CHARACTERISTICS OF THE MAJOR FOSSIL GROUPS

by Donald M. Hoskins

INTRODUCTION

Living creatures are divided into two main groups—the animal kingdom and the plant kingdom. There is also a group of living and fossil creatures that have some aspects of each kingdom—these are the Protista. Because they cannot be allied with either plants or animals exclusively, the protistans are classified as a separate kingdom.

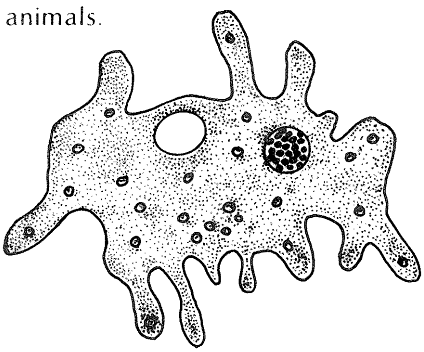
The animal kingdom is divided into 21 separate groups called phyla (singular: phylum). A phylum is a group of organisms assumed to have originated from one common ancestor. Only 9 of the 21 phyla are represented by abundant fossils, and thus these 9 phyla are of great importance to the paleontologist. The other 12 phyla lack hard parts and are rarely found as fossils. The phyla that are important because of their fossils also contain many groups not found as fossils. Only those groups that have fossils will be discussed in this book.

The plant kingdom is composed of four major divisions. The term phylum is not applied to these divisions because they are not defined in quite the same way as are the animal phyla. One division, the Tracheophyta, produced almost all of the fossil plants found in Pennsylvania.

KINGDOM PROTISTA

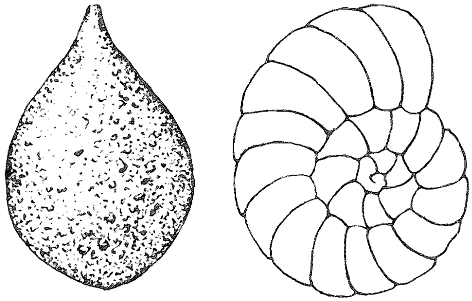
Phylum Protozoa

Protozoans are simple, one-celled creatures that include such forms as the living *Amoeba*. They are found by uncountable billions in our sea water, where they provide much of the food for many other large aquatic animals.



Amoeba **—a living protozoan (x50).**

Only a few groups of the phylum Protozoa are found as fossils because most of the animals in the phylum form no hard parts. The most important of these groups belong to the subphylum Sarcodina, class Rhizopodea, and are called Foraminiferida, or "forams" for short. These microscopic one-celled animals secrete (build) a shell around their body made of chitin (an organic compound similar to a fingernail) or calcium carbonate; some make their shell from sand particles. Large portions of our deep-sea bottoms are covered with the minute shells of these animals.



***Lagenammina* (left) and *Endothyra*— foraminifera genera (x85).**

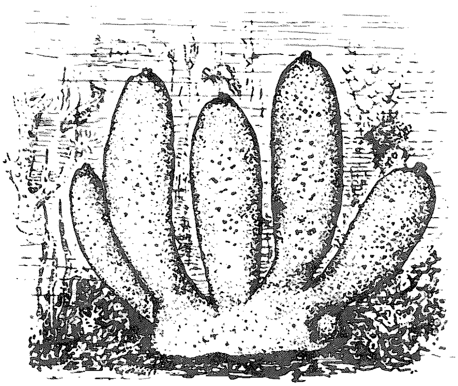
Most of the forams are so small that they can be seen only with a high-power microscope. A few, however, have built a shell up to 6 inches across and are a major part of some rocks. The limestone that was quarried to build the great pyramids of Egypt is made up largely of the genus *Nummulites*, one of the largest forams that ever lived. One family of forams, the Fusulinidae, secreted shells about the size and shape of wheat grains.

Foraminiferida are not common fossils of Pennsylvania, but fusulinids have been found in the Pennsylvanian age Vanport Limestone in the western part of Pennsylvania.

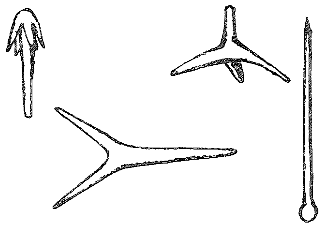
KINGDOM ANIMALIA

Phylum Porifera

The phylum Porifera (meaning pore-bearing) is the group of simple, many-celled animals we call sponges. Sponges have many shapes, ranging from encrusting to ball-shaped, flask-shaped, and leaflike forms. These animals consist of fleshy material that has numerous pores, supported by a rigid or semi-rigid internal skeleton. The skeleton of most sponges is made up of many very tiny pieces, called *spicules*, composed of calcite or silica, or fibers composed of spongin, a protein compound containing sulfur. The common bath sponge, used until recently replaced by plastic "sponges," is the fibrous spongin skeleton of the genus *Euspongia*. The skeleton of some classes is made of a mass of calcite or aragonite (a mineral whose composition is close to that of calcite), similar to coral skeletons.



Sycon **— a living marine sponge (x2).**



Sponge spicules (x15).

Sponge fossils generally are very rare because the spicules that form the skeleton fall apart soon after the death of the sponge; those without spicules have even less of a chance of preservation because their skeletons of fibers are rapidly destroyed.

