl is large and well inflated, ending in a very wide aperture. The outer surface is usually sculptured by thick spiral ribs. The animals lack the operculum. Most tun shells can be found living in sand, in the tropics beyond the edge of the coral reef.



No. 79 – 86 HarpShells Ancient harp in Greek Mythology.

Family Harpidae (Harp Shells and Morums)

The Harpidae, better known as the Harp shells, encompass two rather divergent groups in the Subfamilies Harpinae, which includes the genera *Harpa* and *Austroharpa*, and the Moruminae, or Morum shells.

Harps are unquestionably some of the most handsome shells. The shiny, globose shells with their intricately variegated patterns of pinks and purplish reds create a form most pleasing to the eye. The raised axial ribs are suggestive of the strings of a harp, thus giving the group its name.

Morum shells are quite different in form, but the animals themselves are similar to harp animals. Morums characteristically have a broad parietal shield near the mouth of the shell. Some species' shields are highly colored or shiny, while others' are thin and insignificant. Harps and morums both live in sand and prey primarily on crabs and shrimp. Most species in the genus *Harpa* are found intertidally, whereas most of the *Morum* species and all of the *Austroharpa* live in subtidal to extremely deep water habitats. Many of these *Morum* and *Austroharpa* are quite rare, due to the inaccessible deep water habitats and limited geographical ranges. Many of the deeper water species surface as a by-product of fishing trawlers.

These creatures have the peculiar ability to detach a small part of their foot. This sacrifice was thought to be a defense mechanism to facilitate escape from a predator, and nothing more. But recently a harp was observed being pursued by a box crab, a species that feeds on mollusks. The harp detached a small piece of the posterior end of its foot and the crab began to consume it. Thereupon, the harp circled around behind the crab, engulfed it in a thick coating of mucus and sand, and began to suck fluids from the soft tissues inside the crab's shell. In other words, the detached tidbit was offered as bait to distract the crab, and the predator became the prey.

Oysters – These are sea oysters collected from Andaman Sea, Thailand. They are a popular delicacy for locals and visitors to many provinces bordering the sea of Thailand.

2nd Floor, exhibition for Bivalves, Nautiluses and some other gastropods!

Family Pectinidae - Scallops

Scallop shells have figured prominently in art, architecture and religion from ancient times to the present. The scallop gained popularity in the ancient world with the myth of Aphrodite, who supposedly rose in birth from a scallop shell (This myth was immortalized by Botticelli's famous 15th – Century painting "The Birth of Venus") Scallop shells even became a symbol of renewed life. The Ancient Greeks used a stylized scallop as a shoulder clasp, called *chlamys*, for their tunics. Romans modeled glass bottles in the shapes of scallops and created exquisite floor mosaics and wall murals depicting scallops. Indeed, the scallop has been a venerated and noble shells. The scallop became a symbol of Christianity from the very beginning. The apostle James was a fisherman, and a group of his followers gave him a gift scallop as a representation of his profession. St. James was thereafter strongly associated with the scallop as a souvenir for the ultimate pilgrimage to Jerusalem.

Scallops are special favorites with collectors because they come in a fantastic array of color and pattern as displayed in this hall. There are more than 400 species and the majority produce vivid color forms and exhibit a surprising diversity of pattern.

Scallops are of great economic importance throughout the world because they taste so good and occur in such great numbers. More than 50 species are commercially harvested worldwide. More than 30 million tons of Atlantic Deep Sea Scallops alone are trawled annually. The scallops provide such great meat because it has only one large disk-like adductor muscle – the part we eat (through evolution, they have combined two into one), whereas most other bivalves have two small ones.

Family Haliotidae (Abalones, Ear-Shells or Ormers)

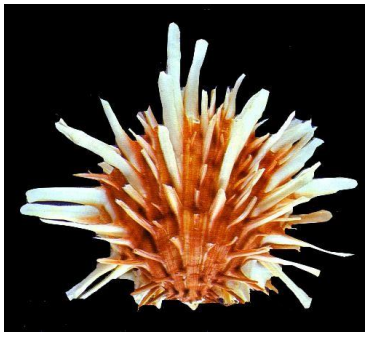
Abalones are another group of primitive gastropods, closely related to slit shells. However, the slit is present as a series of small holes which have the same function of passing excretions and waste water. As the animal extends the edge of its shell in growth, a new hole is added as an older one is sealed. “Abalone” is the American English variant of the Spanish name Abulón used for various species of shellfish (mollusks) from the Haliotidae family (genus *Haliotis*).

Abalone meat has long-been known by Chinese as food, perhaps for a couple of thousand years. The foot muscle is a popular and expensive seafood item in many countries as well. Abalones are in such demand that several larger species are successfully raised by aquaculturists in commercial abalone farms. Most of the commercially raised abalone are from several countrie. U.S.A., Mexico, New Zealand, Australia and South Africa, supply Japan, Hong Kong, Korea, China and Taiwan where demand is greater and the prices are much higher.

The recreational and commercial collecting of natural-grown abalone is strictly controlled in California, with size and quantity limits imposed by species and region. Some areas are closed to collecting until stocks have reached a sustainable size. In the state of South Australia, the government grants a limited number of permanent collecting permits for commercially harvesting abalone. Divers holding permits are on a quota system and must take only a certain volume of meat.

The Paua shell (Haliotis iris Martyn, 1784) from New Zealand is amongst the most beautiful of all abalones, the inner iridescent part of shells is widely used to make jewelry which sometimes is called Sea Opal.

Abalones reach maturity at a small size. Their fertility is high and increases with size (from 10,000 to 11 million eggs at a time). The larvae feed on plankton. The adults are herbivores and feed on macroalgae, preferring red or green algae. Sizes vary from 10 mm (Haliotis thailandis) to 300 mm (or larger, in Haliotis rufescens).



