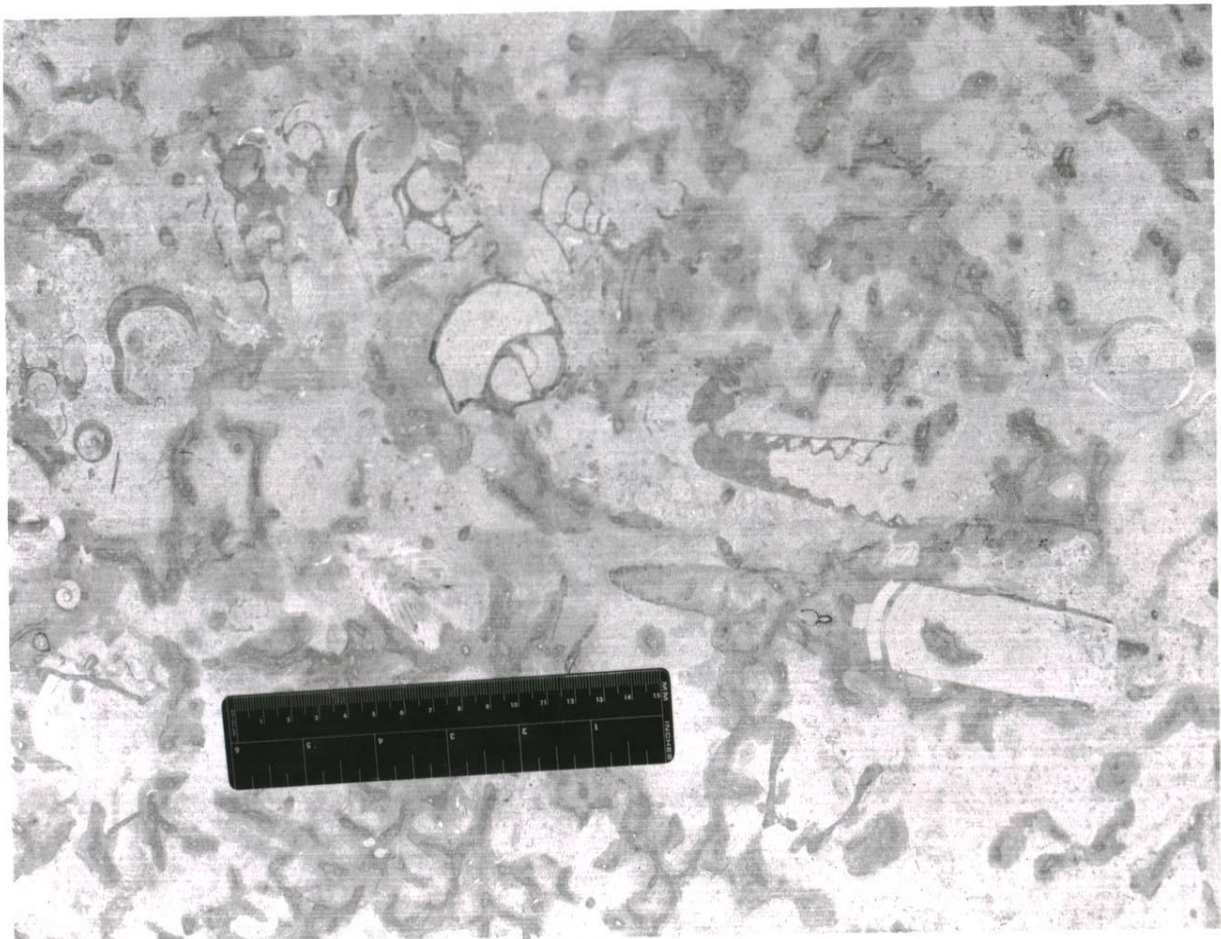
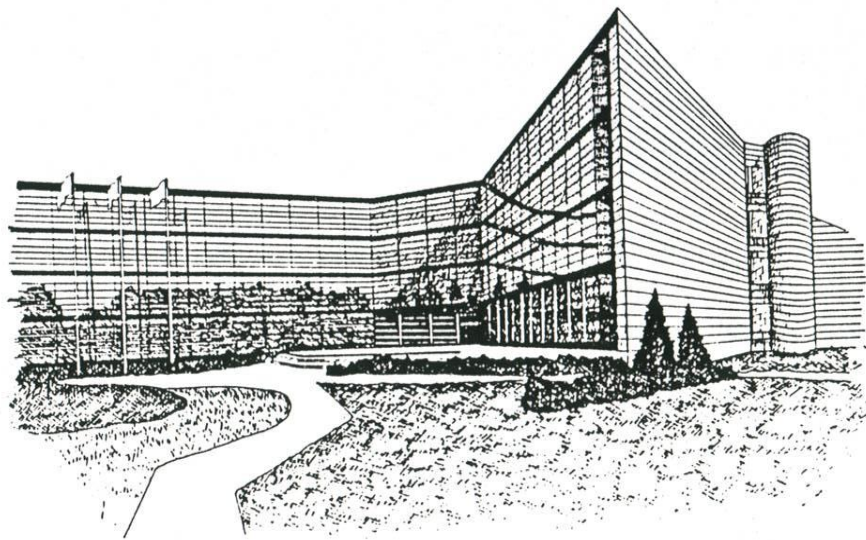




Bishop Building
FOSSIL CATALOGUE

THE BISHOP BUILDING



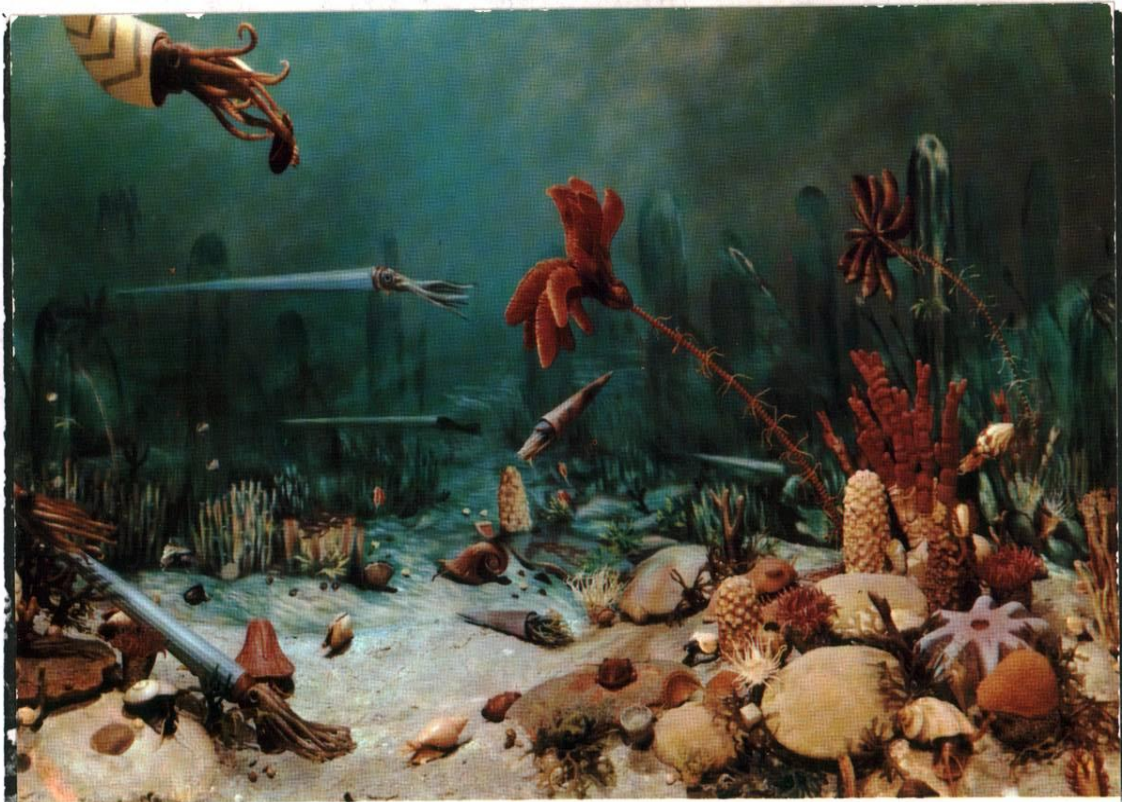


LIFE IN THE ORDOVICIAN PERIOD

The creatures whose remains can now be found in the limestone walls of the Bishop Building lived 450 million years ago, during the Ordovician Period. This was long before the dinosaur era (200 million years ago) and long, long before the time of glacial Lake Agassiz (only 10,000 years ago). The age of the world itself is estimated to be five billion years, and first evidence of life on earth dates back 3.4 billion years, in the form of tiny cells that resemble modern-day bacteria.

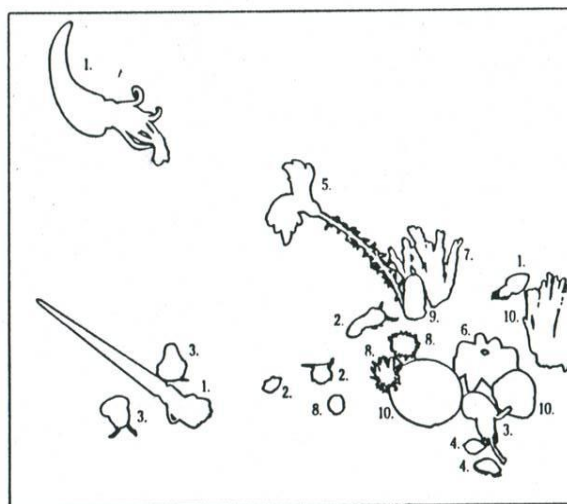
The duration of the Ordovician Period was approximately 75 million years, from 425 to 500 million years ago. During that time the continents were moving together. With Greenland, North America and Europe colliding, the Appalachian Mountains were being formed on America's east coast. Inland the prairie was, not unlike today, quiet. A great sea covered probably all the area that is now Manitoba. With the equator then passing on a northeast-southwest line through the southeast corner of the province, the North Pole was far, far to the northwest. In this great equatorial sea there flourished a multitude of invertebrate fauna (literally, spineless creatures, predecessors of today's squids, clams, corals and snails), the flora of the period (such as the ambiguous Receptaculites), and the first vertebrates (creatures with backbones). These last were the Ostracoderms, the first fish, with no jaws, and ancestors to all other vertebrates.