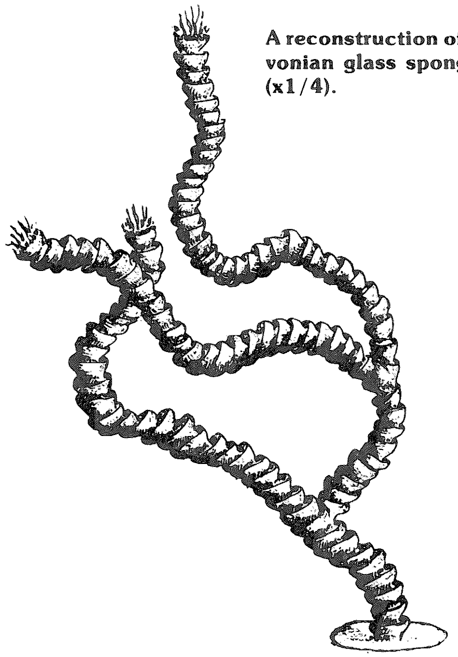
There are five classes of sponges, four of which have fossil representatives. However, most fossil sponges in Pennsylvania belong to two classes: Hyalospongia (glass sponges) and Stromatoporoidea.

Fossils of the class Hyalospongia are rare, but in some areas of northwestern Pennsylvania molds of hyalospongid skeletons showing the characteristic mesh of the spicules are found in Devonian and Mississippian age rocks.

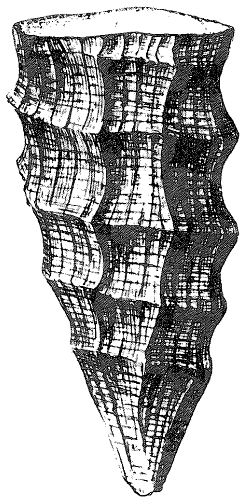
The Hyalospongia have a skeleton composed of an intricate network of siliceous spicules. The skeleton was flask shaped or tubular and covered inside and out with fleshy layers. (See page 4 for a sketch of fossil sponges in a reconstructed scene.) When the animal died, the fleshy material disintegrated and the skeleton was filled and covered with mud. Because the siliceous spicules were strongly interconnected and hard, their shapes were impressed in the mud and were thus preserved as molds. The silica disappeared by dissolution.

The living class of sponges, the Sclerospongia, do not have a skeleton supported by spicules. Instead, they build a skeleton of calcite, which contains many pores and interconnected canals. The fleshy part of the sponge lives on the surface and in the pores and holes.

An extinct class, the Stromatoporoidea, built a skeleton much as the living sclerosponges do. The skeletons consist of ball-, mound-, or twig-shaped masses, which internally are composed of many layers (lamellae)

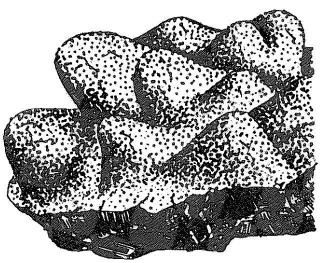


A reconstruction of *Titusvillia*, a rare Devonian glass sponge from Pennsylvania (x1/4).

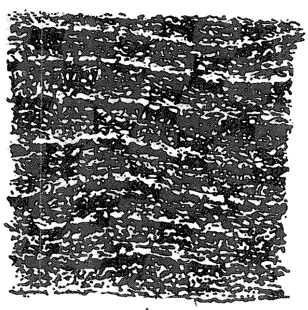


***Hydnoceras* — a Devonian glass sponge (x1/3).**

that have pores and holes. Stromatoporoids were an important reef builder in the Silurian and Devonian Periods, as were corals. They are often found in some of the limestones of Late Silurian and Early Devonian age in central Pennsylvania.



a



b

***Stromatopora* — a fossil sponge.**

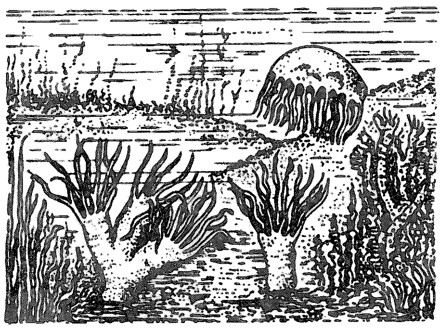
a. **Part of a colony (x1-1/2)**
b. **Section through colony showing layers (lamellae) (x3)**

Phylum Coelenterata

The phylum Coelenterata is a large group of animals exemplified by the living corals, which exist mainly in sea water. The phylum includes many forms, both living and extinct, that superficially do not look much alike. Many of the groups within the phylum have almost no fossil record, whereas others have no living representatives.

Corals make up the largest part of the phylum and are well known from the large reefs they make near islands in tropical and subtropical seas. Also included within the phylum Coelenterata are jellyfish, sea pens, sea fans, sea feathers, and a multitude of other forms.

There are two general body types in this phylum. One type, called a medusa, is a rounded, bell-shaped body that floats and is carried about by sea currents. Tentacles hang from its lower edge to catch food. The medusa type of coelenterate is rarely found as a fossil because it has no skeleton. Living jellyfish have this form of body. The other body type is the polyp, which is like a tube that has one end closed and attached to something on the sea bottom. A ring of tentacles is present around the edge of the other end. Coelenterates having the polyp form are mainly responsible for the coral reefs because they secrete a skeleton.



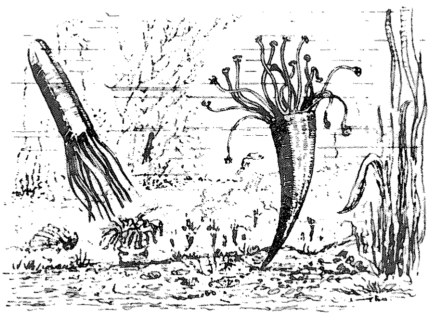
Diagrammatic sea-bottom sketch showing a floating medusa and attached polyps.

Corals are characterized by the colonial mode of life, whereby many individuals join together to grow one large skeleton on which they all live. Some corals, however, are solitary, and their skeletons are grown singly.

In Pennsylvania two classes of this phylum are found as fossils. All genera of these classes are extinct, but because of their similarity in skeletal form to living coelenterates they are placed in the phylum Coelenterata, and reconstructions of what they must have looked like can be made.