Family Spondylidae (Thorny Oysters) – Family Spondylidae

Thorny Oysters are more closely related to scallops than to true oysters, but like true oysters, they live a stationary life attached to a solid base. The valves are usually slightly open, exposing the colorful mantle while the animal filters microscopic algae from the sea water. These bivalves prefer areas with strong currents that carry a constant supply of the phytoplankton upon which they feed.

Thorny Oysters have multiple eyes along the mantle’s edge like scallops and can detect changes in light intensity. They have a relatively well developed nervous system. Their nervous ganglia are concentrated in the visceral region, with recognizable optic lobe connected to the eyes.

Spondylus shells are much sought after by collectors. Collectors find their beautiful colors and long spines irresistible and there is a lively commercial market in them. Archaeological evidence shows that people in Neolithic Europe were trading the shells of *Spondylus gaederopus* to make bangles as long as 5000 years

ago. The shells were harvested from the Mediterranean but were transported far into the centre of the continent. *Spondylus princeps* are found off the coast of Ecuador, and have been important to Andean peoples since pre-Columbian times.

Chambered Nautilus (Family Nautilidae) - Class Cephalopoda

The Nautilus is a member of the Class Cephalopoda, a group including the squid, octopus and cuttlefish. Cephalopods are the most highly evolved mollusks, possessing a well developed nervous system and increasingly keen eyes. They have a number of sensitive, prehensile tentacles surrounding a parrot-like beak.

The Nautilus is the only cephalopod to have a true external shell. The form of the shell itself has fascinated naturalists, mathematicians and physicists for years. The spirally coiled, chambered shell is perfectly proportioned mathematically – a remarkable feat of natural engineering.

Shown here in the center of glass showcase is a sectioned shell showing the design of its interior. The Nautilus is famous for its multi-chambered shell. The animal only occupies the outer compartment, but is attached to the other chambers by a membranous tube called the siphuncle. The chambers contain a nitrogenous gas and saline fluid whose volume can be regulated by the siphuncle. The volume of fluid influences the gas pressure and therefore the buoyancy of the shell. The animal can maintain neutral buoyancy and hover near the bottom in search of prey or it can regulate the gas/fluid ratio to sink or float. Nautiluses spend most of their time around 600-800 feet, but may migrate vertically at night to 200 feet or less. Nautiluses are able to swim in much the same manner as an octopus by expelling a strong jet of water out of the funnel.

Heart Cockles

The fantastic Heart Cockle is truly heart-shaped, nature's own valentine. It has a vast array of delicate colors, but most specimens are white. This unusual Indo-Pacific bivalve has no foot for digging, nor does it have siphonal tubes for filtering sea water. It simply sits immobile on reefs. The valves are so thin that sunlight can penetrate the shell, allowing symbiotic algae to grow in the soft tissues of the animal.

The algae provide food for the cockle and receive protection in return. In other words, these bivalves live by eating their own home-grown algae. A similar relationship works well with the famous Giant Clams.

Family Xenophoridae (Carrier Shells)

Xenophora pallidula

Stellaria solaris

The Xenophoridae are a small family of medium sized molluscs, having typically fragile shells in general, but specimens from different type of habitats and environments may produce a thin or thick, light or heavy, and fragile or totally solid shell. It is Top-shaped, with a fairly depressed spire and a flat to concave base. The body whorl overhangs at the periphery and in some species (*Xenophora calculifera*, *X. caribaea*, *X. indica*, etc.) forms a flange or skirt which greatly increases the apparent size of the shell compared to the main body of the shell. Most carrier shells have an open, deep umbilicus and a thin, usually smooth, horny operculum, although some are without an umbilicus and at least one (*Xenophora indica*) has ridges on the operculum. The outer finish is generally dull and colored in white, beige, tan or brown while the animal may be a brilliant scarlet color (*Xenophora conchyliophora*).

Characteristically, the shell is covered (self-decorated) with other shells, shell fragments, coral pieces, or stones that are attached or cemented with secretions from the animal. The shells are attached dead, although there is one account of a live kitten's paw being attached in an aquarium. All bivalves and bivalve pieces are attached inner side up and gastropods are usually attached with the aperture up. Once an object is selected, it is cleaned (as is the site of intended attachment), and then the object is rotated and fitted to the attachment site. This may take up to 1 1/2 hours. The piece is then held in place with the animal's foot, snout, and tentacle bases and glued into place.

The Xenophora may then lay motionless for up to 10 hours, only rocking in place now and then, seemingly a check on the strength of its new attachment.

The purpose of the attachments has not been explained, although theories include camouflage, to add strength and rigidity to a fragile shell, and shell support to remain on top of a muddy substrate. Some species remove the attachments from all but the outer whorl leaving small, empty attachment sites around each whorl as in the *Xenophora caribaea*; others attach objects only on the early whorls - subgenus Onustus; while others may attach small particles when young and often lack any attachments when fully adults - subgenus *Stellaria*.

Xenophora pallidula is known for its wealth and variety of attachments and because there is often a large sponge attached to the apex. In this case, it is assumed the sponge does the attaching rather than the carrier shell, although this is by no means certain. The molluscs are active and move rapidly in a leaping, Strombus-like motion; except while the Strombus pushes with its foot, the *Xenophora* pulls itself along.

Carrier shells inhabit tropical waters, mostly in the West Pacific, and are found from shallow down to extremely deep waters. There are approximately 26 species grouped within one genus with two sub-genera, Onustus and Stellaria, which sometimes are given generic status.

The Carrier shells are best known for their ability to attach foreign material such as stones, shells and pieces of coral onto the upper surfaces of their own shells. These snails live on sand and rubble bottoms, feeding on organic matter and foraminiferans collected from the substrate beneath the rim of their shell.