FIGURE 1



Ordovician Sea Bottom, Manitoba Museum of Man and Nature

Winnipeg, Manitoba, Canada



INDEX TO ORDOVICIAN DIORAMA

- | | |
|-------------------------|--------------------|
| 1. Nautiloid cephalopod | 6. Sponge |
| 2. Trilobite | 7. Coral |
| 3. Snail | 8. Horn coral |
| 4. Brachiopod | 9. Coral |
| 5. Crinoid | 10. Tabulate coral |

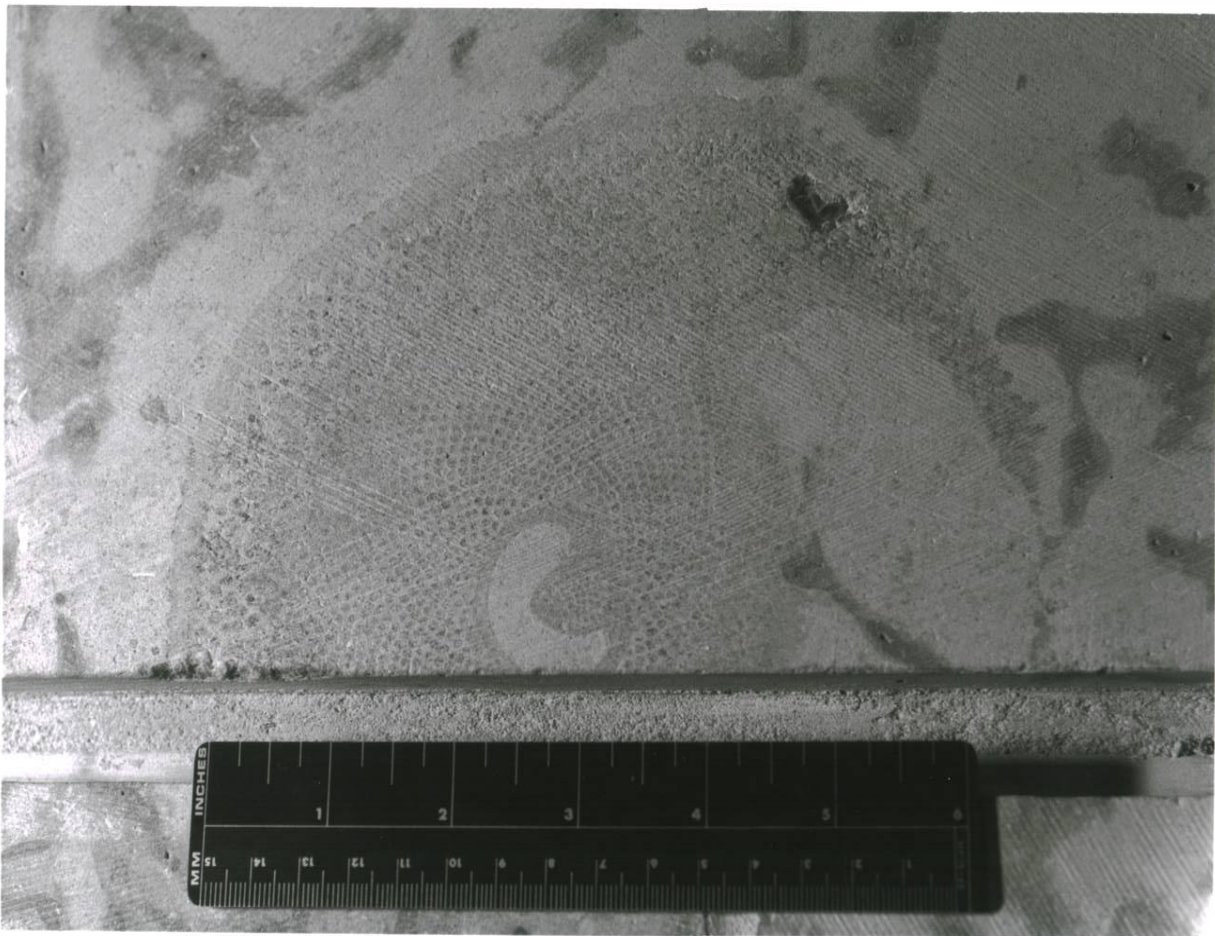
Life in the Ordovician Period, as illustrated in the diorama at left (Figure 1), was little different from life in a tropical sea today, with creatures alternately hunting and escaping, and, as always, evolving more successful forms through the process of natural selection. In the diorama's top left corner, a nautiloid cephalopod, a relatively highly-mobile and sophisticated creature, has captured an unfortunate trilobite for lunch. At centre, the brown plant-like creature leaning to the left is actually a crinoid, a sessile (sedentary) ancestor to modern mobile forms such as the starfish. It beckons with its arms (used to capture and reduce prey) towards another species of nautiloid cephalopod as it searches for its meal. Harmless looking gastropods prowl about the floor of the ancient sea, wary of each other. The fossil record has yielded many specimens with holes bored through their protective shells, evidence of one snail having had another over for dinner, the rasping tongue of the latter having bored a deadly hole in the former's shell in search of the succulent contents.

The sea in which these ancient creatures played out their lives was rich in the salt calcium carbonate. This mineral was used by the creatures to form their shells. When they died these remains readily mixed with the precipitate calcium carbonate that continuously settled on the sea-bed. With time and pressure these sediments compressed to form the fossiliferous (rich in fossils) limestone and dolomite that are found in Manitoba quarries

PLATE 1

TYPE: RECEPTACULITES

LOCATION: ATRIUM ENTRANCE TO OPS DIVISION, CHEST HEIGHT



today. The Tyndall limestone that forms the walls of the Bishop Building was quarried 25 miles, as the crow flies, northeast of Portage and Main, near Tyndall and Garson, Manitoba. As a matter of interest, 90% of all known fossils are marine animals, due to the ease of their formation and preservation in sediment. Of the creatures rediscovered in the walls of this building, a few brief case studies will now follow.

STUDY NO. 1 - RECEPTACULITES

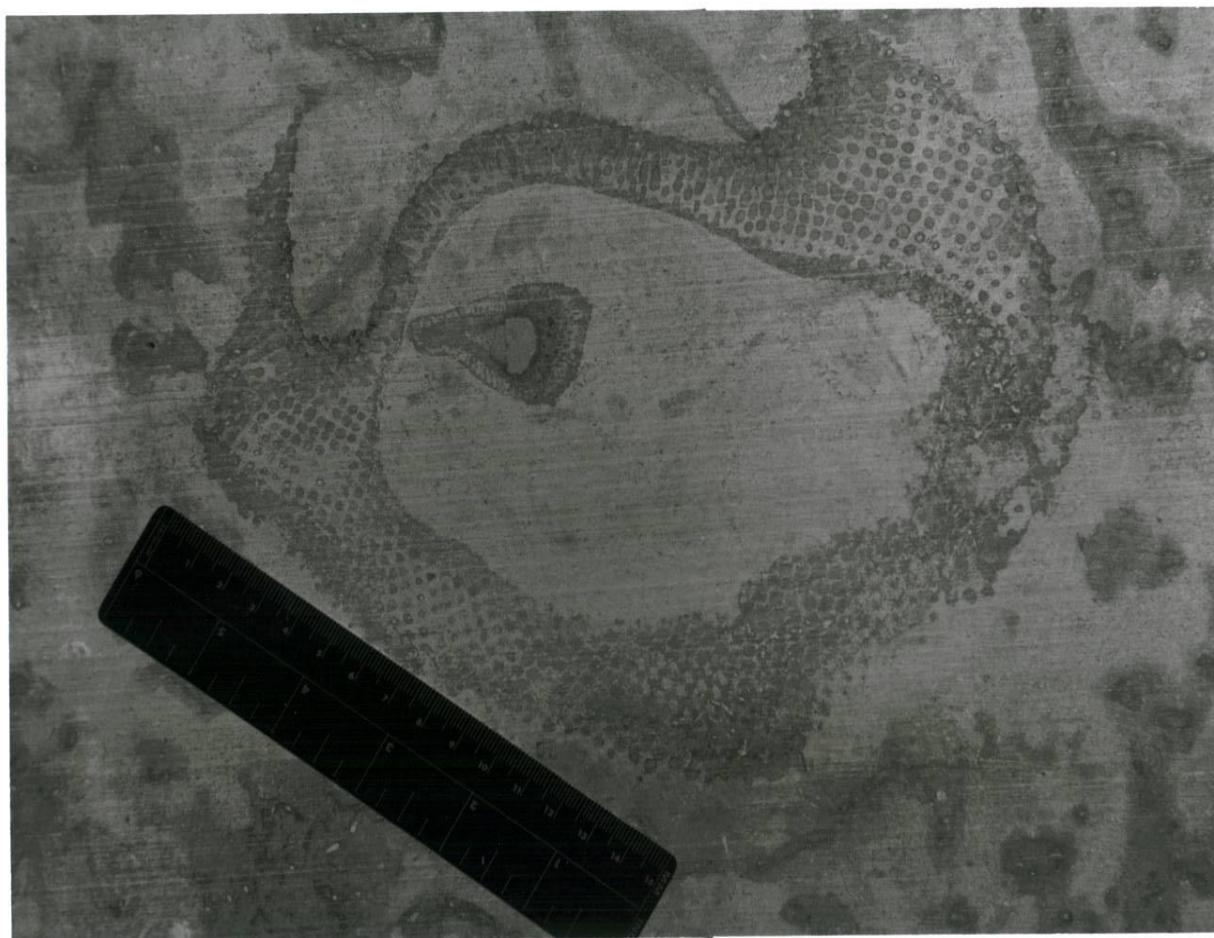
Psychologists, fond of studying personality with their ink-blot pictures, might find Plates 1 and 2 interesting. Plate 1, a specimen found just outside the Operations Division on the first floor, has been labelled by residents there as their "elephant" fossil. One can envisage the Ops Div, Hannibal-like, marching off to battle on their mini-Mastodon. Meanwhile, on the fourth floor is found Plate 2, resembling perhaps a sunfish. The rigours of war! While the Operators march, the Maintainers fish, a fanciful and, of course, unfair presumption.