Class Scyphozoa

This class of coelenterates includes the free-floating jellyfishes that have the body form of a medusa. However, there is one small group of



Reconstructed Devonian sea-bottom sketch showing attached and floating conulariids (x1/4).

fossils called Conulariida that are placed in this class. Unlike the jellyfish, some of the conulariids were attached to the sea bottom.

The fossil conulariids are generally cone shaped or pyramidal and consist of a thin, flexible chitin outer "skin" that is usually marked with many curved or angular lines. Because some members of this group may have floated like a medusa, and because of other similarities, this unusual group is placed in the class Scyphozoa.

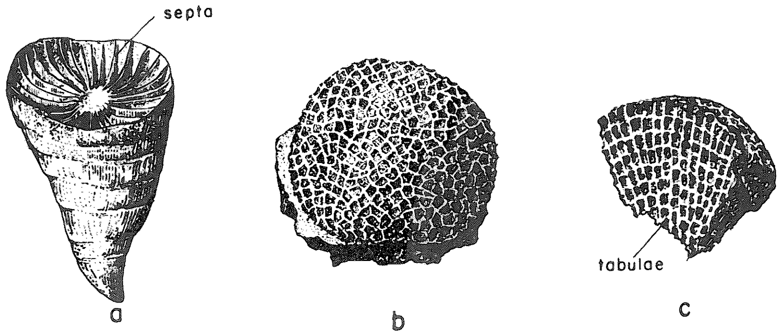
Conulariids have been found in Devonian age shales in central and eastern Pennsylvania.

Class Anthozoa

The anthozoans include most of the corals that build our modern reefs. Only the polyp form of individual occurs in this class and is exemplified by the living sea anemones.

Anthozoan polyps form a tubular, cup-shaped, or horn-shaped skeleton that may be joined with others or be solitary. Each skeleton formed by a group of polyps is called a *corallum*. The individual polyps live mainly in the cup-shaped depression at the upper or outer end of each individual *corallite* and rest on radial partitions (*septa*) that extend the length of the tube, or on plates (*tabulae*) that extend across the tube. As the polyp adds more to the walls of the corallite, it also adds to the septa so that its soft body always remains near the outer end. In those forms that have tabulae, a new tabula is periodically added so that the polyp is not too far down the tube. The polyp can retract itself into the tube in case of danger, but it usually remains outside with its tentacles waving about in the sea water to catch food. (See also page 4.)

Within the Anthozoa are several groups, three of which include most of the corals of the world. The corals of our present oceans belong to the Scleractinia. Corals of this class are also found as fossils as far back as Triassic times, but not in the rocks of Pennsylvania. Pennsylvania corals belong to the Rugosa and Tabulata, two groups that are extinct. Both the Rugosa and Scleractinia have septa, but the septa are arranged in different patterns that readily distinguish the two groups.



Anthozoan corals (x1).

a. A solitary, rugose corallite; the radial partitions are the septa.
b. A colonial, tabulate corallum; each hole housed a polyp.
c. A section through a tabulate corallum showing the transverse partitions, the tabulae, and the vertical walls of each corallite.

The Rugosa built large, massive colonial skeletons and horn-shaped solitary skeletons. Individual corallites are characterized by a rough and ridged outer surface, hence the name Rugosa. Rugose corals also contain septa. The Tabulata are colonial and are characterized by having tabulae, generally without septa. A few tabulate genera have septa, but the septa are usually very small.

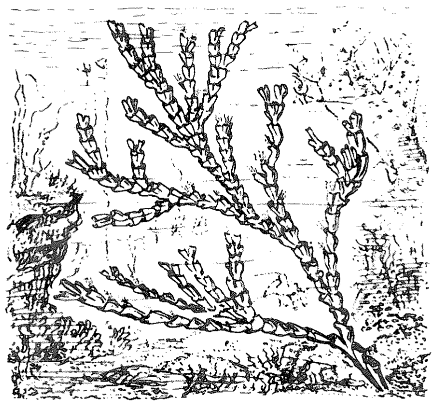
Both rugose and tabulate corals are found in the Paleozoic rocks of Pennsylvania. They are relatively common in some of the Silurian and Devonian age rocks of central and eastern Pennsylvania.

Phylum Bryozoa

The bryozoans are a group of exclusively colonial animals that live mainly in sea water. Although some of them build encrusting skeletons that contribute to reefs, most of them secrete delicate skeletons that look much like plants, moss, or seaweed. Because of their delicacy, few are found complete. After death, they are usually scattered about like broken twigs and branches of a tree. Some bryozoans build very thin, delicate, crustlike skeletons on rocks, sea shells, and corals.

Bryozoans as individuals are extremely tiny, and the colonies they form may have dimensions of only about one inch. A hundred or more bryozoans may live in a colony that is an inch or two long. The soft body of the bryozoan looks similar to the polyps of the coelenterates in that the body is tubular and has a ring of tentacles around its outer edge. However, this resemblance is only superficial because the bryozoan body, called the *zooid*, has much more complicated internal organs than does the relatively simple coelenterate polyp.

Each of the zooids secretes a tubular skeleton that may or may not have various cross partitions similar to tabulae. Surrounding the tubes is



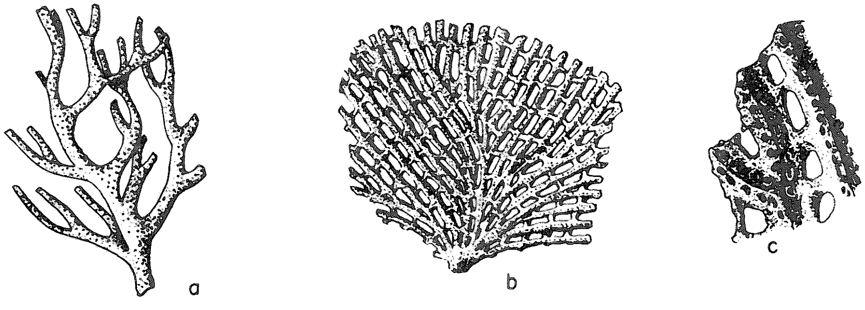
***Bugula*, a living bryozoan (x1). Each of the small sections houses a zooid.**

other skeletal material that binds them all together. A complete colony is called a *zoarium*. By the use of complex muscles, the individual soft body is capable of pushing itself out of its *zooecium* to collect food with its tentacles or to completely retract itself within its skeleton.

