Fossils explained II—Palaeozoic invertebrates

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Overview

The first fossils are known in some of the most ancient rocks on Earth—in Australia and Africa, where three-billion-year-old silica-rich rocks such as cherts preserve, incredibly, the minute cells of rather unimpressive but nevertheless vastly significant organisms. These fossils, the first to be preserved on the planet, require specialist knowledge to unlock their secrets, and the same is true for many of the sparse fossils found in that part of the Earth's geological record known as the Precambrian (divided into the older Archaean, and younger Proterozoic), which stretches from the origin of the Earth some 4.6 billion years ago to the beginnings of abundant, recognisable life, some 540 million years ago.

Following the Precambrian came the Phanerozoic Eon (meaning 'evident life'), containing the fossil-bearing rocks of the last 540 million years. The rocks forming this record of time can be further subdivided, again on the basis of fossils, into three main units of time known as eras: Palaeozoic (ancient life), Mesozoic (middle life), Cenozoic (modern life). These roughly equate with what older popular science books have called the 'Age of Fishes', 'Age of Reptiles' and 'Age of Mammals'.

The interpretation of fossils as living organisms from all of these layers gets easier as the rocks get younger. Fossils of the Precambrian and Palaeozoic are distant in time, and it is difficult to find living organisms that might be directly compared with the fossil ones, in the manner of Cuvier and his comparison of mammoth with elephant. For the extinct trilobites of the early Palaeozoic Era, horseshoe crabs, common on the Pacific Coast of North America are the closest analogy; for the ammonites of the Mesozoic Era, the Nautilus of the Indian Ocean is the best guide. For some organisms we may never know exactly how they functioned.

As invertebrates—animals without backbones—are (barring bacteria and viruses) the commonest organisms alive today, so they were in the geological past. In this release, some examples of typical invertebrate fossils from the Palaeozoic Era are discussed

Trilobites are extinct sea-dwelling organisms related to crabs, lobsters and insects, in that they have an external jointed skeleton with multiple jointed limbs. Their name comes from the fact that they can be divided in to three 'lobes' from left to right; they are also divisible into three parts from head to tail. Trilobites have a great diversity of form, with various spines, pits and knobs displayed upon their head and tail. Most possessed compound eyes, externally similar to those of their relatives, the insects, but others, such as *Trinucleus*, had no eyes at all (Fig. 1). To protect themselves, many of these bug-like animals were able to roll up, tucking their jointed limbs inside their hard outer shell. Nevertheless, trilobites are often found in pieces, as with all animals with an external skeleton, they had to shed it periodically to grow. Trilobites are found in rocks of Cambrian to Permian age.

Graptolites are planktonic colonial organisms that were mostly contemporary with the trilobites. Graptolite colonies may have a single (Fig. 2) or multiple branches (Fig. 3), which, in some examples, hung downwards from a float, or in others, spread upwards. Still others were spiral in form. These shapes helped graptolites made it easier to feed on nutrients suspended in the water. Extremely valuable to geologists, as these floating organisms were widespread and quick to evolve—the mark of good indicators of relative geological age—graptolites can nevertheless be difficult to find. Their name comes from reference to the fact that they often look like pencil marks on rocks. They are found in rocks of Cambrian to Permian age.

Brachiopods are shellfish that were dominant in the seas of the Palaeozoic (Fig. 4) (Cambrian to Permian), but that were largely replaced by the clams and snails to struggle on after the great extinction event decimated much marine life (up to 90% of all species) at the end of the Permian. We know a reasonable amount about how brachiopods lived from study of their relatives, still alive today. Today, we know these organisms feed differently from other shellfish, filtering out food particles using a lophophore, supported on shelly 'brackets', which can be seen in some exceptionally preserved specimens. Brachiopods were extremely common in the Palaeozoic; surviving the Permian extinction, brachiopods can also be found in much younger rocks.

Crinoids are common fossils in Palaeozoic rocks, so common in fact that whole bands of limestone are made up of their remains, particularly in the Carboniferous of northern England. Sometimes confusingly named 'sea lillies', because of their resemblance to stalked flowers when whole, these organisms are actually related to star fishes and sea urchins, part of the major group called the echinoderms. Crinoids have stalks made up of many plates (called ossicles, Fig. 5), which fell apart easily on death. On top of the stalk was an enclosed cup (which resembles, in part, the shell of its relative, the sea urchin), and a set of arms to gather food. Crinoids were a major part of Palaeozoic reefs, but were to be cut back in numbers at the end of the Permian; there are relatively few species existing in today's oceans.

Eurypterids are otherwise known as 'sea scorpions', and are an extinct group of arthropods that are related to present-day spiders. Some eurypterid fossils are very large, representing, in fact, the largest known arthropods, reaching up to 2.5 m long. The eurypterids lived from the Ordovician to the Permian.

Fig. 1. *Trinucleus fimbriatus*, a trilobite from the Ordovician of Wales (Image: P. Doyle).

Fig. 2. *Monograptus*, a single stipe (branch) graptolite from the Silurian of England (Image: P. Doyle).

Fig. 3. *Didymograptus murchisoni*, a double stipe graptolite from the Ordovician of Wales (Image: P. Doyle).

Fig. 4. *Gigantoproductus*, a large brachiopod from the Carboniferous of North Wales (Image: P. Doyle).

Fig. 5. Crinoid ossicles from the Carboniferous of northern England (Image: P. Doyle).