In fact, what is being seen in Plates 1 and 2, and in all the fossils in the building, are cross-sections of the Ordovician flora and fauna, two-dimensional pictures. The flat limestone building blocks, sawed into shape at the quarry, yield only slices of actual fossils. In the case of Receptaculites, due to the nature of the plant,

PLATE 2

TYPE: RECEPTACULITES

LOCATION: FOURTH FLOOR LOUNGE, LEFT OF WINDOW, LOW

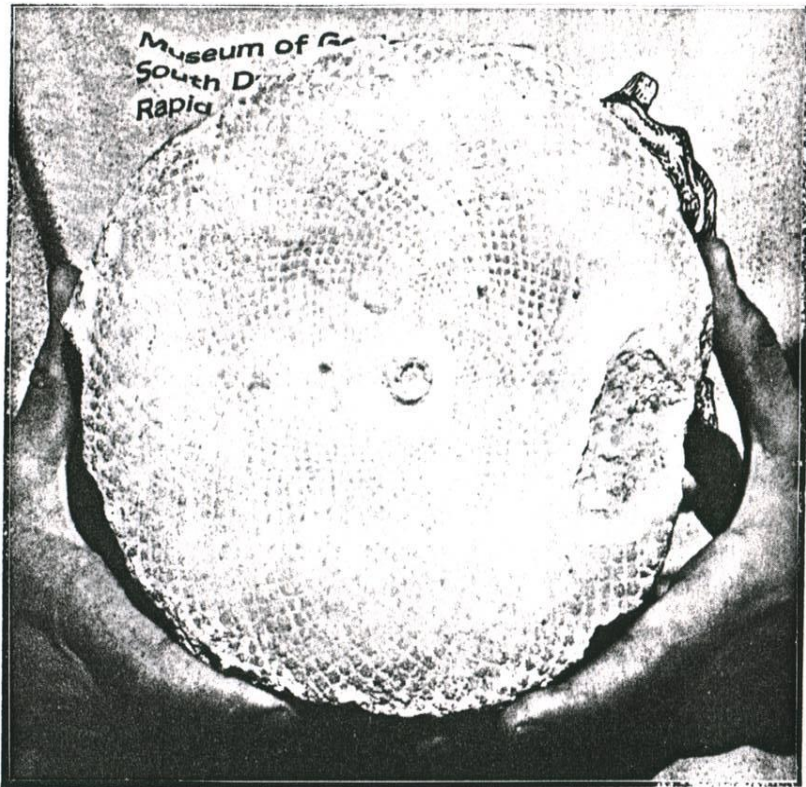


different slices yield different images, but each with its recognizable characteristic, sunflower-like dottings in a symmetrical curving pattern. What was Receptaculites, and why was it referred to as "ambiguous" earlier in these notes?

Receptaculites is actually a rogue fossil, still a bit of a paleontological mystery. Long described as the 'sunflower coral', although believed to be a sponge, it is now considered by most to be an algae, although some are unable to pigeonhole it into existing categories. Instead, they ascribe it to a Phylum (major grouping after Kingdom) all its own, the Receptaculitida. A review of the literature yields comments such as the following:

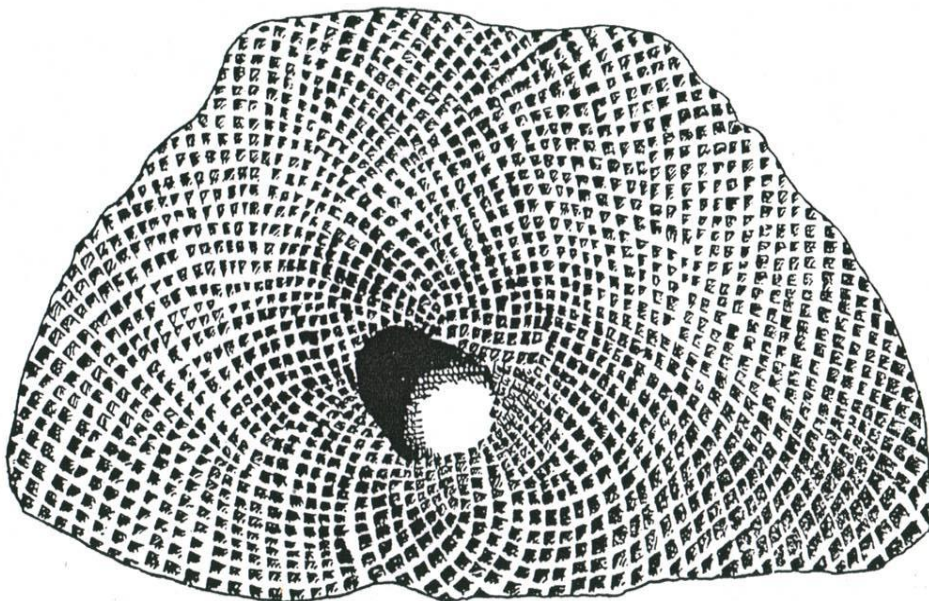
1. MacDonald in The Fossil Collector's Handbook (1983): "...mid-Ordovician, a common 'sponge'. This fossil is placed in the Porifera (sponges) for lack of a better pigeonhole, as there is no certainty as to whether or not it really belongs here."
2. MacFall in Fossils For Amateurs (1983): "The 'sunflower corals' are still a paleontological puzzle. Despite their often excellent preservation they cannot yet be assigned to any plant or animal group."

FIGURE 2



Receptaculites, an Ordovician spongelike animal from the Midwest.

FIGURE 3



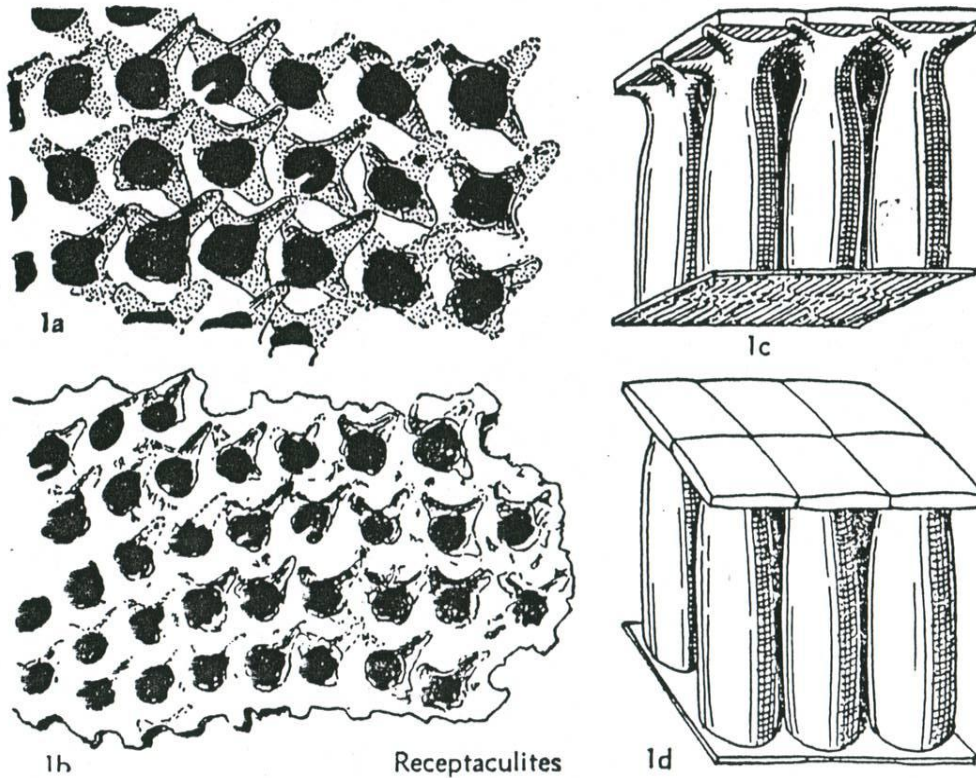
Receptaculites

3. Thompson in Audobon Field Guide (1983):

"...a whole specimen is globular to platter-shaped, and may measure from a few inches to one foot across. The surface is covered by rectangular plates arranged in intersecting sets of clockwise and counter-clockwise spirals, rather like the arrangement of seeds in a large sunflower.... Up to 20 years ago used to be thought of as sponges, but careful study of the skeleton reveals they are indeed algae."

Dr. George Lammers, geologist-in-residence at the Manitoba Museum of Man and Nature who identified the fossils in this catalogue, confirms the Audobon view that Receptaculites was indeed a member of the Kingdom Plantae, an algae. The appearance of this plant can be reconstructed in one's imagination with the assistance of the diagrams at left. At Figure 2 the circular surface area platter shape is shown in a hand-held whole specimen. In Figure 3 is evident the flagstone-like mating of the rhombic (diamond) tops of each individual pillar of the plant. Figure 4 shows in detail the close packing of the pillars, expanding at the extremities into fingers to support the rhombic surface plates. The living plant would look globe-like and quite

FIGURE 4



Receptaculitids. Fossils of this group, known from Ordovician to Devonian, have a calcareous skeleton consisting of plates or pillar-like elements surrounding a central cavity. Externally, the individual units fit together to form a smooth pavement of quincunxial pattern, formed by intersecting spirals.