Family Fasciolariidae

Tulip Shells, Spindle Shells & Horse Conchs - Family Fasciolariidae

The family Fasciolariidae, or Spindle shells, contains a wide variety of groups, such as the tulip shells, the horse conchs, and the spindle shells. All species are carnivorous and very active, feeding on other mollusks. The Opeatostoma have developed a hook-like tooth, or protuberance, which help the snail pry open bivalves. Other Fasciolarids have a claw-like operculum with similar utility for opening bivalves.

Shells of the Genus *Fasciolaria* (tulips) are densely porcelain-like and rather large. They have a large body whorl, two or more folds on the columella, a short syphonal canal, and may be attractively patterned.

Shells of the Genus *Latirus* are rather similar to *Fasciolaria*, but with ornamented tubercles (knobs) arranged in spiral rows, as are the shells of the Genus *Pleuroploca* (horse conchs). The horse conchs have spiral lines visible in the aperture, unlike the *Latirus* Shells.

Shells of the Genus *Fusinus* (spindle shells) have characteristically long syphonal canal and equally matched long spire, well delineated sutures, knobs and vertical folds, and both spiral ribs and spiral ridges visible inside the aperture. Some have a left-handed spiral.

Most of them prefer life near shallow coral reefs or rocks offshore, or sandy areas in protected lagoons or bays in tropical and semitropical waters.

Giant Tube Bivalve

These are actually "BIVALVES" in spite of having a unique a tube-like form.

The bivalve itself is much smaller and inhabit inside this much larger, self-built tubular bored into shore rocks or woods.

We can still notice their inhalant and exhalant siphons; a character is tic of bivalves for filter-feeding, at the smaller end of each tube, This is the part where the inner bivalve inhabits.

Family Turbinellidae (Vase Shells, Tudiclas, Afers & Sacred Chanks or Shanks)

The family Turbinellidae consists of five subfamilies, until recently regarded as separate families, but now aggregated because of common features in the anatomy. The family is best known for the large, tropical, heavy-shelled species in the subfamilies Turbinellinae and Vasinae. The subfamilies Columbariinae and Ptychatractinae occur in the bathyal zone and are more diverse and widely distributed, occurring from equatorial to polar latitudes. The subfamily Tudiclinae has only one living representative but an extensive fossil history. The externally visible uniting features of the subfamilies are bulbous protoconchs, open, elongate siphonal canals, and corneous opercula with a terminal nucleus. Their diet is sipunculids (peanut worms) and polychaete worms

Indian Chanks – Family Turbinellidae

In Turbinellas, shells are generally large, thick and overall spindle-shaped. Vase shells have 3 to 5 strong, squarish, spiral teeth on the columella. They have a chitinous, claw-like operculum, and a quite large foot, which is characteristic of the Turbinellidae molluscs.

Most species are grouped together in a single family because of similarities in anatomy and fossil lineage rather than the more superficial shell shape. It is an ancient family reaching back 40 - 50 million years. The living species feed mostly on marine worms and a few on clams. Eggs are laid in horny, circular capsules.

The Sacred Chank Shell, *Turbinella pyrum* (Linné, 1758) found in India, is fashioned into ceremonial trumpets and bangles, the operculum is used for incense, and the animal provides a food source for the local economy. Sinistral, or left-handed Shanks (locally known as **Valampuri Shanks**) are highly revered due to the association with the Hindu god Vishnu. Shanks are found in tidal muds, mainly of the Indian Ocean and also the Caribbean.

Giant Ammonite – This is a very large piece of Ancient Ammonite from German. Ammonites are a large group of extinct mollusks comprising more than 10,000 species in their time, believed to be a close relatives to those Chambered Nautiluses, all ammonites have been extinct since the late Jurassic Period, about 65 million years ago.

Giant Ammonite from Germany.

3rd FLOOR

Margin Shells - Family Marginellidae

The Marginellidae is a family of minute to moderately sized gastropods with shells that are usually smooth, shiny surfaces with a remarkable range of color patterns, Margins are so-named because the thickened outer lip found in most species forms a margin around the outside of the shell.

Most species of the family are less than 15 mm in length, although there are some larger, attractive tropical species. There are more than 400 species found in a number of habitats, mostly sand or under rocks in shallow water. Margins are most diversified and numerous in West Africa, where many species are found in muddy sand and rubble. Margins feed on carrion or small invertebrates.

Moon Shells - Family Naticidae

Moon Snails are a large family comprising several hundred species, many of which are exquisitely patterned. Moon snails are not often seen during the day. They are usually more active at night, and remain buried in the sand during the day. They usually move just under the sand surface.

Moon Snails are aggressive carnivores feeding chiefly on clams as well as other snails. Most prefer sand bottoms where they can locate clam beds. Moon snails are fierce predators. A Moon snail wraps its huge body around the hapless prey to suffocate it. If this fails, it has a gland at the tip of its proboscis that secretes an acid to soften the victim's shell. With some help from its radula, a hole is created, it doesn't take long for the proboscis to remove the soft tissues for digestion. The hole is usually neat and bevelled.

The sand collar is the Moon snail's egg mass. A moon snail lays her eggs at night, combining these with mucus and sand in a gelatinous sheet which hardens. She lies at the center of the collar as she creates it.

Although the collar feels hard, plasticky and appears dead, each collar can contain thousands of living eggs. When the eggs hatch, the collar disintegrates. Thus, an intact collar has living snails in it! Please don't damage the sand collars. Sand collars are sometimes numerous on the sand bar and seagrass lagoon.

Some larger Moon snail species are sold as food in Asian markets.

Freshwater mollusks

Are closely related to human life, abundantly distributed in ponds, rivers, lakes and most fresh water sources on land, our home. The importance of freshwater mollusks to humans and the environment is greater than one may believe. Some negative aspects, where they are a source of problems themselves, will be considered, also.

1) As parasite vectors; freshwater mollusks act as intermediate hosts for a great variety of human and animal parasitic flatworms, mainly as food in the certain parts of the inland world.