Many bryozoans may be identified by their surface character, but positive identification of bryozoans frequently can be made only by microscopic examination of thin, transparent slices cut from the specimen.

Two of the forms of fossil bryozoans that you may find are the twig-, branch-, or mound-shaped form that has zooecia all over its surface, and the ribbon or lacy form that has zooecia on one side or surface and often consists of several long branches connected by short bars, which gives it a lacy appearance. Fossil bryozoans found in Pennsylvania all belong to the class Gymnolaemata.

Bryozoans are found in all of the periods from the Ordovician to the present. They are found most often in Silurian and Devonian age limestones and shales throughout the Commonwealth.



Fossil bryozoans.

a. "*Batostomella*," a branching type (x25).

b. *Fenestrellina*, a lacy type (x1). The black dots are zooecial apertures.

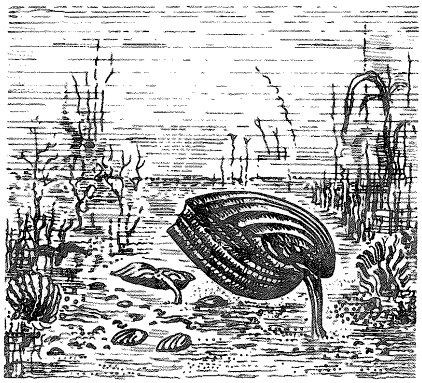
c. Part of (b), expanded to show the zooecial apertures (x15).

Phylum Brachiopoda

Brachiopods are small marine animals that possess two shells (or "valves" as they are most commonly called) that completely enclose the soft body.

Only a few living representatives of this once-immense phylum are to be found in our present seas. Brachiopods, however, flourished on the bottoms of Paleozoic seas and are one of the most common fossil types found in Pennsylvania. At times they accumulated in large deposits similar to the oyster banks of today.

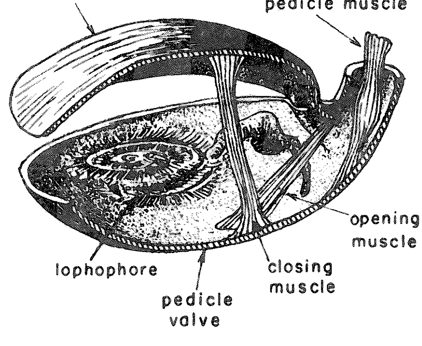
Brachiopods were animals that burrowed into or were attached to the sea bottom; they were not capable of moving about.



Brachiopods on the sea floor.

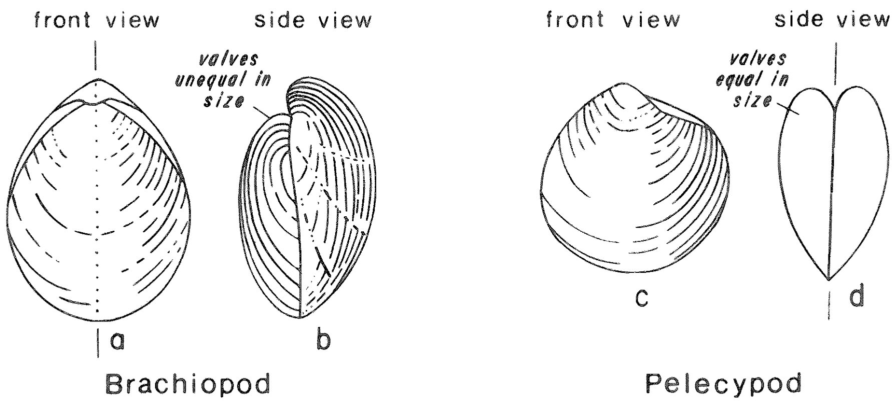
They bear superficial similarities to, and may be confused with, pelecypods (the clams and oysters), which are also marine. They are, however, easily distinguished from pelecypods because both the soft body and the enclosing valves of brachiopods differ very much from the pelecypods. The fleshy parts of pelecypods consist mainly of a large muscular "foot" for digging and moving about, and a set of strong muscles that close the shell. Brachiopod fleshy parts consist mainly of a compli-

Cut-away sketch of an articulate brachiopod, showing the muscle system and the lophophore. Certain other organs are omitted from the sketch.



cated feeding mechanism called the *lophophore* and specialized muscles that both open and close the valves.

The simplest method of determining whether a shell is a brachiopod or a pelecypod is by examination of the valves to determine their symmetry Brachiopods and pelecypods are both bilaterally symmetrical, which means that the animals may be divided into two equal halves, but the plane of symmetry is different in these two kinds of animals. Brachiopod valves are unequal in size, but each may be divided into two symmetrical halves, as shown by "a" in the drawing below. Pelecypod valves are equal in size but each valve cannot be divided into two equal halves ("c" of the drawing below). The plane of symmetry of a pelecypod is *between* the valves; thus each valve is a mirror image of the other. In the case of a brachiopod, the plane of symmetry is *through* the valves.



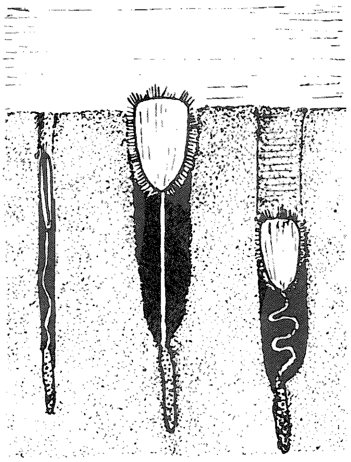
Differences in symmetry between pelecypods and brachiopods.