1a-d, *Receptaculites oweni* Hall, Middle Ordovician, Missouri; (1a, b) exterior surface of fossil mold, showing round cavities which correspond to pillars, and impressions of ridges on underside of the rhombic expanded ends of the pillars, $\times 4$ and $\times 3$; (1c, d) reconstructed small portion of the skeleton viewed obliquely from below and from above, $\times 4$.

solid at the surface, with the very machine-like clockwise-counterclockwise line patterns very evident as in Figure 3. The reason for this design can only be speculated upon. Perhaps by giving the appearance of size and substance, or by resembling a sponge, this algae was successful in discouraging, or deceiving, certain Ordovician vegetarians. Certain tropical crabs today use a similar ruse. By nipping off a piece of a sponge and carrying it on their back until it begins to grow there, they eventually give an appearance much larger than they are, and thus discourage predators.

STUDY NO. 2 - CORALS

Not surprising inhabitants of the ancient Manitoba equatorial sea were the corals. Most of their modern-day relatives need clear, sunlit waters, with a minimum temperature of 70°F. Important rock builders then and today, corals may be found in the single (solitary) state, Plate 3, or the colonial (compound) state, Plate 4.

On the evolutionary scale, corals represent about one rung on the ladder above sponges. They possess simple sac-like bodies with a single opening, the mouth. Most are sessile, or sedentary, laying down a baseplate on a solid surface when the creature is young and building up an external skeleton (coral shell) as it grows. In Plate 4, the solid surface appears as the horizontal arc from which

PLATE 3

TYPE: SOLITARY CORAL

LOCATION: THIRD FLOOR LOUNGE AT STAIRWELL, WAIST-HEIGHT

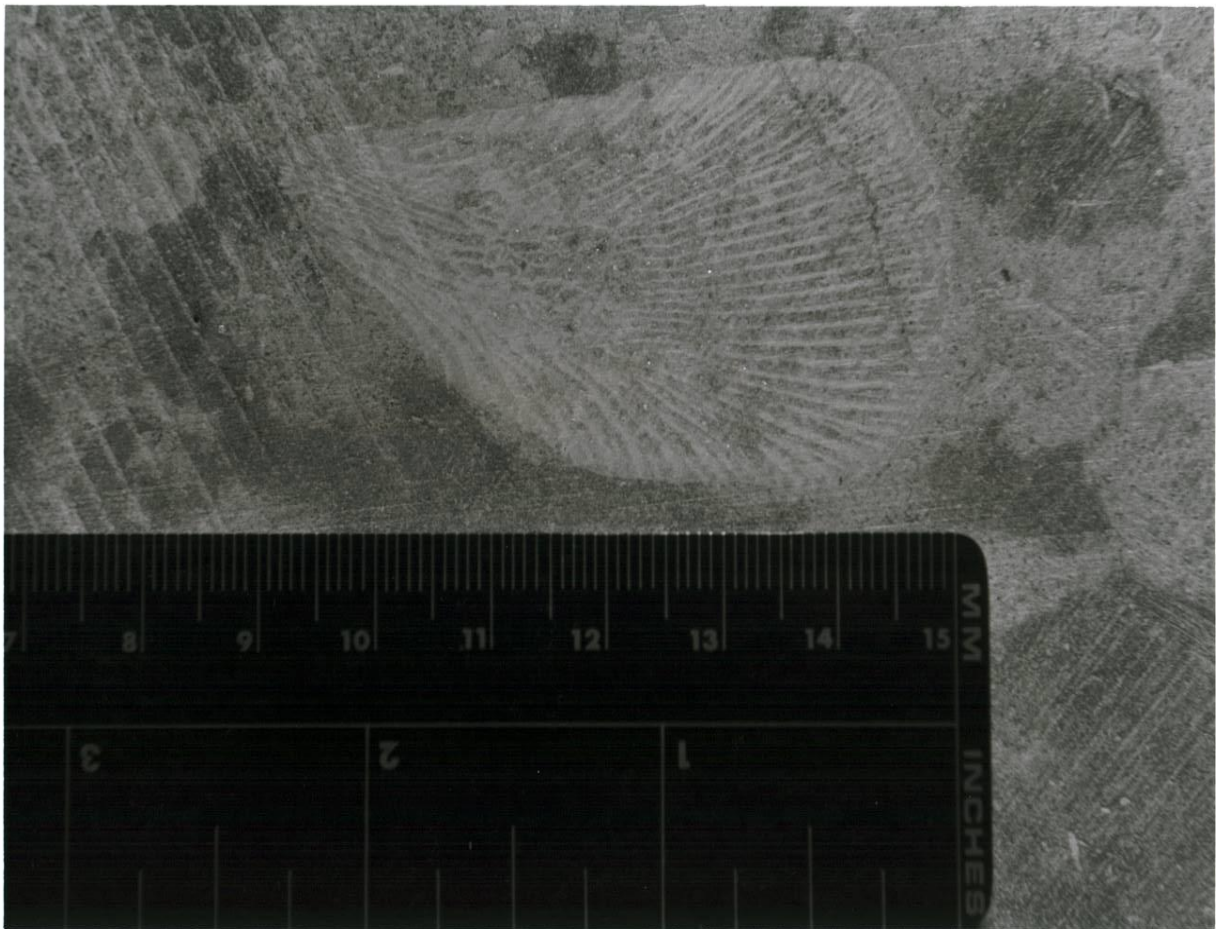


PLATE 4

TYPE: COLONIAL CORAL

LOCATION: THIRD FLOOR LOUNGE AT STAIRWELL, WAIST-HEIGHT

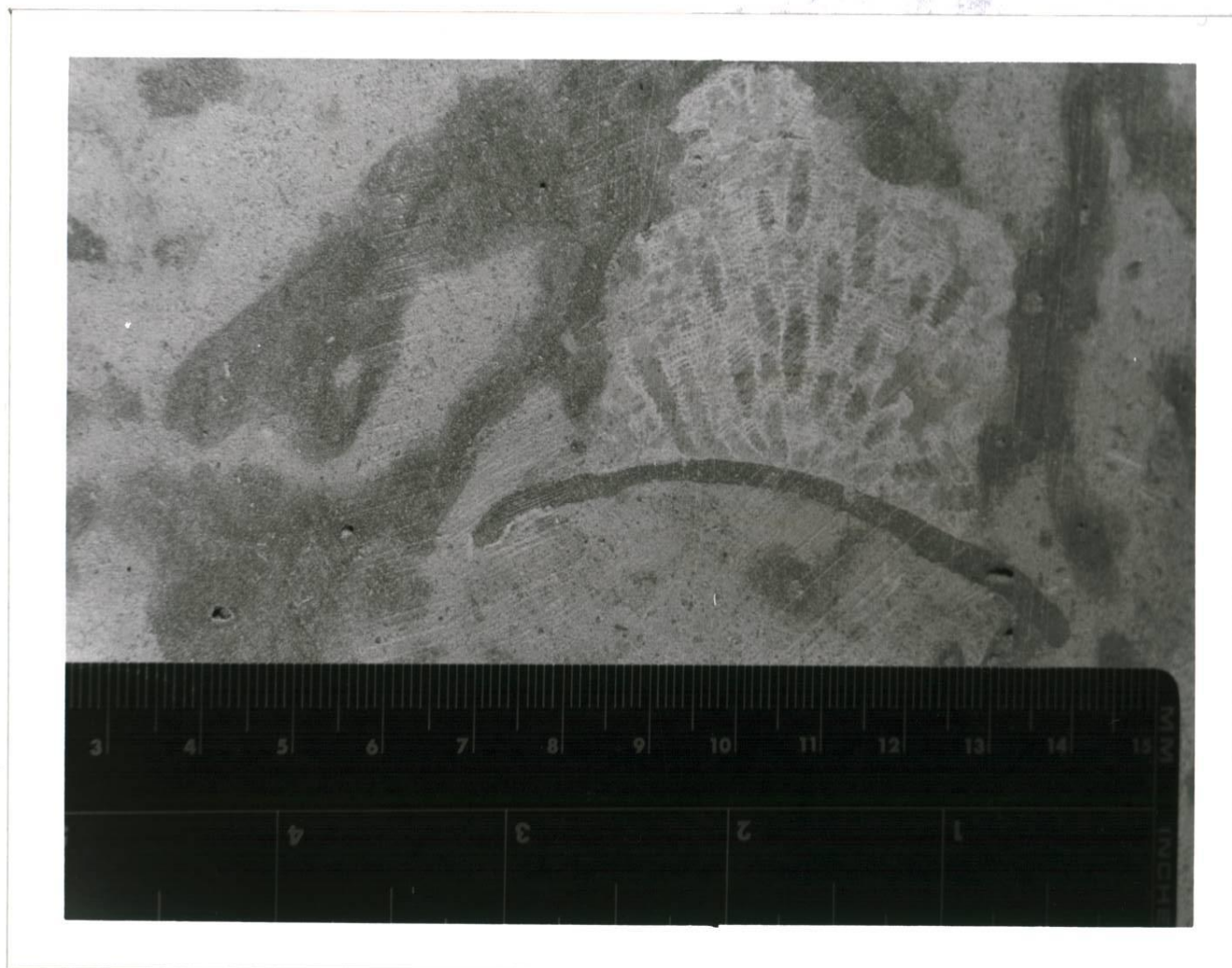
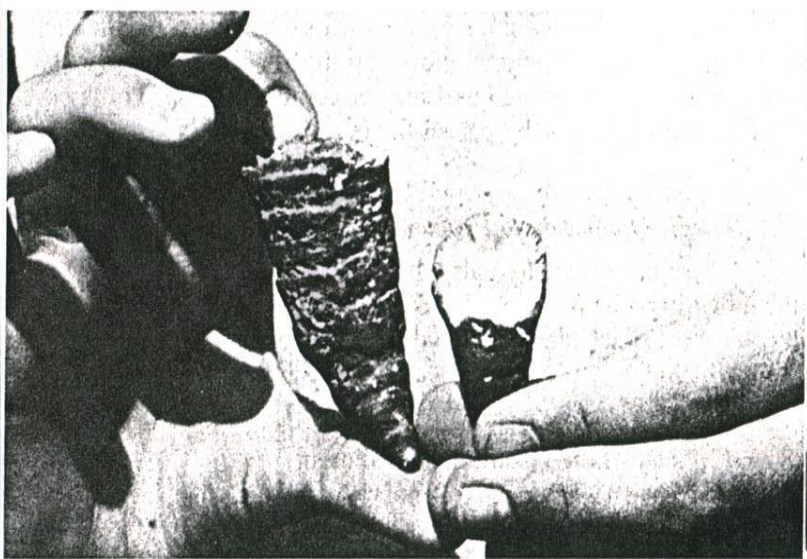
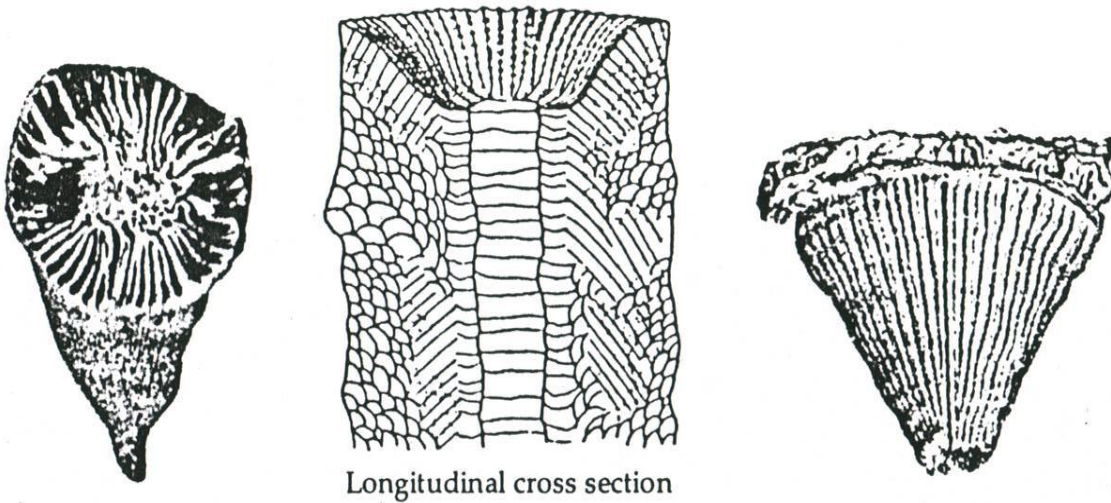


