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It's a Mollusk

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The following quotations are a challenge to any one who professes to be a teacher:

"The true aim of every one who aspires to be a teacher should be, not to impart his own opinions, but to kindle minds." F. W. Robertson.

"The teacher who is attempting to teach without inspiring the pupil with a desire to learn is hammering on cold iron." H. Mann

"Do not train boys to learning by force and harshness; but direct them to it by what amuses their minds, so that you may be the better able to discover with accuracy the peculiar bent of the genius of each." Plato

In order to be an effective teacher, one has to have the ability to kindle in a student a curiosity, and have him, consequently, be stimulated to forever strive to satisfy a forever increasing curiosity. To do that a teacher must, himself, be interested in and curious about some subject. To what degree I have succeeded in stimulating students remains questionable. Nevertheless, I do have an interest in a certain subject matter, namely, zoology. The group of animals known as the Mollusca is my special field of interest.

The Mollusca constitute, what is known in the animal kingdom, a phylum. A phylum may be defined as a group of animals sharing a common basic anatomical pattern. The bodies of mollusks are basically bilaterally symmetrical and non-segmented. However, the recently discovered *Neopillina*, a "living fossil", demonstrates that segmentation does occur in the phylum although, it may be a secondary rather than a primary feature. The soft bodies are enclosed in a mantle which secretes the skeleton known as a shell. The ventral portion of the body is modified into a locomotive organ referred to as a foot. A head varies from being a distinct structure to an indistinct anterior region of the body containing scarcely more than anterior nerve ganglia and a mouth. A unique feature of this phylum is a rasping, tongue-like, food gathering organ known as a radula. Such a structure may contain as many as 90 rows of "teeth" and up to 70 or more "teeth" to a row. Historically this phylum dates from pre-Cambrian times, namely, more than 550,000,000 years. It includes about 40,000 described fossil and over 80,000 living species. It is probable that this phylum is now at its peak on the basis of the number of species living at the present time and also its evolutionary development.

The phylum Mollusca has, in its course of evolution, undergone adaptive radiation which has resulted in mollusks becoming adapted to various habitats ranging from a depth of almost 17,000 ft. in the sea to intertidal zones and shore lines in marine environments, to brackish water, fresh water, and terrestrial habitats up to an altitude of 18,000 ft. The evolu-

tion, or adaptive radiation within the phylum, has resulted in mollusks being divided into five classes on the basis of the modifications of the ventral foot, the mantle, and the shell.

The most primitive mollusks comprise the Class Amphineura. These are small marine mollusks which are bilaterally symmetrical, have a dorsal shell composed of eight, overlapping, transverse plates, and have a broad, ventral foot. The chitons are the best known members of this class.

The Class Gastropoda includes 15,000 known fossil and 35,000 known living forms of snails, limpets, slugs, abalones, and nudibranchs. The shell is a univalve with the exception of those of a few recently discovered bivalved gastropods. The foot is ventrally flattened and adapted for creeping on surfaces. The mantle secretes the shell, excepting in those forms such as the nudibranchs in which the shell has been lost. The mantle may also serve as a respiratory organ, namely a lung.

The Class Pelecypoda, or Lamellibranchia, contains the "hatchet-footed" mollusks—those whose foot is laterally compressed and is adapted for ploughing through the soft mud. The shell is a bivalve; the two valves are united dorsally by means of a hinge ligament. The mantle secretes the shell. The cilia, which line the mantle, sweep microscopic organisms within the mantle cavity toward the mouth. The mantle is also a vascular organ, i.e. it contains many blood vessels, enabling it to serve, in part, as a respiratory organ. The mantle is frequently extended to form elongated excurrent and incurrent siphons which enables the animal to receive oxygen and food-laden water and also to eliminate waste materials while it is burrowed deeply in the mud. This class includes the fresh water clams, the marine scallops, pectins, teredos (shipworms), rock borers, oysters, etc.

The Class Scaphopoda contains about two hundred species of burrowing, marine, univalved mollusks known as the tusk or tooth shells. These mollusks form a minor group.