The larger of the two brachiopod valves is called the *pedicle* valve, because this valve bears the pedicle, a long muscular stalk that is used to attach the shell to the sea bottom. Not all brachiopods used this method of attachment. Some grew long spines all over the valve and rested on these. Others lay loose or burrowed into the muds on the sea floor. Some even cemented themselves to stones or to other animals.

The smaller valve, the *brachial* valve, bears the brachidium, the skeletal support for the feeding organ, or lophophore.

The phylum is divided into two classes, the Inarticulata and the Articulata, which are separated on the basis of the way the two valves are joined together at the hinge. The hinge allows the valves to open and close without having the valves come apart.

The inarticulate brachiopods are characterized by the absence of teeth and sockets near the hinge line; they possess only muscles to hold the two valves together. Their valves are usually composed of phosphatic and chitinous materials. *Lingula*, a modern inarticulate, lives along some seashores and burrows deep into sand, where it is attached by a very long pedicle. Fossil valves of the genus *Lingula* are found in rocks as old as the Cambrian and thus provide one of the best examples known of an animal that assumed its present form over 500 million years ago and has remained the same since then.



Schematic sketch of the burrowing life habits of *Lingula*, a living inarticulate brachiopod (x1/4).
a. Side view showing narrowness of the brachiopod and its burrow.
b. Extended feeding position.
c. Retracted position.

The class Articulata is characterized by having teeth in the pedicle valve and sockets in the brachial valve. The muscle system of the articulates is less complex than that of the inarticulates because it is used only to open and close the valves. The majority of all known fossil brachiopods are articulates.

Brachiopods were very common during the Paleozoic Era (see page 4) but have declined in number since then. Because of their abundance during the Paleozoic and because the various fossil genera evolved and became extinct quickly, the brachiopods are useful in identifying, subdividing, and correlating Paleozoic rocks over the whole world.

Articulate brachiopods, in a variety of shapes and sizes, are one of the most common fossils found in Pennsylvania. They are present in nearly all fossiliferous rocks in the Commonwealth.

Phylum Mollusca

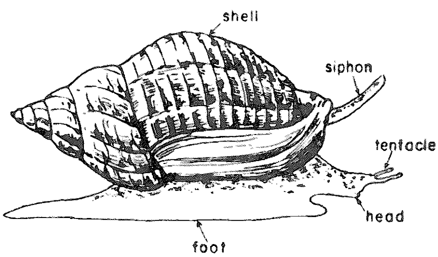
The phylum Mollusca includes a varied group of animals such as the well-known chitons, snails, oysters, clams, squids, octopods, and others. Although they differ greatly in size (from less than an inch to several feet) and shape, these animals are all closely allied. The phylum is divisible into seven classes. Of the seven classes, only four are found as fossils in Pennsylvania, and of these only three are abundant in occurrence. These are gastropods, pelecypods, and cephalopods.

With certain modifications, the soft bodies of the animals in all classes of this phylum are similar. Six of the classes (the cephalopods excluded) contain animals that have a muscular "foot," which is used for moving and burrowing. In the cephalopods (squids and octopods) this foot is modified into structures near the head region which aid in propulsion. Six of the classes also have a well-defined head region with tentacles and a mouth. The Pelecypoda ("clams") is the only class that does not have a definable head. Soft parts of various molluscan animals can be shown to possess many more similarities than those mentioned above.

Class Gastropoda

Gastropods are the most diverse group of molluscans; they live throughout the world both on land and in the sea. Those that have no shells are the slugs; those that carry shells are snails. Snails that live on land have developed lungs; the others have gill structures for living underwater.

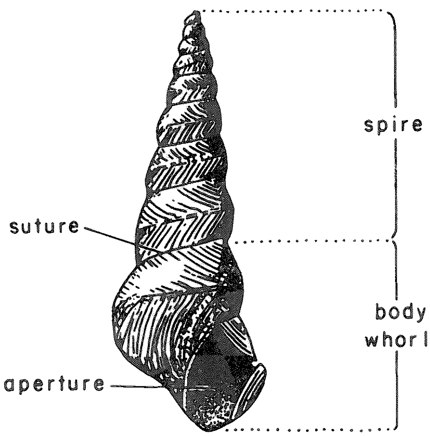
The individual gastropod consists mostly of the muscular foot on which it moves, a head that generally contains a pair of tentacles, and a body upon which is carried a coiled, unchambered shell. In times of danger, the snail withdraws its body into its shell. Some gastropods have evolved an *operculum* or "door" that covers the opening to their "house."



Anatomical parts of a snail.

Starting with a simple coil, gastropods build many very different kinds of shells. Some have complex external structures and ornamentation; some are smooth. Some are coiled tightly, whereas others uncoil as they grow.

The snail shell is divided into two main parts: the *body whorl*, which is the last turn of the spiral, and the *spire*, which encompasses all of the other spiral turns above or behind the body whorl. The opening is called the



The parts of a snail shell.

aperture; the line between the many whorls (turns of the spire) is called the *suture*.

After the snail dies, the shell often fills with mud. If, after fossilization, the shell disappears by dissolution, an internal mold is left. Such molds are called *steinkerns*.

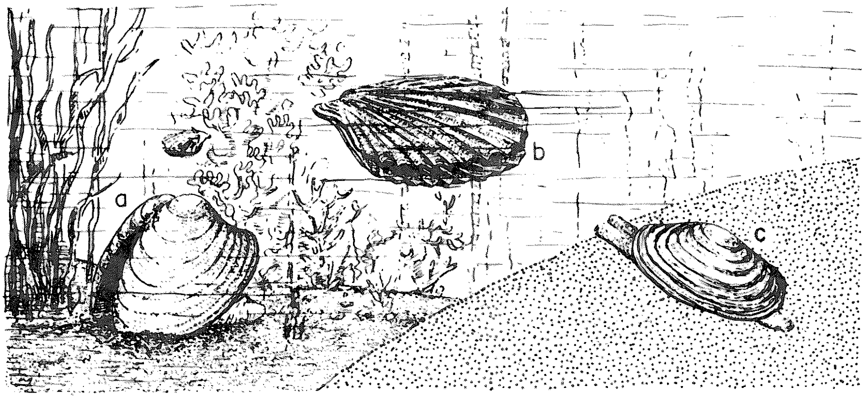
Gastropods, like brachiopods, can be found in almost all of the fossiliferous rocks in Pennsylvania.