FIGURE 5



Rugose horn corals, very common in the Devonian.

FIGURE 6



have grown up and away the coral colony, usually descendants of an original single unit.

Members of the Phylum Coelenterata (coelenteron or gut), about the only advanced organ system the corals possess is their digestive tract. By folding this along radially-symmetric septa inside the coral cone, (the lines visible in Plate 3), the square footage of digestive tissue was expanded greatly, making them efficient consumers.

For defence the corals possessed stinging tentacles on the exposed body wall (nematocysts). Further tentacles surrounded the mouth and were used in feeding. Modern day relatives of the ancient corals include the sea anemones, also sedentary, and the jellyfish, which, over time, have abandoned the protective corallite and become mobile. Three-dimensional images of corals are shown left at Figures 5 and 6. Only the hard part is preserved. In Figure 5, if one can imagine two fleshy little creatures waving their tentacles, sitting in the two horns, themselves rooted fast at their narrow end to some rocky surface, one can visualize two solitary corals saying hello. Figure 6 shows clearly the radial symmetry of the septa, against which the coral folded its digestive tract inside its corallite armour.

STUDY NO. 3 - GASTROPODS

Plates 5 and 6 will say 'snail' to the child's eye in the observer, and the observer will not be wrong. This

PLATE 5

TYPE: GASTROPOD

LOCATION: FRONT ENTRANCE TO BUILDING, ABOVE WARNING
PANELS OPPOSITE COMMISSIONAIRE STATION

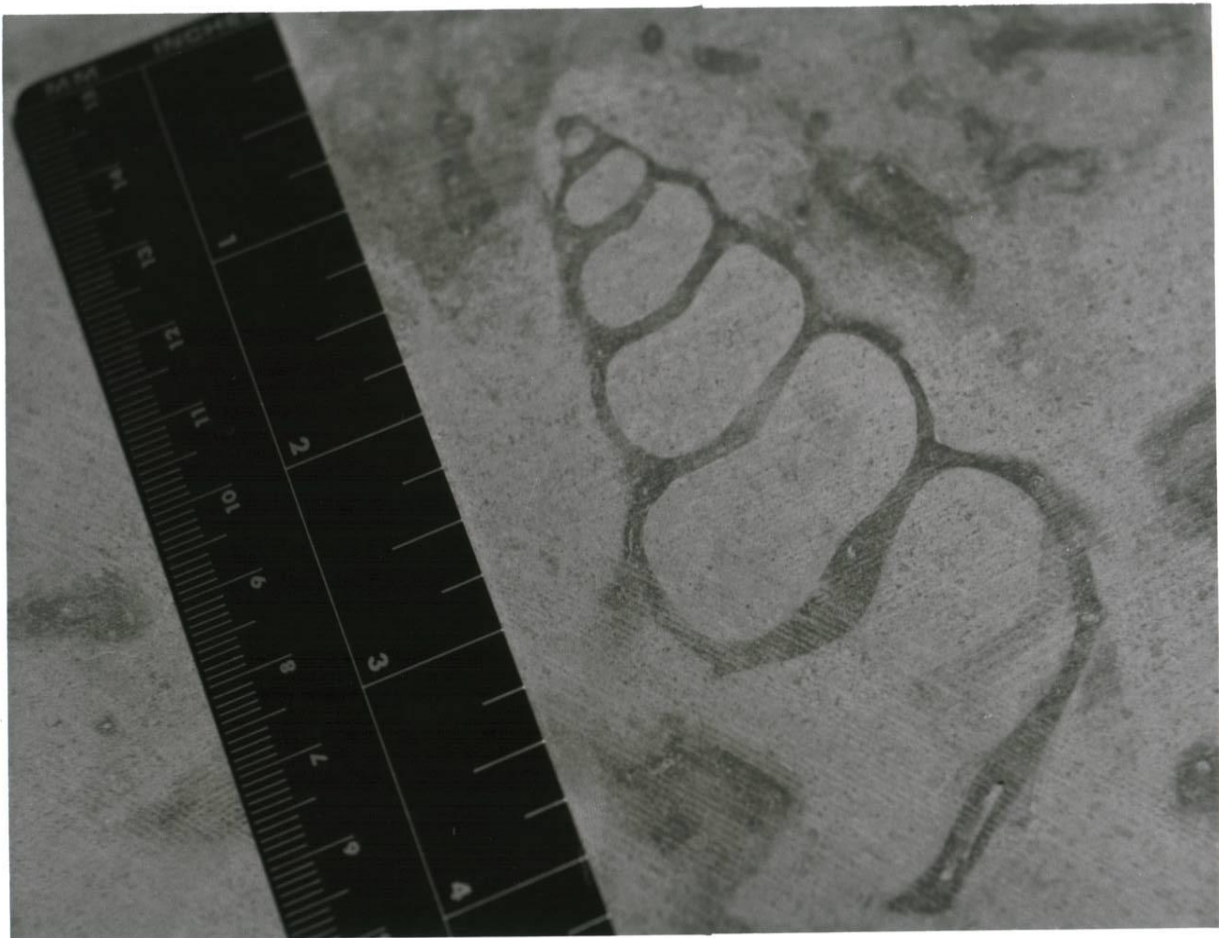


PLATE 6

TYPE: GASTROPOD

LOCATION: FRONT ENTRANCE TO BUILDING, SEATING AREA, HIGH

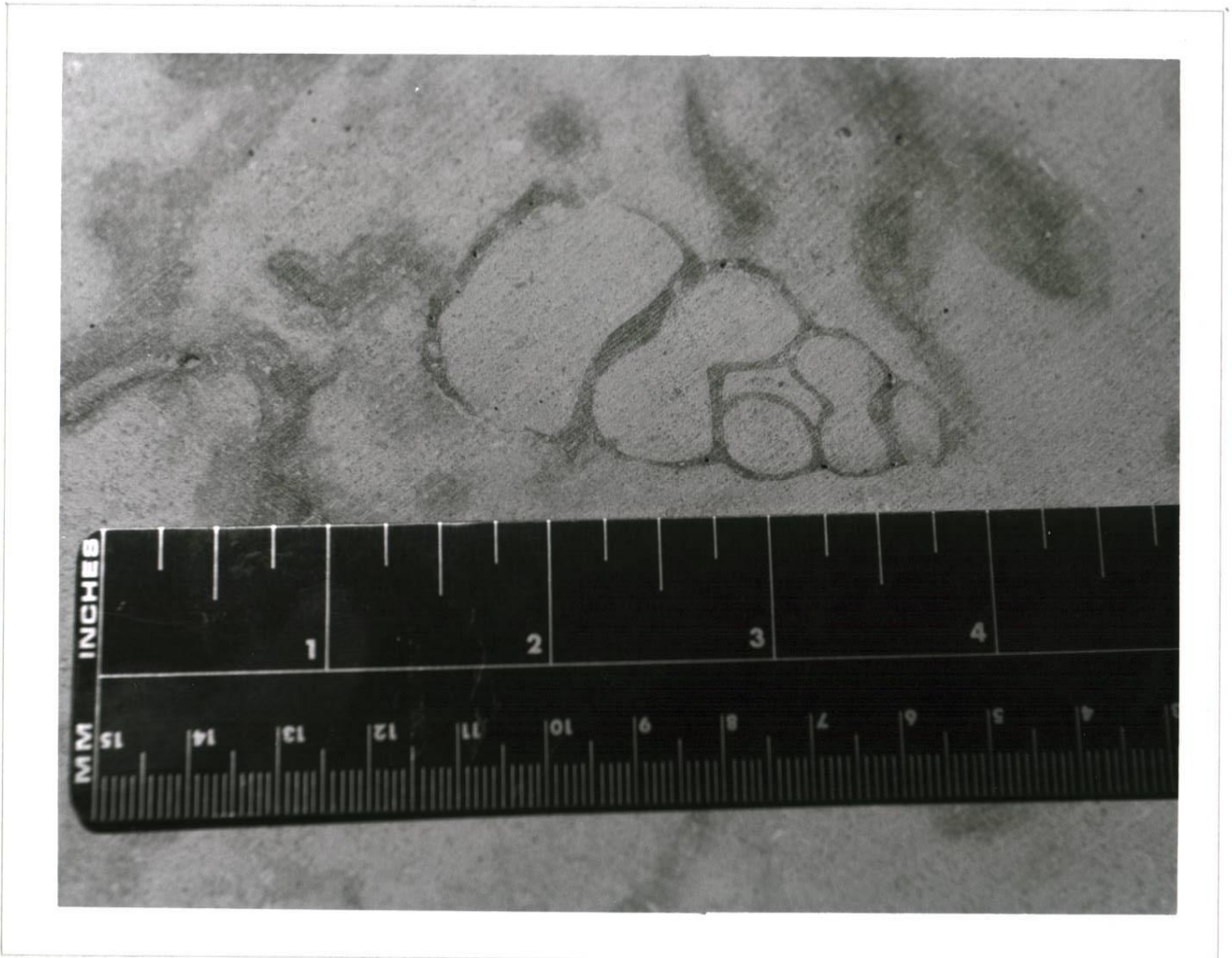
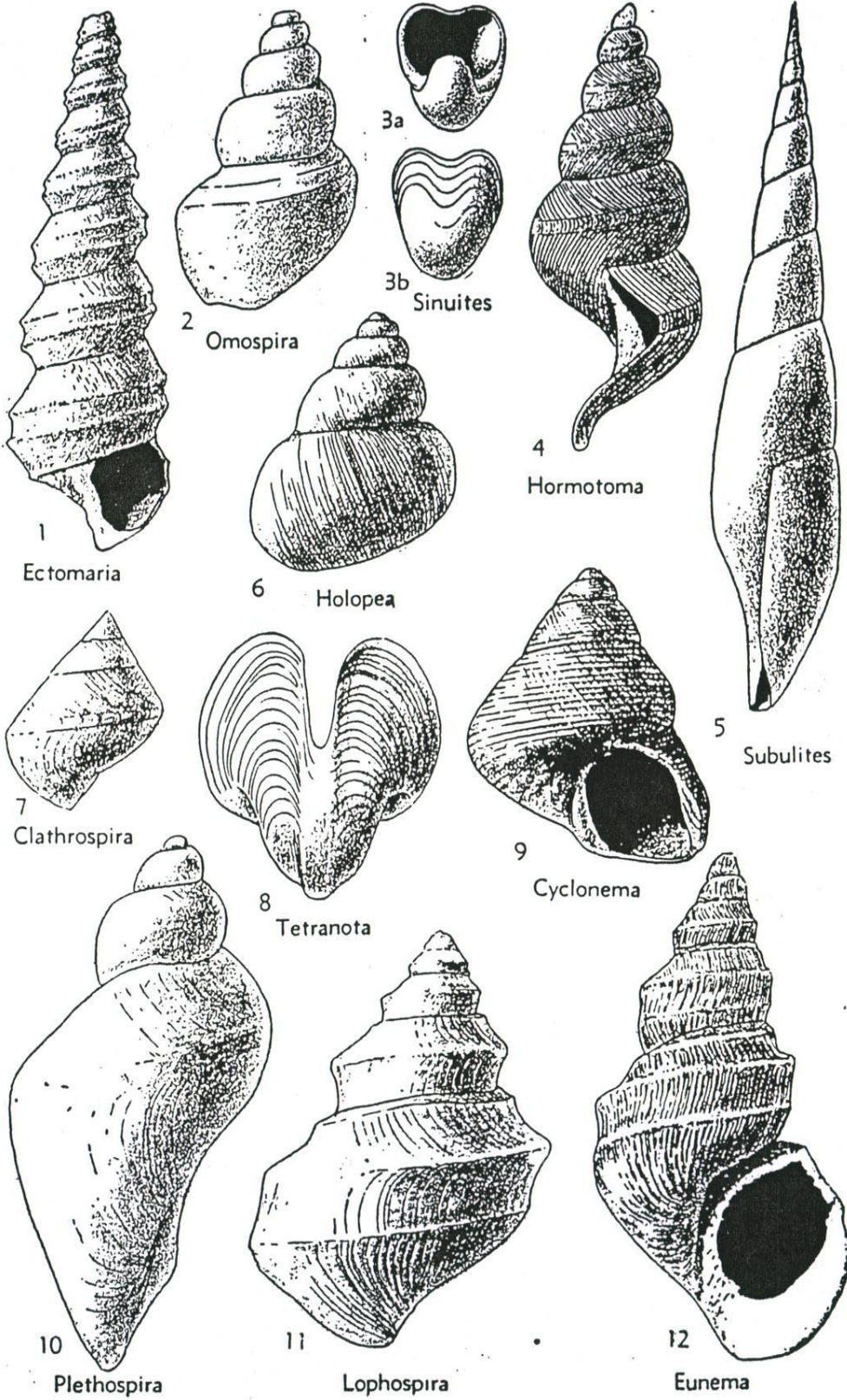


FIGURE 7

GASTROPODS



most versatile, and therefore successful, member of the Phylum Mollusca, has evolved forms to inhabit all environments - marine, freshwater, and terrestrial. Some have been dredged from ocean depths of more than three miles, others have been found on mountains at elevations of 18,000 feet. Of over 50,000 species, 35,000 are living. Modern-day types include snails, slugs, limpets and winkles.

Typically, the gastropod, Class Gastropoda (stomach-foot), is a highly-developed creature characterized by many organ systems - digestive, reproductive, circulatory, even visual in some species, that creeps, slides or burrows about on its muscular foot. In many species, the foot and all other exposed parts - tentacles, eyes, mouth - can be withdrawn when threatened into the often elaborately whorled shell, and protected there behind a sliding trap-door, a horny disc known as the operculum.

