GENERAL SCIENCE NOTES

NEOPILINA: A LIVING FOSSIL

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On May 6, 1952, ten living specimens of an extraordinary mollusc were discovered. While trawling off the Pacific coast of Costa Rica, the Danish deep-sea "Galathea" expedition hauled these specimens to the ocean surface from a depth of 3590 meters. They were given the name *Neopolina galathea* and their discovery has been described as "the most dramatic one in the history of malacology." It was an unusual discovery in more than one way.

Neopilina has a single dome-shaped shell reminiscent of limpet shells. Before *Neopilina* was discovered, similar fossil shells were known. Originally these fossil shells were classified either as chitons (class Polyplacophora) or limpets (class Gastropoda, which includes snails, slugs, etc.). Eventually, however, a new molluscan class was established for these fossils based on a unique characteristic of the shell. On the inner surface of the shell, several pairs of serially arranged muscle scars occur. This new class was called Monoplacophora. (literally, single-plate-bearer).

When *Neopilina* was discovered it became the only living representative of Monoplacophora. For this reason it is often referred to as a "living fossil." Living fossils are unique extant organisms that are representative of much larger fossil groups. They are remnants of an otherwise extinct type of organism. Living fossils occur among both plants and animals. Other than *Neopilina*, plants and animals commonly referred to as living fossils are the horsetails or scouring rushes, the gingko or maidenhair tree, the coelacanth fish, the horseshoe or king crab, the chambered nautilus and the brachiopod *Lingula*.

Neopolina is a particularly interesting example of a living fossil. Although the genus *Neopilina* does not occur in the fossil record, it closely resembles the genus *Pilina* that does. *Pilina* occurs in Silurian (Paleozoic) deposits low in the geologic column. Neither *Pilina* nor *Neopilina* occur elsewhere in the fossil record. *Neopilina* is said to so closely resemble *Pilina* that "the differences may prove to be of only subgeneric value."

The significance of a Recent organism closely resembling Silurian fossils is best appreciated when it is realized that according to the commonly accepted geologic time scale, 400 million years stretch between the Silurian and Recent. In the context of the evolution paradigm (model), this means that *Neopilina* underwent only insignificant changes in 400 million years. Is it any wonder that the discovery of *Neopilina* was met with surprise? In the case of *Neopilina*, such a slow rate of change has been explained as the result of the supposedly stable deep-sea environment in which it lives.

Since the initial discovery of *Neopilina* in 1952, several other similar specimens have been collected. At least five species have been described. All specimens have been collected in deep water ranging from about 2000 to more than 6000 meters deep. Collections have been made in the eastern and central Pacific, the south Atlantic, and the western Indian Oceans. Although reasonably widespread, they have gone undetected until relatively recently — presumably because of their restriction to deep water.

The discovery and occurrence of *Neopilina* at great depths served to strengthen a theory held by some scientists that the deep-sea contains a high percentage of "ancient life." ("Ancient life" need not imply a long chronology. It could, for example, include living fossils and other organisms that occurred in the deep-sea and were buried during the Genesis flood.) These scientists supposed that the constancy of the deep-sea environment provided a place of refuge for the survival of ancient life. It was expected that in further sampling of the deep-sea fauna, much ancient life would be discovered. In general, this expectation has not been fulfilled. *Neopilina* is an apparently anomalous group in this respect. Other than possibly some Foraminifera (protozoans), it is apparently the only Paleozoic living fossil that is known to occur in the very deep oceans.

Evidence is now accumulating that the deep-sea is not the unchanging environment it was once considered to be. Thus, it could not have served as a refuge for ancient life. Changes in the bottom sediments and deep-sea temperatures have occurred. Present deep-sea temperatures are apparently much lower (at least 15ºC) than in the past. A significant temperature decrease would have eliminated any ancient life that may have previously existed in the deep-sea. It is possible that a deep-sea, as it is now known, did not even exist when sediments low in the geologic column (Paleozoic) were deposited, since Paleozoic deposits do not occur in the deep ocean basins.

What this means in the context of a creation/flood paradigm is not certain. There may not have been any deep-sea or deep-sea fauna in the antediluvial world. Alternately, an antediluvial deep-sea fauna may have existed but was destroyed by catastrophic sediment and temperature changes during the Genesis flood. Colonization or repopulation of the deep-sea would be a post-flood event and the "ancient" antediluvial organisms would not generally occur there today.

The discovery of living fossils permits the study of the biology of an almost extinct group of organisms in ways that would be impossible from the preserved hard parts of the fossils alone. They provide living links to now generally extinct groups. As previously mentioned, in the fossil Monoplacophora, a unique serial repetition of paired muscle scars occurred on the inner surface of the shell. Interestingly, although originally a main characteristic of the group, these muscle scars do not occur in the single living representative of the group. *Neopilina* does, however, have 8 pairs of serially arranged pedal (foot) retractor muscles. Not only are the muscles serially arranged, but there is a serial repetition of paired nerve connectives, nephridia (kidneys), gills, and to a lesser extent, perhaps gonads and auricles.

Molluscs are not ordinarily considered to be a segmented group; yet this serial succession of structures suggested to scientists describing *Neopilina* that it might be a segmented group of molluscs. This had considerable significance in the evolution paradigm because it made *Neopilina* a potential "missing link" between the unsegmented molluscs and the segmented annelids (earthworms, etc.) and arthropods (insects, spiders and crabs). It seemed to provide a pathway between segmented and nonsegmented organisms.

The discovery of a "missing link" is an important event for the evolutionary invertebrate zoologist because the gaps between the major invertebrate groups are so strikingly difficult to bridge. The difficulty of doing so is emphasized by the numerous contradictory theories that have been proposed to bridge the gaps. Some of these are outlined by G. A. Kerkut in his book *Implications of Evolution*. Although writing within the evolution paradigm, he forcefully demonstrates the great difficulty in establishing phylogenetic (evolutionary) relationships between the invertebrate groups.

With further study of *Neopilina* many scientists now feel that its segmentation is fundamentally different than that found in either the annelids or arthropods. It is doubted that it has a truly segmented type structure. In either case, a common designer (creator) of the annelids, arthropods

and molluscs may well have incorporated common features in all three groups. Similarities between groups do not prove phylogenetic relations between groups.

Neopilina was thought to support the ancient-life hypothesis for the deep-sea. It was also designated a missing link. Now many scientists consider *Neopilina* anomalous rather than supportive in the first instance and an unlikely candidate in the second. The story of *Neopilina* emphasizes a phenomenon inherent in the scientific method. New data and changing interpretations can quickly make previously held positions untenable. This is both the strength and weakness of the scientific method — strength coming from openness to new ideas, weakness from the fact that present ideas may be incorrect.

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