Class Pelecypoda (= Bivalvia)

The pelecypods, or bivalves, include many of the organisms we call shellfish—the clams, oysters, and scallops. These are an important food product of the sea. They differ from the other members of the molluscan phylum by their habit of secreting an external skeleton of two valves, as do brachiopods.

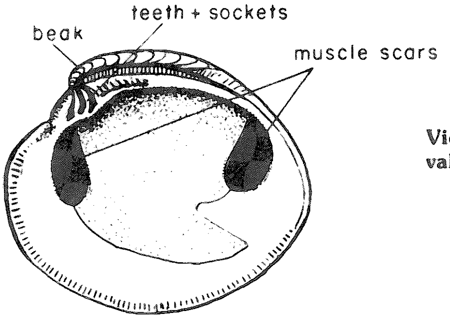
Pelecypods are more varied in their home sites and methods of movement than are other groups of the Mollusca. The snails (gastropods), being nonswimmers, usually dwell on a surface such as the sea, a lake, or a stream bottom. The cephalopods (squids, etc.) are largely made up of swimmers, but some pelecypods dwell on a surface, some burrow, and some swim about. The scallop *Pecten* swims about in the water by strong muscular movement of its valves. Many pelecypods live on the bottoms of bodies of water, where they move by using their foot. They often bury themselves deeply into the mud. Some even bore into rock to find a hiding place. A few of the pelecypods, such as the oyster, cement themselves to the bottom. The oyster is one of those unusual pelecypods in which both valves are not the same size.

The two valves are called right and left valves because many of the pelecypods move about with the foot downward and the beak (the pointed part of the shell) upward. Thus the valves are the "sides" of the ani-



Schematic sketch depicting the life habits of clams (pelecypods) (x1/4).
a. *Venus*, a bottom dweller.
b. *Pecten*, a swimmer.
c. *Mactra*, a burrower.

mal. Both valves have teeth and sockets along the hinge line to keep them attached. Fossils that preserve the interior often show the position of the large muscles that hold the valve closed.



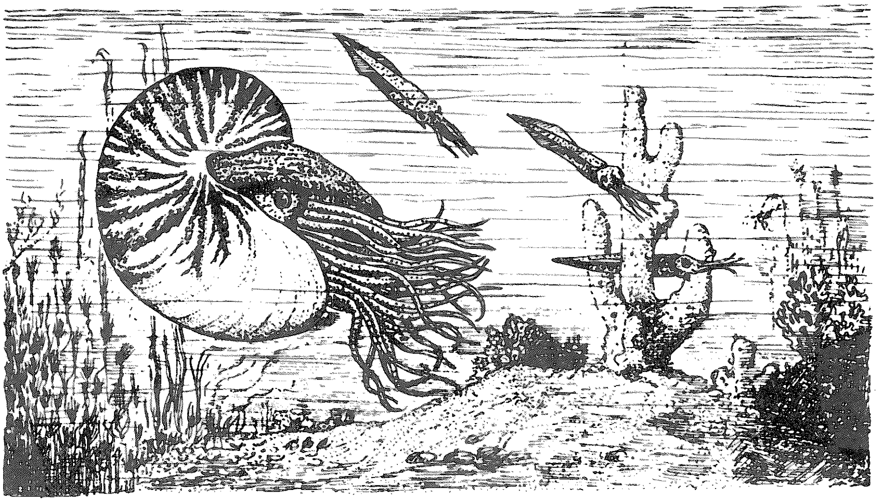
View of the interior of a pelecypod's right valve.

Pelecypods are a common fossil in some of the fossiliferous rocks of Pennsylvania but are found most often in the Middle and Late Devonian age sandstones and shales of central and northern Pennsylvania.

Class Cephalopoda

The class of mollusks called cephalopods, instead of having just an external shell as do "snails" and "clams," may have shells that are either external or internal. Some, such as the modern octopus, have no shell. The cuttle fish *Sepia* has only a very small internal shell called the *rostrum*, often used in bird cages. Most fossil cephalopods, however, possessed a rather intricate external shell.

Only one living representative of the external-shelled group is known. This is the pearly *Nautilus*, which is found in our south seas. From this sole living member of a nearly extinct group, we know much about how many fossil cephalopods must have looked and how they must have lived.

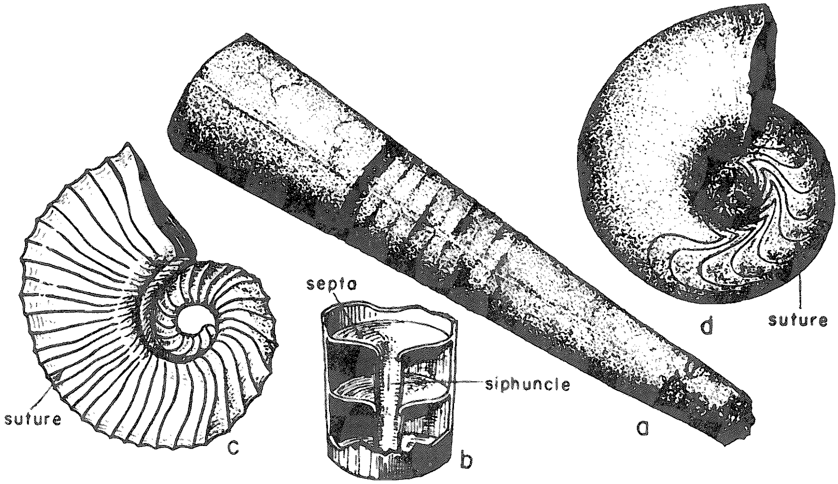


The "pearly" *Nautilus* and its relatives, the squids (x1/4).