The gastropod generally moved sluggishly about, carrying its aragonite shell (firm calcium carbonate not easily broken) for protection, in its search for food. With its file-like tongue (radula) it had the capability of boring through the shells of other mollusks to satisfy its hunger. The samples at Plates 5 and 6 may be compared with the species shown at Figure 7 and described at Figure 7A. *Hormotoma* may be a candidate identification as it lived in the same Ordovician sea and resembles the plates in form. At Figure

FIGURE 7A

Representative Ordovician gastropods. Two bellerophontids (3, 8) are illustrated, the others being archaegastropods (Pleurotomariacea, 1, 2, 4, 7, 10, 11; Trochonematacea, 6, 9, 12; Subulitacea, 5). All natural size unless indicated otherwise.

Clathrospira Ulrich & Scofield, Ordovician–Silurian. A rather evenly biconical shell which has a slit band at the periphery. *C. subconica* (Hall) (7), Middle Ordovician (Trentonian), New York.

Cyclonema Hall, Ordovician–Devonian. A conical shell with rounded periphery, marked by fine spiral costae; no slit. *C. bilix* (Conrad) (9, ×2), Upper Ordovician (Richmondian), Indiana.

Ectomaria Koken, Ordovician. High-spired shell having rather deep sinus but no slit or band. *E. pagoda* (Salter) (1, ×3), Middle Ordovician (Blackriveran), Quebec.

Eunema Salter, Ordovician–Devonian. A high-spired shell having angulated whorls but no slit band. *E. strigillatum* Salter (12, ×2), Middle Ordovician (Blackriveran), Quebec.

Holopea Hall, Ordovician–Pennsylvanian. Whorls well rounded, oblique growth lines. *H. symmetrica* Hall (6, ×3), Middle Ordovician (Trentonian), New York.

Hormotoma Salter, Ordovician–Devonian. Moderately high-spired shell which has a selenizone. *H. trentonensis* Ulrich & Scofield (4), Middle Ordovician, Minnesota.

Lophospira Whitfield, Ordovician–Devonian. Whorls bear three angulations, the middle one marking location of a narrow selenizone (classed as subgenus of *Loxoplocus*). *L. milleri* (Miller) (11, ×2), Middle Ordovician (Trentonian), New York.

Omospira Ulrich & Scofield, Ordovician. A sloping slit band on the shoulder of the whorls. *O. laticincta* Ulrich & Scofield (2), Middle Ordovician (Blackriveran), Tennessee.

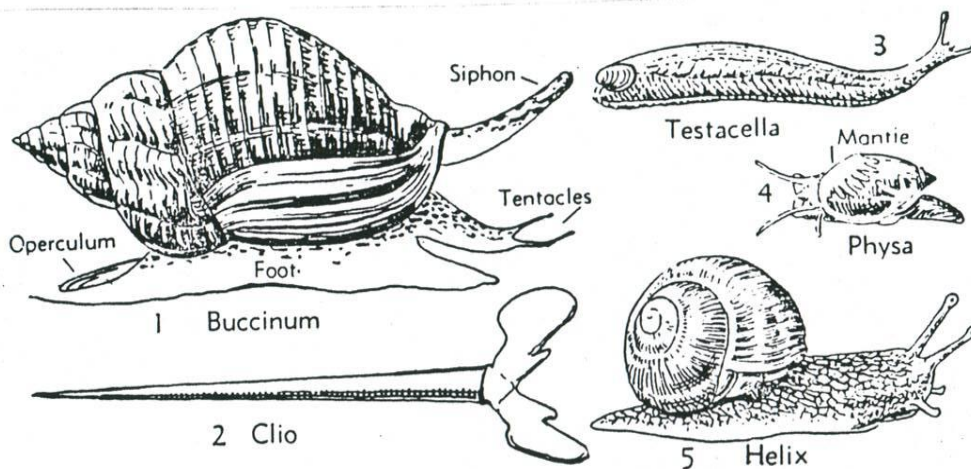
Plethospira Ulrich & Scofield, Ordovician. Body whorl elongated anteriorly. *P. cassina* (Whitfield) (10), Lower Ordovician, Vermont.