The Class Cephalopoda, including the squids, nautili, and octopuses, contains the most specialized and most highly organized of all mollusks. The cephalopods have attained the largest size of any invertebrates. The giant squid, *Architheuthis,* of the North Atlantic, has been reported to have attained a body length of about fifty-five feet including the tentacles which measure up to thirty-five feet in length, and a body circumference of about twelve feet. The ventral foot has become an elaborate system of eight arms and a pair of tentacles. The inner surface of each arm is flattened and covered with teacup-sized cups. The octopuses and nautili are equipped with similar arms. These arms are useful in capturing prey and also in swimming. To be embraced by those arms is to be avoided rather than desired. The mantle may secrete a vestigial shell, as in the squid and cuttlefish, or a coiled chambered shell, as in the nautili and as it did in the extinct ammonites. The intake and ejection of water into and from the mantle cavity is an effective means of swimming. This, then, is an adaptation of the mantle for locomotion. Could it be that man got the idea of jet propulsion from the squid?

The development and anatomy of the eye of an octopus approach that of the mammalian eye. The eye structure includes a cornea through

which light passes. The iris controls the amount of light which enters the eye through a lens which is supported by ciliary muscles. The rod-like photoreceptors, which are connected with the nerve cells of the retina, converge to form an optic nerve.

Having thus surveyed, briefiy, the phylum, I shall concentrate more specifically on the class Gastropoda. The Gastropoda include the largest number of species of the phylum—15,000 described fossil and over 35,000 recent species. On the basis of the existing numbers as well as evolutionary development, this class is considered as being at its peak. The gastropods inhabit salt, brackish, and fresh waters and they have emerged onto land. They occur in ocean depths of 17,000 feet, in the intertidal zones, on the shore lines and live at altitudes up to 18,000 ft. in the Himalayas. Their geographic range extends from the tropics to subpolar regions, from moist tropical regions to arid deserts.

The modifications of the structures of the ventral foot, the mantle, and the shell have become adapted for various habitats. The ventrally flattened foot is adapted for creeping on surfaces or may serve as an adhesive organ. The shell is a means of protection against dessication as well as against some enemies. The mantle, which secretes the shell, may serve also as a lung. The rasping of the radula is a means of obtaining algae from surfaces of rocks or scraping surfaces such as of leaves for food. The reproductive system includes an intromittent organ which makes internal fertilization of the ovum possible. The eggs of egg-laying snails are covered with a protective shell. Some gastropods are ovoviparous—the eggs embryonate within the parent snail. The gastropods have the basic features essential for survival in the intertidal zones where they are exposed to the air for a part of the day, on the shore where only the spray of the waves provides water, or on land where the breathing of air, propagation, and prevention of dessication are serious problems.

Several forms of gastropods inhabit the intertidal zone. The colorful nudibranch winds its way gracefully on the leaves of plants. The abalone, an attraction because of the tasty abalone steak or of the colorful shell, attaches itself onto rocks by its foot which functions as a powerful suction cup. It might be noted that should you wade in the intertidal zone during low tide and wish to bring in an abalone, it would be advisable to use some flat tool rather than slipping your hand under its foot. It could be that the tide would come in, but you wouldn't, because the abalone had clamped its foot tightly onto the rock and you could not free your hand from its clasp. The limpets have ventured a bit farther out of the water. The foot, also, holds the animal firmly on the rock even when large waves pound the shore. The shell serves as a means of prevention of dessication while the limpet is exposed to the air and hot sunshine.

Life originated in a marine environment. A question which frequently comes to mind is what might have been the probable route or routes which animals followed to emerge onto land. Also, what anatomical and physiological adaptations were essential for survival in a terrestrial habitat. The gastropods, having a broad flat foot for locomotion on surfaces, a mantle which can serve for aerial respiration, provided with a shell to prevent dessication, having the ability to propagate on land, probably

followed several routes which led them out of the sea into fresh water and/or onto land.