2) As invasive species; the invasion of North America by the zebra mussel has had catastrophic consequences in some places. Their colonization of Unionid mussel habitat and the shells of living native mussels has been lethal to the native inhabitants. A mass die-off of zebra mussels has resulted in the death of large numbers of fish and native Unionid mussels.

3) As passive indicators of environmental degradation; for example, a number of species in North America and other parts of the world have become endangered, or been driven to extinction due to the fourfold attack of pollution, siltation due to agricultural runoff, river impoundment, and invasive exotic species. The freshwater mussels were among the first victims of widespread pollution. Siltation from agricultural runoff and other disturbances harms freshwater species directly through smothering them, covering them with silt, and altering the habitat by covering what was formerly clean sand, gravel, and algae-covered stones with anywhere from a thin layer to many meters of silt.

Dam construction changes habitat radically, both above and below the dam. Populations in the free-flowing reaches above the impoundment become isolated. In the reservoir itself, deep quiet waters no longer favor the abundance and variety of species originally present. Below the dam, released water may be clear and clean, but with radically different chemical and physical properties. This is typical of deeper reservoirs, where cold winter temperatures and low oxygen contents are retained in the bottom waters and released through the turbines year-round.

There are good reasons for studying the freshwater mollusks of the world, besides the objective of controlling snail transmitted diseases. Snails and mussels are an important part of the freshwater ecosystems on which depend the inland fisheries that are a valuable source of human food. The strange and beautiful freshwater snails and mussels displayed here are some of the wonders of the living world to be loved and preserved for the interest and enjoyment of future generations of our people. Since the well being of human societies depends much on conserving water and supplying uncontaminated water to people, rich snail fauna

will come to be appreciated as a sign of healthy and sustainable aquatic ecosystems, on which the water supply depends.
References : http://members.aol.com/mkohl1/FWshells.html & David Brown's "Freshwater Snails of Africa and their Medical Importance", ISBN : 0-7484-0026-5, page 4.

Strombs, Spider Conchs, Tibias - Family Strombidae

Family Strombidae (Conchs)

The family STROMBIDAE is one of the more well known of the molluscan groups. Though many larger molluscan species are commonly referred to as Conchs, the Strombus are the true Conch shells.

The number of species in the family is small in comparison with other molluscan families, yet the size difference between the largest and smallest Strombus is huge. A few grow to be the largest and heaviest of the marine mollusks such as *Strombus goliath*. At the other end of the size spectrum is *Strombus helli*, rarely reaching 25 millimeters in length. A comprehensive display of Conchs is quite beautiful. Some of the species can vary considerably in color and make for an eye-catching display. This family also consists of the interesting Tibia shells, and *Lambis* or Spider Conchs.

Great Spider Conch (Left)

All conchs are herbivores and most live in colonies, grazing on the fine algae that grow on sand flats or on the blades of sea grass. The conch animal is noted for its large stalked eyes that have four or five concentric rings of varying colors. The right eye protrudes through a depression in the shell lip called the stromboid notch, a characteristic unique to conchs. The left eye stalk sticks out of the siphonal canal. The animal can be quite active. The muscular foot has evolved into a club-like appendage with a sickle-shaped operculum at the end. The operculum has been modified for digging into the sand and unlike most snails, which glide slowly across the substrate on their foot, strombids have a characteristic leaping motion, using

their pointed, sickle-shaped, horny operculum to propel themselves forward in a leaping motion so the animal can "hop" along with a flip of its "foot" when it is necessary to make a fast getaway from predators. Some small conchs have been observed to leap as much as three feet along the ocean floor when prodded.

Conchs produce long gelatinous strings of eggs, often with sand particles adhering to the mass. Conchs are short-lived, many reproducing after only one year. The large Queen Conch (*Strombus gigas*) has a life span of only three to four years.

Queen Conch or Pink Conch from the Caribbean Sea (Left).

Murex Shells - Family Muricidae

The Muricidae is another large family among the marine mollusks, having extremely variable shells. They do not have smooth, glossy colorful shells like Cowries (Family Cypraeidae), or beautiful patterns like Cones (Family Conidae), but they are attractive in forms of structures with wide variety of ornamentation - frondose spines, webbed wings, lacy frills, and knobby whorls.

All are active predators and most are tropical or semi-tropical in habitat. Most have radulas adapted for tearing flesh and capable of drilling. However, for most, chipping away the edges of a clam shell is preferred to boring. In borers, an accessory boring organ secretes a calcium chelating compound that softens a shell during the drilling process, like the Naticids (Family Naticidae). Drilling is then carried out by the radula. The paralytic agent that most muricids use for killing is a neurotoxic mucus secretion of the hypobranchial gland. Oddly enough, this secretion also turns up in several entirely unrelated gastropod families (Family Naticidae and Family Turridae for example)

The mucus secretion, particularly from the Thaiidinae (*Thais*), has been used by people of antiquity, to manufacture a remarkably stable purple dye known as "Royal Purple".

Many murexes and rock shells possess a specialized gland in the mantle that produces a fluid called punicin, used by the mollusks as a protective hardening agent around its egg capsules. The foul taste of this substance may also keep predators away. In ancient times, people discovered that the peculiar properties of punicin gave it practical value as a color fast dye for textiles and paints. Pre-Columbian Indians in Mexico and the Minoans in Crete discovered this use for punicin at nearly the same time, around 1600 B.C. Some years later, the Phoenicians of Tyre, by the Mediterranean, made production of purple dye a fine science and one of their most important industries. Although many countries around the Mediterranean tried to copy the process, none could produce the quality or purity of color obtained by the Phoenicians, so Phoenician dyes became very expensive and in great demand. Finally, only royalty were allowed to use it, and Tyrian purple became known as royal purple. The dye works of Tyre operated until 814 A.D.

Snipe Bill's Murex or *Murex haustellum* L., 1758 moving on sea floor (Left).