Sinuities Koken, Ordovician–Pennsylvanian. A sinus, rather than a slit, indents the outer lip. *S. cancellatus* (Hall) (3a, b), Middle Ordovician (Blackriveran), Minnesota.

Subulites Emmons, Ordovician–Silurian. High-spired smooth shell with elongate narrow aperture and an anterior siphonal (?) notch. *S. regularis* Ulrich & Scofield (5), Middle Ordovician (Blackriveran), Kentucky.

Tetranota Ulrich & Scofield, Ordovician. Prominent revolving ridges. *T. wisconsinensis* (Whitfield) (8), Middle Ordovician, Wisconsin.

FIGURE 8



Types of living gastropods. All except *Clio* (2), which is a pelagic swimming snail, crawl about on their broad muscular foot, carrying the shell with its apex pointed obliquely or directly toward the rear. Most snails can pull themselves inside their shell, and many are equipped with a horny or calcareous lid (operculum) which fits over the aperture when the animal is inside. *Buccinum* (1) is a shallow-water marine gastropod. *Testacella* (3) and *Helix* (5) are terrestrial air breathers. *Physa* (4) is a fresh-water snail, which, like many marine forms, may extend the shell depositing mantle over the exterior of the shell (×1, except 2, ×2).

8 are shown living gastropod types, with Buccinum apparently most similar to the fossil-types in the plates.

STUDY NO. 4 - NAUTILOID CEPHALOPODS

The most fascinating creatures in the Phylum Mollusca are the cephalopods (head-foot). Modern forms include the squid, the octopus, and the pearly nautilus. Just as the giant squid remains a frightful legend in human folklore, capable, with its massive tentacles, of doing battle with the great sperm whale or of dragging entire slave ships to the bottom of the sea, likewise the nautiloid cephalopods, whose shells may be examined in Plates 7 through 10, were fearsome predators of the Ordovician period. Unlike their sedentary and slow-moving contemporaries, the nautiloid cephalopods were mobile, aggressive hunters:

This great mobility enables these animals to be pelagic, predacious carnivores - catching food by the tentacles, minimizing prey by the mandibles, and pushing it down the esophagus by the radula (from P. Lof, Elsevier's Invertebrate Fossil Chart.)

What did the nautiloid cephalopod look like, and what adaptations did it possess that made it a successful hunter? Figure 9 shows Loligo, a modern cephalopod, the common squid. The ancient cephalods did not really differ