Fossil cephalopods built many varied and intricate shells. The simplest type of cephalopod shell is straight and shaped like a cone. Others grew a slightly curved shell, and still others grew completely coiled. The coiling of the cephalopods was generally in one plane rather than spirally as in most snails. A few cephalopods, however, did build a spirally coiled shell.

A major difference between cephalopod shells and the somewhat similar gastropod ("snail") shells is that cephalopods separated their shells into many chambers by building partitions (septa) at regular intervals. The animal itself lived in the last chamber. The septa were perforated by a tube called the siphuncle, through which a fleshy stalk was extended from the bulk of the animal in the living chamber to the tip of the shell.

In a simple cephalopod each partition (septum) was shaped much like a watch glass—a simple, smooth, concave partition. Where the septum is attached to the shell wall, a visible line occurs, called the suture line. More complex cephalopods built septa that were wavy along their edges, thus creating a more complicated suture line. The individual chambers, separated by septa, were filled with gas during life so that the animal could float and swim in the water, yet carry around a strong, heavy shell that provided protection against its enemies.



Types of fossil cephalopod shells (x1/2).
a. *Michelinoceras*, a simple, uncoiled shell.
b. Enlarged portion of (a), showing interior partitions (septa) and the connecting tube (siphuncle).
c. *Centroceras*, a coiled shell that has even septa, shown by the even sutures.
d. *Manticoceras*, a coiled shell that has wavy septa, shown by the uneven sutures.

The exterior of the shell was ornamented in some cephalopods. Most had a smooth exterior; others had ridges along or around the cone. A few built spines along their shell. (See page 4 for a reconstruction of the common cone-shaped cephalopod found in Devonian age rocks.)

Cephalopods are not common in Pennsylvania; however, they may be found in many of the Devonian age rocks of central Pennsylvania, particularly in the rocks of the Mahantango Formation. They also occur in some of the Pennsylvanian age limestones of western Pennsylvania.

Class Scaphopoda

The scaphopods are a small living class of exclusively marine molluscan animals. Only two living genera are known. One of these, the distinctive genus *Dentalium*, lives buried in the sea-bottom sediment so that only a small portion of the shell extends above the water-sediment interface. The scaphopod shell is a small, tapering tube open at both ends, similar to a drinking straw.

The foot that extrudes from the larger of the two openings is used to bury the bulk of the shell in the sea bottom in a nearly vertical position. The scaphopod eats small bits of food in the muds, and the currents moving over the exposed end of the shell remove waste products.

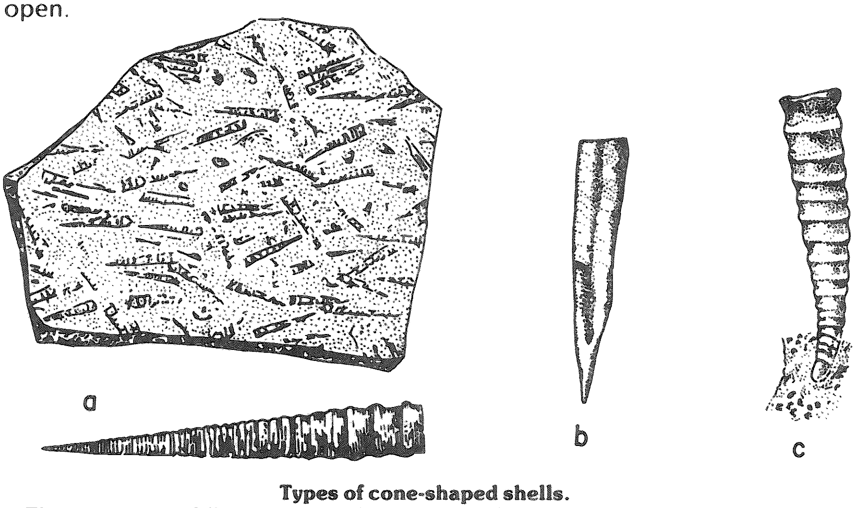
A modern scaphopod in life position, with foot extended.

Fossil shells of the genus *Plagioglypta* occur at some of the localities of Late Paleozoic age rocks in western Pennsylvania. These have transverse wrinkles as ornamentation.

Conoidal Shells of Uncertain Affinity

A few unusual fossils of extinct animals are placed in the class Cricoconarida and assigned to the phylum Mollusca because of some similarities they have to other molluscans. Because they are extinct, it is not known if they truly belong to this phylum.

One of these extinct fossils is *Tentaculites*, which is very small, cone shaped, and needlelike, and has several raised ringlike ridges around its surface. The shell was hollow in life, having one end closed and the other open.



Types of cone-shaped shells.

a. **The cricoconarid *Tentaculites*, shown in a rock containing many individuals (x1), and in a closeup view.**
b. ***Styliolina* (x10).**
c. ***Cornulites* (x3).**

Another is *Styliolina*, which is also small and cone shaped, but which does not have any external ornamentation. Most specimens of this fossil are crushed so that they appear to have a longitudinal groove.