Living Pleurotomarrid Snail feeding on Deep Sea Sponge (Left).

Family Pleurotomariidae (Slit Shells)

The Pleurotomariidae, commonly known as Slit Shells, are the most primitive group of gastropods, dating from the beginning of molluscan evolution in the Upper Cambrian period, 500 million years ago. Slit shells are characterized by their long, narrow notch, or slit, and their trochoid shape. The long, narrow slit that gives their name is a primitive characteristic retained for the purpose of voiding wastes and deoxygenated water. The size and angle of the slit along the side of the shell varies in different species, but this slit fills in as the shell grows, leaving a distinctive track on the shell called selenizone, a feature easily observed on all slit shells.

Slit shells ware once regarded as living fossils, with a mainly tropical and subtropical worldwide distribution. All of the known species inhabit very deep water beyond the continental shelf, in some cases down to several thousand feet deep, which until recently, has made it difficult to obtain specimens.

There are more than 20 living species and some specific forms. The majority of these species were described after 1960. Specimens are rarely taken by deepwater trawlers that drag the bottom with nets.

Deep-diving mini-submarines have also taken living specimens while on oceanography research expeditions. After studying the animals of many species of slit shells, biologists now realize that most of the slit shells are highly specialized predators on sponges and not evolutionary relics as has often been assumed.

Cone shells - Family Conidae

Marble Cone or *Conus marmoreus* L., 1758 (Left)

This is a large and diverse family. Cones rival and sometimes exceed the cowries in popularity among shell collectors and malacologists. There are more than 600 species by some accounts, most of which display a high degree of variability in their patterns. Many live in deep water, and there are a number of rare species. Most cones, however, are reef mollusks that live buried in sand under rocks, emerging at night to search for prey. Some cones prefer open benches of reef rock (flat, table-like rocks) where they can pursue other mollusks or marine worms.

Cones are notorious for their ability to immobilize their prey with a modified, harpoon-like tooth at the end of the proboscis which is attached to a venom duct. All cones have this venomous tooth, and their proboscis can be extended a considerable distance, at least the length of the cone's shell. The cone animal locates its prey using its well developed sense of smell. Once the prey is detected and stalked, the cone plunges a barbed tooth into the body of the victim. In some cases, three or four harpoon-teeth may be used. The paralyzed or dead victim is then swallowed whole. Digestion proceeds over a period of hours and concludes with the ejection of undigested parts like shell or bone.

Most cones are highly specialized as to what they eat. The majority prefer marine worms, but some eat other mollusks, and a few recently-evolved species hunt fish. Because of their specialized feeding habits, many different cones can live in the same area, each species occupying a certain microhabitat and not competing with other species.

With a number of cones, especially tent cones and some fish-eating species, the venom is so potent that it can be fatal to humans. Many incidences of cone-shell "stings" have been documented and at least ten human deaths verified, all from Indo-Pacific species. Live cones should never be handled carelessly. Collectors are warned to pick up live cones by the large end of the shell, since the animal's proboscis emerges from the small end. However, several species can extend their proboscis back over the entire length of the shell when provoked.

Although the venom can be highly toxic, scientists have found that the venom of at least fourteen species functions as a powerful muscle relaxant. The most potent venoms are the best relaxants, especially that of the Geography Cone, Conus geographus, a fish-eating species. Other venoms have proved to be muscle stimulators. Future research may produce useful drugs derived from the venoms of cone shells.

The Cones inhabit tropical oceans around the world. They live in shallow, intertidal habitats to extremely deeps water.

Olive Shells - Family Olividae

No 227 "Tent Olive" with American Indian tent-like pattern, Mexico (Left).

Olives are glossy gastropods found in tropical and warm seas. Shaped like pointed olives, they have been used for jewelry and as ornaments since prehistoric times. Olives produce polished, colorful shells, and like many gastropods, these mollusks maintain a highly-polished shell by pulling their mantle flaps over the exposed surface. They have cylindrical shells designed for burrowing through sand. They spend most of the day buried in the sand and are active at night. They generally live in colonies.

Olives are carnivorous scavengers and some large species can be caught on a baited hook. They feed mostly on small bivalves, snails, and polychaete worms. Many species also scavenge carrion, especially dead crabs. Its greatly expanded foot forms a modified pouch which can be stretched over its victim. The prey is then covered with a thick coat of slimy mucus, dragged beneath the sand, and smothered before being consumed. There are more than 400 species in the olive family, many of which are common, shallow-water inhabitants that can easily be collected.

All members of the Olividae family are carnivorous sand-burrowers. Although in a different superfamily than the Muricidae, the Olividae secrete a similar mucus from which a purple dye can be made.

Cowries - Family Cypraeidae

The cowries, with their shiny shells and astonishing variety of patterns and colors, probably have been the shell family most popular with collectors over the centuries. Some of the members of this group command high prices of up to several thousands of dollars for just a single specimen. By the late 1600s, cowries were already favorites in Europe. Merchants brought back hundreds of cowries from the tropical seas, along with spices, rare woods, and herbal medicines.

Even earlier, in Roman times, cowries were well known and were called *porculi*, or little pigs. Later cowries became known as *porceletta* or *porcellana* shells. When Marco Polo brought fine, shiny pottery back to Europe from China in the 13th century, the appearance of this pottery reminded people of the *porcellana* shells. Soon the term "*porcelain*" was coined for the pottery. The name of cowries in French today is porcelains.

Cowries were apparently first prized as fertility symbols by Neolithic peoples who considered them female talismans. In Japan, it was believed that a cowrie would facilitate childbirth if the expectant mother held one in the palm of her hand during labor. In ancient China, cowries represented life-giving forces of a female nature. The earliest European cultures considered cowries important symbols of the renewal of life and often included them in burials. The Yoruba of Nigeria regarded cowries as tokens of good luck and fertility hundreds of years before they came into use as money.