PLATE 7

TYPE: NAUTILOID CEPHALOPOD

LOCATION: THIRD FLOOR LOUNGE, LEFT OF ELEVATOR,
CHEST HEIGHT



PLATE 8
TYPE: NAUTILOID CEPHALOPOD
LOCATION: CLASSIFIED

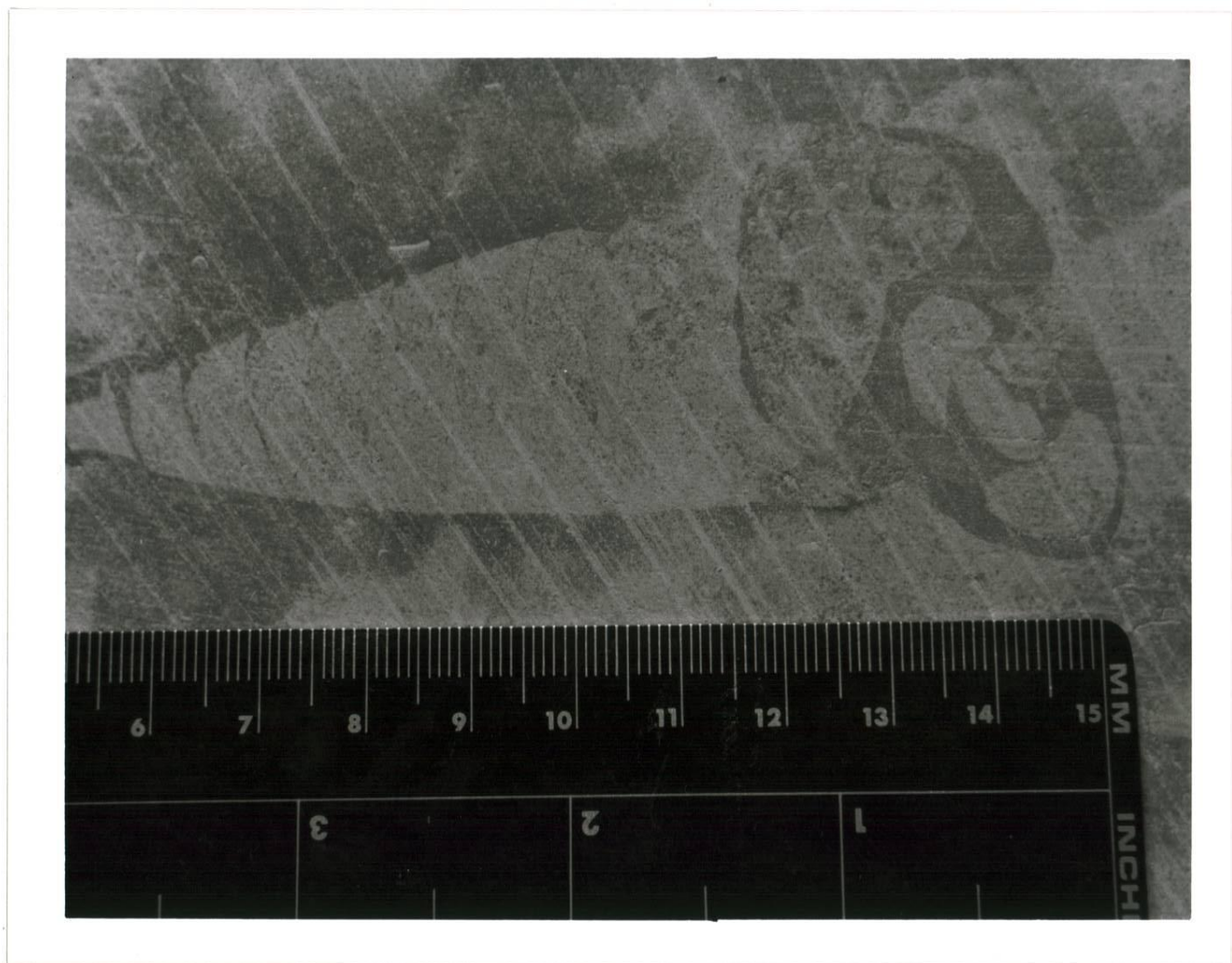


PLATE 9

TYPE: NAUTILOID CEPHALOPOD

LOCATION: ATRIUM, ABOVE ENTRANCE TO ROOM 134A



PLATE 10

TYPE: NAUTILOID CEPHALOPOD

LOCATION: SECOND FLOOR ATRIUM, LEFT OF WINDOW, LOW

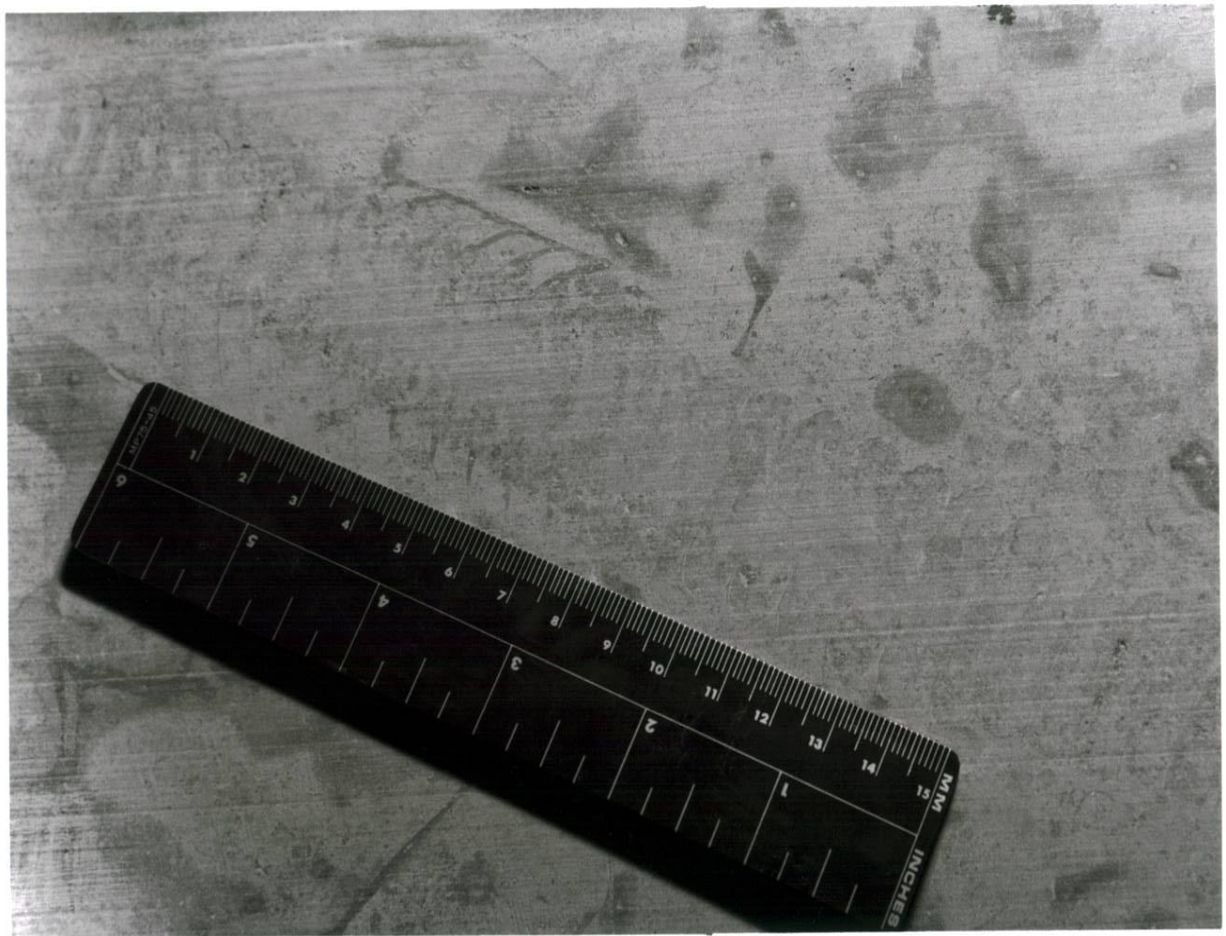


FIGURE 9

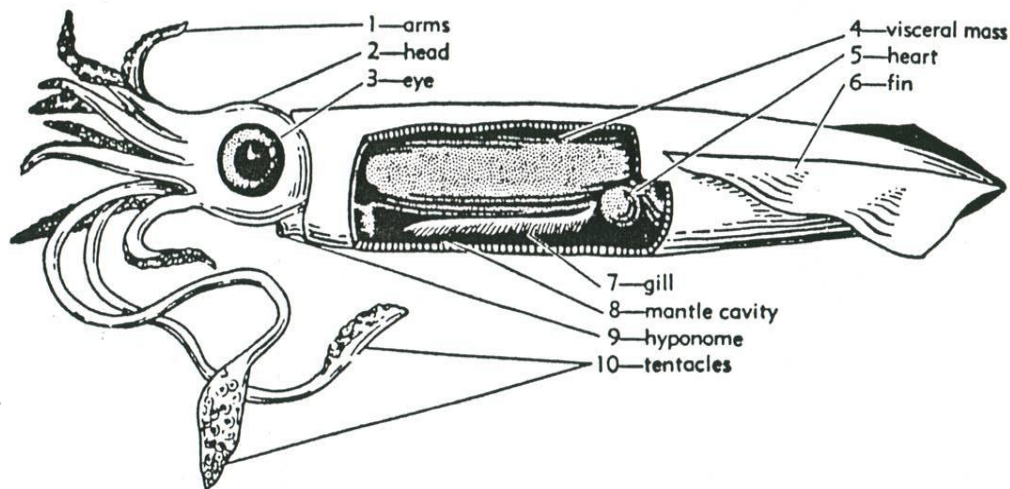


FIG. 9 Structure of *Loligo*. The drawing shows a partial dissection of the common squid, $\times 0.5$. Main parts of the body are defined in the following list cross-indexed to the figure by numbers.

arms (1). Appendages surrounding mouth, bearing sucker disks.

eye (3). Large visual organ, equipped with lens, located on side of head.

fin (6). Horizontal extension of mantle, used for slow locomotion and for steering.

gill (7). Fringed respiratory organ (one of a pair), suspended in mantle cavity.

head (2). Anterior part of animal, containing brain, mouth, eyes, and bearing arms and tentacles.

heart (5). Contractile organ (one of a pair) which pumps blood through the body.

hyponome (9). Nozzle through which water is ejected from mantle cavity; used for rapid jet propulsion.

mantle cavity (8). Large space between ventral mantle and visceral mass, connecting with outside through a slit and the hyponome.

tentacles (10). Two of the appendages surrounding mouth; longer than the eight arms.

visceral mass (4). Organs, chiefly digestive and reproductive, located above and behind mantle cavity.

much from Loligo. They possessed the same highly developed head with keen eyes and clusters of arms and tentacles. They did not possess Loligo's "pen", a long horny blade which is his rudimentary internal skeleton. Instead, the nautiloid cephalopods inhabited their shells, which took many forms; the examples in our plates being orthocone (straight, slender and tapering) and brevicone (short and blunt, straight, or coiled).

A most interesting feature shared by Loligo and his ancestors was the mantle cavity with hyponome. The mantle is the body wall, tough muscular tissue. Besides the visera, it encloses the mantle cavity. The cephalopod, by drawing water into this area and then forcefully expelling it through the hyponome (a nozzle affair), was able to propel itself in the opposite direction to its jet of water. Sound familiar? It should, at least to all turbine operators and maintainers. The nautiloid cephalopod, ancient ancestor to Newton, was putting into practice his third law. It used jet propulsion as its primary method of locomotion. Loligo, like Harrier, possesses an adjustable hyponome and is, therefore, capable of controlling its direction of movement. It is unknown if the ancient nautiloid cephalopods could likewise direct their nozzles; however, their large variety of fossil shell types suggests that, through the process of natural selection, they may have been experimenting

FIGURE 10



Weathered specimen,
showing interior
septa and siphuncle



Siphuncle



with this part of their manoeuvring surfaces.

The nautiloid cephalopods have greater claims than being the world's first jets. Figure 10 details some of the shell structure of the cephalopod. In the weathered specimen is illustrated the interior septa and siphuncle. The septa were lateral separations that gave structure to and built chambers in the animal's shell. Only the outermost chamber was the 'living chamber'. The animal sealed off previous chambers by means of the septa; however, it pierced these with the siphuncle, a long tubular extension of the mantle that projected all the way back to the shell's initial chamber, the protoconch. Much like a submarine dives and climbs by regulating its ballast, the cephalopod, by regulating gas transport along the siphuncle and into and out of the chambers, was able to regulate the buoyancy of its shell. The only modern cephalopod that still possesses a shell is Nautilus, shown in Figure 11. Little is known about Nautilus' actual mode of life because specimens captured alive soon die; however, the function of its shell has been described by Moore in Invertebrate Fossils as follows:

The shell serves as protection, and the gas chambers within it are a hydrostatic device by means of which the weight of the shell is compensated and the specific gravity of the entire organism is brought near that of water ...

FIGURE 11



Modern cephalopods. *Nautilus* in center foreground, $\times 0.3$; a school of squids in the background, an octopus at lower left.

A gas-filled space between the septum and the body could be altered by muscular contraction so as to compress or rarify the gas and, thus, raise or lower the specific gravity.

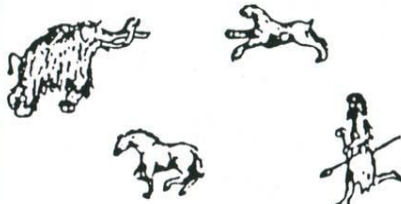

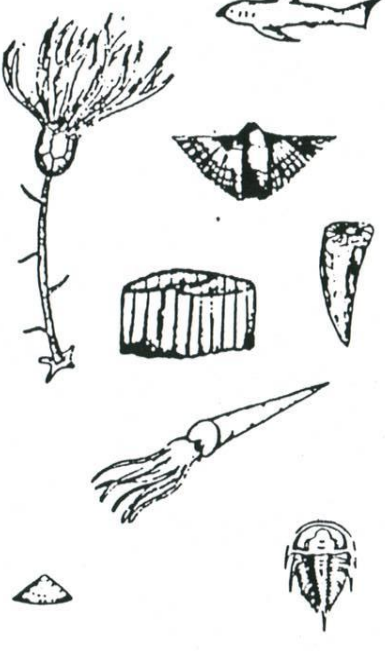
Refer back to Plates 7 through 10 and consider the cross-section fossils of the nautiloid cephalopods. The concave checker-pattern of the orthocone shell in Plate 7 suggests the simple septa divisions that are characteristic of the nautiloids. These divisions are shown more clearly in the brevicone conch of Plate 8, and still more clearly in the orthocone shell of Plate 9. Plate 10 is interesting because, although it shows only slightly the septa details of its conch, it clearly shows the interior tube of the shell, that is, its siphuncle.

IN CONCLUSION

The time chart at Figure 12 (over) will assist the reader in understanding the Bishop Building's position in history. Ordovician stone is indeed old, preceded only by Cambrian and Pre-Cambrian rock. There still remain many unidentified fossil species within the building's walls - brachiopods, crinoids, trilobites, limpets, and so on. Most, but not all, are extinct.

FIGURE 12

GEOLOGIC TIME CHART

ERA	YEARS BEFORE PRESENT	Important Life Forms	Succession of Life
CENOZOIC	RECENT 11 THOUSAND		Mammals spread with development of modern grasses. Mollusks important on land and in the seas
	PLEISTOCENE 3 MILLION		
	PLIOCENE 13 MILLION		
	MIOCENE 25 MILLION		
	OLIGOCENE 36 MILLION		
	EOCENE 58 MILLION		
	PALEOCENE 63 MILLION		
MESOZOIC	CRETACEOUS 135 MILLION		Decline of dinosaurs and ammonites Development of modern invertebrates
	JURASSIC 180 MILLION		Earliest birds Reptiles abundant Cephalopods
	TRIASSIC 230 MILLION		Comeback of ammonites
PALEOZOIC	PERMIAN 280 MILLION		Decline of ammonites Extinction of trilobites
	PENNSYLVANIAN 310 MILLION		Plants, insects, and marine invertebrates
	MISSISSIPPIAN 345 MILLION		Crinoids, blastoids, and brachiopods important
	DEVONIAN 405 MILLION		Trilobites waning Brachiopods, corals, first land plants Fishes
	SILURIAN 425 MILLION		Brachiopods, corals, crinoids trilobites
	ORDOVICIAN 500 MILLION		Trilobites, corals, graptolites, crinoids, and nautiloids important
	CAMBRIAN 600 MILLION		Trilobites, inarticulate brachiopods, and gastropods important
PROTEROZOIC and ARCHEOZOIC ERAS 4 1/2 billion years		