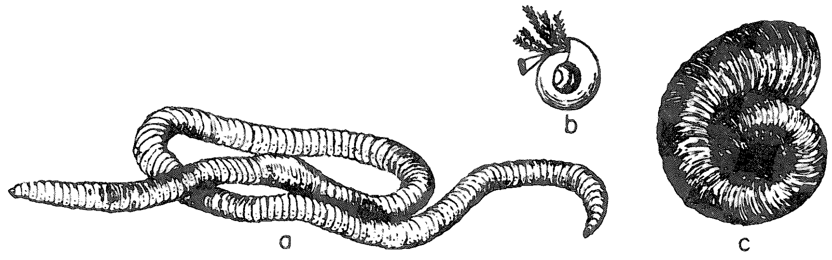
An additional small conoidal shell found rarely in Pennsylvania is *Cornulites*. The phylum and class are not assignable for this fossil, but it is included in this section because of its superficial similarity to cricoconarids. The shell of *Cornulites* may be curved and is much thicker than that of *Tentaculites*.

The types of animals that lived in these shells are unknown. A truly accurate idea of what they looked like in life is impossible to recreate because many very different animals build tubular skeletons.

Tentaculites is a very common fossil in many of the Late Silurian and Early Devonian age limestones of central Pennsylvania. The other conoidal shells are much rarer.

Phylum Annelida

The common earthworm *Lumbricus*, and other similar worms used by fishermen, are the animals included in the phylum Annelida. Annelids are characterized by the segmented nature of their bodies; the body is made up of many ringlike segments (annulae). These worms, since they generally secrete no hard parts or shells, are rare as fossils. However, a few members of this group do have some preservable parts.



Annelid worms.
a. *Lumbricus*, the common earthworm (x1/4).
b. *Spirorbis*, a polychaete worm in its shell (x5).
c. The shell of *Spirorbis* (x10).

A few annelids of the class Polychaeta form tubes of different substances. These tubes are built either of organic material, or of fragments of sand, silt, or broken seashells, cemented together with calcium carbonate. The worm uses the tube as a protective covering and frequently also creates a door (operculum) to cover the opening. Some of the tubes are attached to rocks and other shells on the sea bottom. Some types of worms carry the tube as they move about. Some worms even leave their "house" for a short time to feed and then return to it for protection. The living polychaete *Spirorbis* forms a coiled shell of calcium carbonate, somewhat similar to a snail shell. This type of tube may be found in rocks as old as the Ordovician and is an example of a genus that has evolved little in the formation of the shell during its long existence on the earth.

Fossil annelids, primarily *Spirorbis*, have been found in some Pennsylvanian age limestones in western Pennsylvania; however, they are rare as fossils.

Phylum Arthropoda

The largest of all animal phyla is the phylum Arthropoda. About 75 percent of all living animals (most of which are insects) belong to this extremely varied group. The animals that are placed in the phylum are all characterized by legs that are jointed and a body that is divided into several segments (head, body, abdomen, tail, and other segments). The body is enclosed by a hard external covering (the exoskeleton).

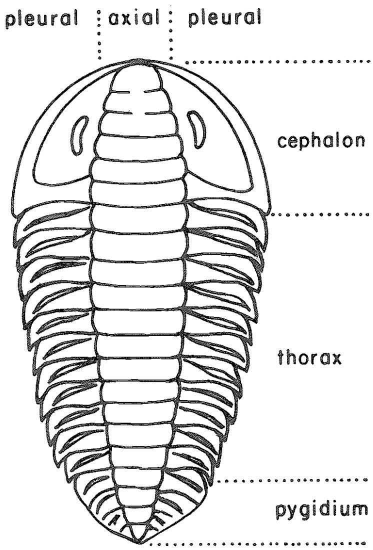
The phylum is divided into several groups, some of which have little superficial resemblance to each other. Only two of these groups are important as fossils in Pennsylvania. These are the extinct class Trilobita, and the class Crustacea, which includes living lobsters, crabs, barnacles, and ostracodes. Some of the other classes placed in this phylum are Hexopoda (all of the many types of insects); Myriopoda (centipedes and millipedes); Arachnida (spiders and scorpions); and Merostomata ("king crabs").

All of these classes have produced fossils but, because of the weakness of the exoskeleton in many of the groups and because many of them dwelled on the land or in the air, their exoskeletons have not been abundantly preserved.

Class Trilobita

Although the trilobites are an extinct group of animals, the similarities of their exoskeletons to those of living arthropods are such that paleontologists can generally reconstruct these fossils as they must have appeared in the past. In addition, some specimens have been found with appendages and other organs partially preserved, thus aiding the reconstruction

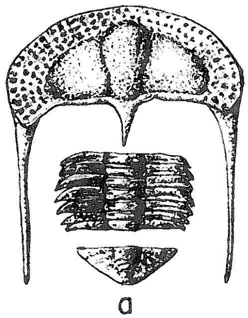
The trilobite body is divided into three main sections, each of which is composed of smaller segments. These three sections are the head (cephalon), body (thorax), and tail (pygidium). In the cephalon and pygidium, the smaller segments are fused together; in the thorax, they are separate. Thus, when a trilobite died, the exoskeleton was usually scattered about.

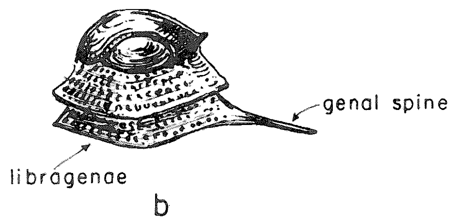


Schematic sketch of a trilobite exoskeleton.

Fossil hunters commonly find the head or tail complete, but the thorax is rarely intact.

Each of the three main sections is, in turn, divisible into three "lobes" by furrows that extend along the length of the animal; hence, the name trilobite. The lobes are marked by indentations and consist of an axial lobe and two pleural lobes; the axial lobe is usually higher than the others. In some genera, a small piece of exoskeleton called the libragenae (free cheek) is attached, but not fused, to the cephalon. Some trilobites also had a long spine at each side of the cephalon. These are the genal spines, which are attached either to the free cheek or to the cephalon.





***Cryptolithus* — an Ordovician trilobite (x4).**

a. **The three major body divisions of *Cryptolithus*.**
b. **Side view of the cephalon showing the libragenae, which fits underneath the cephalon. The genal spines are attached to the libragenae.**