The earliest use of cowries as currency appears to have been during the Bronze Age in China, about 2,000 B.C. The backs of the cowries were filed off to make them lighter. Soon, imitations were being made from freshwater clams, with all the features of the cowries, including the filed back. Later, flat metal copies replaced real cowries. The Chinese character for the word "coin", or "payment", was made to resemble the stylized cowries.

A very deep coating of enamel on the outer surface gives the shell a brilliantly polished appearance, naturally. In life, two lobes of the cowrie's mantle extend out and over the dorsal surface of the shell, meeting at midline, and they continually deposit enamel while protecting the shell from abrasion. Interestingly, cowries are a favorite of collectors because of their beautiful colors and high-gloss finish. This is possible because the animals' mantle is on the outside, secreting the shell from the top-down and keeping it protected, whereas most other shells are secreted from the inside-out, hence the glossy interior of many shells. The mantle is usually ornamented with papillae that provide camouflage and assist in respiration. The color of the mantle sometimes matches the sponge it feeds upon.

Cowries usually remain hidden during the day in holes, dead coral heads, rubble, or under rocks and emerge at night to feed with the mantle fully extended. They may be algal grazers or sponge grazers, or both.

Females lay a cluster of small egg capsules and will sit upon the mass until they hatch.
Veliger larvae hatch and spend some time in the plankton before settlement. Juveniles look like paper-thin olive shells, coiling as they grow until maturity, when the outer lip curves inward, forms teeth, and the shell thickens with a new adult color pattern. The height of an adult cowry does not change once this takes place but rather the shell thickens and the interior is dissolved to create more space inside. Curiously, young cowries stop coiling at random regardless of height, resulting in a broad size range in adults. Empty but intact shells are usually the result of predation by cone shells.

Golden Cowrie, a symbol of Kingship used widely in some of the Melanesian Islands (Above).

Family Neritidae (Nerites)

This large family consists of several hundred species spread throughout the world. Most genera in the Neritidae are amphibious. Nerites are high-tide shore dwellers. They live either on rocks or mangrove trees. Nerites are largely found in the tropics. In the superfamily, Neritacea, most are operculate, except *Helicina* (land operculate snails), in the Helicinidae family. The operculum is shell-like, with a short projection. *Theodoxus*, is found mainly in or near freshwater streams, as are *Clypeola*, and *Septaria*. The latter two closely resemble slipper limpets and have only a rudimentary operculum. The Neritopsidae, another freshwater family, lives in or near streams like Theodoxus, above.

The superfamily, Neritacea, is remarkable compared to most archaeogastropods, in that it shows specific and quite evolutionarily advanced features: e.g., reproduction by internal fertilization, with penis and oviduct, and air-breathing features. Species in the Helicinidae and Hydrocenidae families, for example, possess a lung chamber and vascular plexus for absorbing oxygen directly from air (see Pulmonate Snails), along with renal specializations for living on land. *Neritodryas* while technically amphibious are also adapted to terrestrial living.

Most are common and easily collected on rocks in shallow water or when exposed at low tide. Nerites are famous for the great variability which occurs within a single species. The patterns and colors may appear unending.

Episcopal Miter or *Mitra mitra* burying in sand.

Miters - Family Mitridae & Costellariidae (Miter Shells & Vexillums)

Miters comprise a diverse group of two large families; Mitridae & Costellariidae. There are more than 500 known species altogether. Miters are named because of their resemblance to the peaked caps, also called miters, sometimes worn by the Pope, bishops, and other ecclesiastics.

Miters are carnivores, feeding on other mollusks and peanut worms. A few are scavengers. These aggressive predators have a specialized venom gland for immobilizing their prey. Some species secrete a smelly, purplish fluid when irritated.

Miters are fusiform in shape with a narrow aperture, with plaits on the columella which folds on the inside and are frequently attractive in color. Miters occupy a wide spectrum of habitats. They generally occur in the low intertidal and shallow subtidal, living in clean, muddy, or silty sand, or beneath rocks or coral. They deposit eggs in capsules attached to the substrate.They occur in tropical and temperate waters throughout the world, with the greatest concentration in the tropical Indian and Pacific Oceans.

The Costellariidae family (synonym, Vexillidae) includes very similar shells that were formerly classified with the Mitridae. Differences are based on anatomy of the live mollusk.

Auger Shells - Family Terebridae

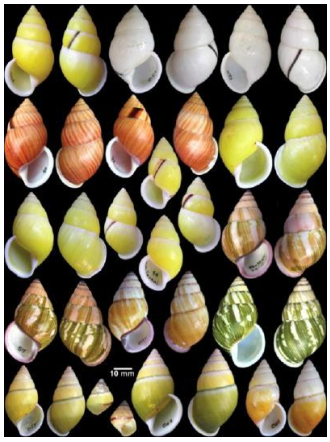
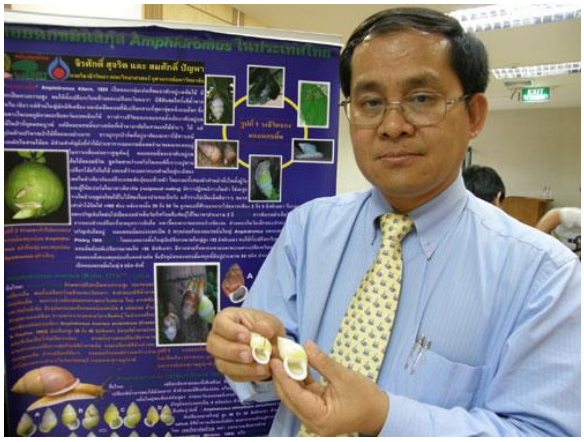
Typically, Auger shells all have slender, pointed shells with many whorls like augers or screws. They tend to have flattened rather than convex whorls; a shape more twisted than spiraled; and, one or two folds on the columella.