Leaving the ocean involves hazards. Merely moving out of the ocean onto the rocks of the shore subjects the animal to environmental changes of temperature and varying degrees of salinity of the water. The emerging animal, still bound to water by gills serving as respiratory organs, must be able to retain moisture around itself in order to respire. It is considered probable that certain animals did move out of the littoral zones of the ocean into the intertidal zone, out onto shores and from there onto land. Among the gastropods, the limpets demonstrate the movement from water onto the rocky shore. These animals are able to adhere to the rocks, and to clamp their shells so closely to the rocks, that a person wanting to dislodge a limpet with a thin-bladed instrument can insert that blade between the shell and the rock only if he does so very swiftly. Because the animal can fasten itself so tightly onto the rock, its body can be kept moist, which makes it possible for it to respire. Should the limpet attempt to leave the rock, and try to move onto the land, the shell, with its large aperture and low, flat, expanded body whorl, would not offer the necessary protection against the drying forces of the atmosphere. The limpet can scarcely be considered as a gastropod ancestoral of terrestrial snails.

On the rocky coast are found snails which no longer live in the intertidal zone. Certain physiological adaptations are also necessary before aquatic animals can become transformed into terrestrial organisms. This can be accomplished gradually on the coast where there are pools among rocks, and where the animal is exposed for periods of time to reduced salinity and variable temperatures. The shells of snails living among the rocks and in pools provide adequate protection for such a habitat. There is evidence that some animals, including some snails, have passed directly, although over a long period of time, from ocean onto land. (Pearse, p. 21).

Another route which animals have found leading out of the ocean is through estuaries into rivers and streams. In the estuaries the salinity of the water fluctuates with the amount of water flowing from the rivers into the oceans, or sea water brought into the rivers by the tide. Because, along with the unstable environment in an estuary, there is also a stratification in the water which enables animals to select a habitat which each can tolerate. A bay may be associated with an estuary in which brackish water is relatively constant. Invertebrates with a hard exoskeleton, such as pelecypod and gastropod mollusks, are more resistant to variations in the salinity of water than are those lacking such means of protection. Animals which can enter into, and survive in estuaries must be able to live in water which is heavily silted. The compensation for the silt is the amount of organic matter per volume, hence food supply, which is carried down stream by the water of the river. The entry into fresh water can thus be accomplished through adaptation over a period of time. However, because of the unfavorable conditions obtaining in an estuary, not many marine animals have given rise to a fresh water fauna.

Another route out of the sea which mollusks have followed is by way

of marshes, swamps, and pools. Such bodies of water are more shallow than are estuaries. Environmental conditions, such as temperature, degree of salinity, essential gasses, and amount of water, fluctuate. In marshes and swamps the water is often deficient in oxygen. Certain snails, because their mantle cavity had the vascular supply for it to become adapted to function as a lung, became air breathers or pulmonates. The bodies of terrestrial snails must remain moist. During periods of drought the snail can retreat into its shell, and seal the aperture with mucous which, when dried, enables the retention of moisture. The snails conserve moisture also by excreting uric acid rather than fluids. It has been asserted that all terrestrial gastropods probably evolved from pond snails. (Pearse, p. 34). Thus, we can learn from mollusks some routes marine animals followed to invade fresh waters and also land.

Mollusks have economic values. Abalone steaks, clam chowder, oyster stew, scalloped oysters, clams on the half shell, snails prepared with delicious sauces whet the appetite. The financial income of the oyster industry amounts to millions of dollars annually because the oyster is a source of food and also because it forms pearls inside its shell. Many beautiful pearl buttons are made from the nacrous layer of shells of fresh water clams. The cameo is carved from certain shells. The abalone shell is used for the making of fancy buttons and costume jewelry. The nacre of shells is the source of mother-of-pearl.