They are sand dwelling carnivores which ingest their prey whole. Their prey usually consists of polychaetes or acorn worms subdued by an injection of venom through a harpoon-like tooth similar to that of cones. Cones and augers are closely related in anatomy, but augers are specialized for a life spent entirely in sand or mud habitats. Most of the 270 species are less than 2 inches in length, but some augers reach 10 inches in length. Many augers are spotted or banded and can be quite attractive.

Auger shells are usually found in small colonies in shallow water. One of their primary enemies is the sand-dwelling box crab (*Calappa*). This crab uses its pincers to clip back the thick lip of the shell to get at the soft animal inside. Species in this family are predominantly grouped in either the *Terebra* or the *Hastula* genera, with a few remaining in two other genera.

World-wide, there are about 300 species. All are sand-dwelling carnivores found in warmer waters. By projecting a venomous barb like that of the cone shell molluscs (e.g., see Conidae), they stun their prey, which consists of various marine worms.

Land and Tree Snails

Images from www.naewna.com

Thailand's vividly colorful tree snails (*Amphidromus* spp.) studied by Dr. Somsak Panha with his team from Chulalongkorn University and by other institutes (TOP LEFT – RIGHT and BELOW)

Living Thai Amphidromus Tree Snail.

Land shells developed from mollusks living in the sea. Nearly 350 million years ago the first air-breathing mollusks invaded the land. These snails are known as pulmonates, with a simple lung for breathing the air. Another group of land shells known as prosobranchs evolved from Periwinkles and Nerites. They never did develop a lung, but they absorb oxygen through a specialized membrane in the mantle. Both groups emerged about the same time and radiated throughout the world's many land habitats. Their remarkable ability to adapt to an endless variety of environments has lead to nearly 40,000 species today. The greatest variety of land shells inhabit the humid tropical forests where many species are yet to be discovered by science. Land shells also inhabit deserts, high mountain forests, and many hostile environments. Only Antarctica and the far northern Arctic are free of land mollusks. Shell form and color is nearly as diverse as their marine cousins.

Pulmonates have both male and female organs in each individual. They comprise the majority of land mollusks, including the slugs, which have evolved away from the need for a shell.

Prosobranch land mollusks form a smaller group with separate sexes. They all have opercula, or trap doors, that fit tightly in the aperture of the shell when the mollusk is withdrawn. This provides much-needed

protection against carnivorous ants and beetles and helps in preventing dessication. Prosobranchs are commonly referred to as operculate land shells.

Florida Tree Snail

The first *Liguus* snails arrived in Florida about 10,000 years ago from Cuba, where there are several distinct species of *Liguus*, including *Liguus fasciatus*, and many color forms. The snails spread quickly in southern Florida but were limited in their northward expansion by winter temperatures colder than they could survive.

The Florida Tree Snail is probably the most beautiful and varied terrestrial snail in the world. This species has unbelievable combinations of colorful bands, flammules, and blotches. There are sixty named forms in southern Florida, where this is the primary tree snail of the hardwood forests of the Everglades and Keys. In the Everglades, tropical hardwood trees grow in isolated clusters called “hammocks” on slightly elevated limestone outcroppings. Hammocks are always above water, whereas the surrounding low areas are submerged for part of the year.

These hammocks, isolated as they are from one another, gave rise to localized strains of snails with distinctive characteristics. But even the most isolated hammocks were subject to occasional introductions of snails from other populations. Crows and raccoons carried live snails from one hammock to another. Hurricanes helped transport them from place to place. Pre-Columbian Indians and recent snail collectors also carried the *Liguus* snails from one hammock to another. The formerly extensive hardwood forests growing on the coastal ridge of southeast Florida, where Miami stands today, harbored millions of these gorgeous snails. However, land developers cut down the trees in most places beginning in the early 1900s. The huge loss of former habitat on the mainland and in the Florida Keys reduced the diversity of the snail. It also reduced the size of the remaining populations, making them more vulnerable to destruction from other causes. Several rare color forms of these snails have become extinct due to hurricanes or fires, and many are now threatened by development.

As far as possible, small colonies of the remaining strains, about 56 in number, have been relocated to isolated hammocks in Everglades National Park, where their only threats are natural. The species is not at all rare, but its remarkable diversity has been diminished. Now the snails are protected in Florida, so live specimens cannot be collected.

Wherever suitable trees are located, the snails may still be found. They prefer smooth-bark trees, especially Jamaica Dogwood and Wild Tamarind, two native trees still fairly common in subtropical Florida. Florida Tree Snails feed by scraping microscopic fungus and algae, as well as lichens, off the bark of their host trees, but they do not damage the trees themselves.

These snails, like most terrestrial gastropods, are hermaphroditic, having both male and female reproductive organs. Each individual is capable of laying eggs. Usually, about a dozen pea-sized eggs are laid in the upper inch of humus around the base of a tree in September, just before the dry season begins. The eggs do not hatch until the beginning of the rainy season in late April or May. The tiny snails, called buttons, climb up the branches of bushes and small trees and start growing rapidly.

Adult snails go into a state of torpor, called aestivation, to survive through the dry months. The animal seals the mouth of its shell with a papery film or mucus, called an epiphragm, which prevents water loss but admits oxygen. The shell is attached to the tree, often in a secluded spot, out of sight of predators.

Florida Tree Snails have a number of natural enemies to contend with. Birds peck holes in the shell, raccoons and rats crush the upper whorls with their jaws, and land crabs and beetles probe the aperture to get at the soft parts.

Fires, too, are a natural part of the Everglades, usually caused by lightning, but the fires are beneficial. They burn through the hammocks and clean out the undergrowth (as well as hundreds of excess snails), and the removal of the dense foliage allows more sunlight to penetrate the forest, which in turn accelerates the growth of algae and lichens on the trees. The natural reduction of the snails' population is helpful in preventing overpopulation and eventual starvation. The surviving snails will have abundant food and grow large and healthy.