The collecting of sea shells has developed into a hobby for some people who are active in, as well as for some who have retired from, various professions. Even though this has been mainly a pursuit of "the lovely and beautiful shells", scientists have benefited by gaining of information of the geographic distribution of various genera and species of mollusks. Many collectors known as amateurs have learned to record locality data which makes their collections of scientific value. The owners of various hobby and souvenir shops enjoy a lucrative business from the sales of various shells. And who, while strolling along on the beach, doesn't derive a pleasure from picking up a few "pretty shells."

Not all mollusks are useful to man. Some are destructive. The *Teredo,* or shipworm, causes extensive damage to wooden pilings and wooden vessels. Snails and slugs are often garden pests. In southern California, terrestrial gastropods are devastating to flower and vegetable gardens. The giant African snail, *Achitina,* is a most dreaded voracious feeder which results in massive destruction of vegetation.

The gastropods commonly known as the cones are to be collected with caution. The animal has a tubular, fleshly proboscis into which opens its radula which is modified to serve as an organ of attack or defense. The radula contains two rows of numerous harpoon-shaped "teeth". The cone can shoot out the proboscis and attack the predator or its prey with the "teeth". Poison exudes from a special poison gland. A number of fatal cone shell snail bites have been recorded from Australian and Melanesian regions (T. Abbott, pp. 310-311).

Certain snails serve as intermediate hosts for human and animal parasites known as flukes. The parasitic worm *Schistosoma* or *Bilharzia,* commonly known as a blood fluke, causes a disease in man known as Schis-

tosomiasis or Bilharziasis. This is a scourage in parts of Africa, the Orient, and South America. In rural areas, where bilharziasis is endemic, infection is nearly hundred per cent of the population. It is estimated that there are approximately 9,000,000 cases in Egypt which amounts to about forty per cent of the entire population (Greenbaum, p. 3). This includes mainly the peasant population along the waters of the Nile. In the Gezira area of the Sudan the development of an irrigation system which included the construction of 2,600 miles of canals, resulted in the infection of 21% of the adults and 45% of the children with Bilharziasis by 1945. In Brazil, the area around the new capital of Brasilia, the same pattern is being repeated (Greenbaum, p. 11).

The liver fluke *Fasciola hepatica* infests cattle, sheep and goats in nearly all parts of the world. This parasite may cause considerable economic loss. It has been estimated that on the Gulf Coast alone there is an annual loss of forty-four tons of condemned livers and fifty-eight tons of meat. The parasite causes mortality especially among calves, reduction in milk production, and curtails breeding (Chandler, p. 288). The oriental liver fluke *Clonorchis sinensis* is widely distributed in the Far East. According to an estimate about 19,000,000 humans are infected (Chandler, p. 292). A debilitating parasite such as this one certainly retards the rate of economic and cultural development of an infected population.

Perhaps the mollusks will assist us in the discovery of a cure for some maladies. As reported recently, Sister Mary Rosarii Schmeer, of the College of St. Mary of the Springs, used clams as subjects for tumor growing experiments. She was unable to induce a growth of tumor in clams. To her this suggested that shellfish might have a natural cancer inhibitor which might be obtained from sea water. She prepared a clam extract which she injected into mice with cancerous tumors. The treated mice made 80 to 100 per cent recoveries whereas an untreated control group died in two weeks. Dr. C. P. Li, of the National Institutes of Health, reported recently to the New York Academy of Sciences that clam extracts also inhibited tumors in tests on hamsters. He also said there is evidence that extracts prepared from abalones and from oysters inhibit several bacteria and viruses in tests on mice. Let us not draw hasty conclusions. However, Sister Mary Rosarii recently received a $23,000.00 grant from the American Cancer Society to assist her to pursue her clam research.

The phylum Mollusca is one from which man can learn about animal evolution and adaptation, geographic distribtuion of animals, and ecology. Mollusks are invovled in the distribution of parasitic diseases of man and animals. If through mollusks, man can find means of controlling maladies, these animals will serve mankind well. The role mollusks play in economics is appreciable. Even though this a brief and sketchy presentation of the Mollusca, may the reader realize that his phylum of the animal kingdom is of greater significance than is probably generally realized.

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