Polymita picta (Painted Polymita)

Painted Polymitas are among the world's most colorful land snails. They are found on the leaves of low bushes and trees where they feed on the black fumagina fungus that often coats the leaves and branches. This unique tree snail is only found in the easternmost province of Oriente on the island of Cuba where they were so common at one time that commercial quantities were collected for handicrafts and jewelry. Today the snails have been greatly reduced in numbers by pesticides used in spraying for mosquitoes. These snails are regarded as a national treasure in Cuba, and attempts are underway to raise them in captivity and reintroduce the species to its natural habitat. Their short life span of 15 months lends itself well to captive breeding.

Yearly Life Cycle

The *Polymita* tree snails have a yearly life cycle which is closely coupled to climatic conditions, specifically the sub tropical rainy and dry seasons of the coastal habitat. The yearly life cycle of the *Polymita* begins in the spring with the first warm rains. Eggs hatch and adult snails wake up from their aestivation (hibernation). The snails grow, mate and lay eggs from spring thru fall, mid to end of May through November. Aestivation usually begins around the first dry weather in October or November. These events can be triggered or stopped by localized weather conditions. Flooding and long dry periods can affect the *Polymita* populations by dessication or death of the eggs by prolonged flooded conditions.

Reproduction

Polymita is a hermaphroditic gastropod, that is, it is both female and male. However, this does not obviate the need for copulation by two individual snails. Mating occurs during July and August with egg laying following during the heavy rains of September. The *Polymita* hollows out a shallow tunnel / chamber in the humus soil near the host tree and lays up to two dozen whitish eggs. The eggs hatch during the first warm rains of the spring and the small perfectly formed *Polymita* crawl toward the nearest bush or tree.

Growth

Polymita have a slightly oblong helical shell which grows in a dextral direction about the central axis. Very rare individuals have been found to be sinistral, that is, growing in a left handed direction about the central axis. The *Polymita* have a natural life span of two to four years and exhibit clearly marked lateral varices or growth marks indicating the yearly arrest in growth which occurs during aestivation.

Aestivation

The *Polymita* undergo a period of dormancy or aestivation starting in November or December and lasting through May or April of the next year. Upon sensing dry conditions, shorter days and lower temperatures, the *Polymita* finds a protected location and secretes a mucus seal or epiphragm. This seal protects the snail from dehydration during the winter period of lessened humidity and rain. The *Polymita* breaks out of aestivation during the beginning of the rainy season in April or May.

Food

The *Polymita* snails feed on the confervoid algae, fungi, sooty molds and lichens which grow on subtropical hardwood trees and shrubs . *Polymita* do not eat the leaves or bark of the host tree. Feeding paths may be seen where the snail has scraped the algae and lichen growths with their radula. The quality of the habitat, that is, the amount of food and type of food, affects the shell growth of the *Polymita*. The *Polymita* is a welcome guest in Coffee and Guava orchards of the Oriente province as they eat the sooty molds on the leaves and branches of the trees.

Habitat and Host Trees

Polymita inhabit the subtropical hardwood forests growing on the coastal plains and mountains of the Eastern end of Cuba. The *Polymita* displays a marked preference for certain tree species. The preferred or host tree is: Hicaco (*Chrysobalanus icaco*). Other host trees are varieties of Poisonwood (*Metopium toxifera*, *M. brownei*), Gumbo Limbo (*Bursera simarouba*), Hicaquillo (*Coccoloba retusa*), and other smooth barked hardwoods.

Predators

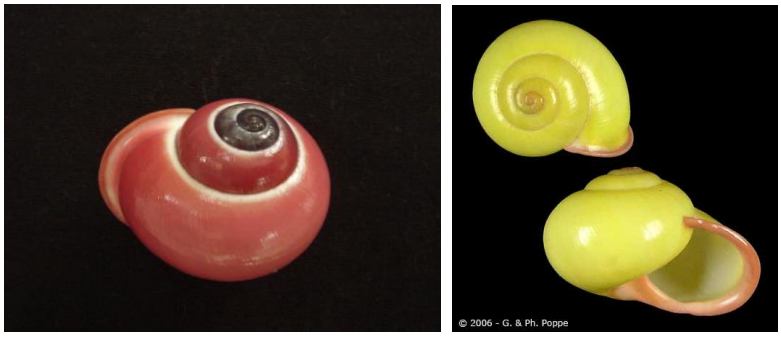
Polymita are preyed upon by a variety of vertebrates and invertebrates: birds, rats, and the most destructive enemies of all: bulldozers and the ensuing destruction of habitat. Habitat destruction is by far the greatest threat to the *Polymita*.

Green Snails from Manus Island or scientifically as *Papuina pulcherrima* Rensch 1931

The beautiful Green Tree Snail is one of the few truly green snails. This species is restricted to the mountainous interior of Manus Island, off the coast of Papua New Guinea. These snails prefer to live on the limbs of tall trees high in the forest canopy. They are not rare but were placed on the CITES (The Convention on International Trade in Endangered Species) List when a survey team could not find a single live specimen from a study which was concluded during the short dry season when most tree snails go into aestivation so they can conserve moisture. Many hide under loose bark, in tree crevices, in epiphytic plants, or similarly well-concealed locations, making their detection nearly impossible.

The snails are collected when local farmers clear-cut forested land for temporary cultivation. After the trees are cut, the snails move to the branches of nearby bushes and trees, where they are easily gathered. Green Tree Snails are not on the endangered list of many countries, but it is illegal to sell or buy these snails in the United States. In Papua New Guinea, they appear by the basketful in local markets.

Pink & Yellow Snails from Palawan Island, Philippines. *(Calocochlia festiva* (Donovan 1825)



Rediscovered again after almost two century after their first discovery. The snails are collected when local farmers clear-cut forested land for temporary cultivation.

THE END

THANK YOU

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