Overview

Fossils, the tangible remains of once living organisms, exert a fascination for people of all ages. Fossils have only been truly recognized as the relics of ancient life from the ‘age of reason’, that time in the late seventeenth and early eighteenth centuries when the basic principles of modern science were laid down.

Writing in the fifteenth and early sixteenth centuries Leonardo da Vinci was perhaps the first to recognize the true nature of fossils, but his work on the subject was to remain unread until the nineteenth century. Independently, eighteenth century scientists such as Robert Hooke, James Parkinson and James Sowerby were to place the study of fossils on a sounder footing, creating the basis for the modern understanding of fossil life. From these distant origins, the subject of palaeontology (literally, the study of ancient life) has developed into a highly technical science that plots, amongst other things, the record of the evolution of life on Earth, reconstructs the body plan of long extinct (and suitably mysterious) organisms, and conjures up images of ancient ecologies divorced in time from our own world. The succession of life through geological time, driven by the pulse of evolution, also has a role in providing a means of placing rocks in relative order, the same principle by which archaeologists use coins or pottery shards to determine the sequence of events in an excavation. All of these aspects of the science of palaeontology draw heavily on an understanding of fossil life in its many forms, plotting out for ancient worlds what we would call biodiversity today—the extent of life on Earth.

The online event

The Geology Today online event will examine aspects of palaeontology, taking as its initial theme the preservation of fossils (the study of which is known by the term taphonomy), and their exceptional preservation in deposits known as Lagerstätten. The releases that follow will deal with examples of invertebrate fossils from the Palaeozoic, Mesozoic and Cenozoic, before finally examining some vertebrates. With the fossil record so rich, all that can be presented is a brief glimpse of its diversity.

Details

Taphonomy is the science of fossilization. Fossils by definition are the remains of once living organisms that have undergone a process of fossilization. (That being said, there are some otherwise lifeless stones that coincidentally resemble shells or bones, or the traces of ferns or other plant life created by chemical action; these are known today as ‘pseudofossils’.) What that process is depends to a large part on the local environmental conditions following the death of the animal or plant. These conditions can vary from desiccation—drying out the flesh on old bones—through to entombment in ancient ice, such as the famous nineteenth century discoveries of long-frozen mammoths in Siberia. For the most part, however, burial is a particularly important part of the process, one that protects the would-be fossil from further decay and attack by wind, water and scavengers. That burial is so important for fossilization is illustrated by the fact that it is much more common for marine organisms to be fossilised than those living on land.

There is much greater possibility of being buried in water-based environments than on land, as rivers eroding sediments and silts routinely dump their loads into the sea, which in turn settle out as the layers that ultimately will become rock over the course of hundreds, thousands, or millions of years. Prior to burial, the remains of organisms are available for erosion, being buffeted along in rivers, broken up by scavengers, or subject to wind erosion over time. Once buried, however, these remains are relatively safe, save for the attentions of burrowing animals scavenging for food, or the actions of fluids passing through the pores of the sediments, and dissolving away the remains of shells and bones. For the most part, preservation is a chance affair (Fig. 1) with full communities of organisms rarely, if ever, preserved. In such cases, palaeontologists have to rely on other evidence to help them reconstruct past life. Trace fossils—the transient footprints and burrows left by organisms—are surprisingly common, and help fill in the gaps of our knowledge.

Fossil lagerstätten are windows into the geological past through the chance preservation of a greater diversity of fossils, often including soft-bodied organisms that are otherwise difficult to preserve. Rapid burial is the best option, particularly where there is no free oxygen available to promote the decay of organic tissue
through the attentions of bacteria. Here, in exceptional states of preservation that define what are now called Lagerstätten (fossil ‘bonanzas’), such conditions mean that soft parts are preserved, often in exquisite detail, providing palaeontologists with the privilege of glimpsing the past through a spectacular preservation window. Lagerstätten are few and far between, relatively speaking, scattered through the geological record and affording amazing insights into the geological past: the Burgess Shale of British Columbia, the Solnhofen Limestone of Bavaria, these are the most famous, but there are many others. Despite these bonanzas, our knowledge of the fossil record is still slim.

The Ediacaran biota is exceptionally important to our understanding of the Late Precambrian. These were first found in the late 1940s in the Ediacara hills of southern Australia, and in Charnwood Forest, near Leicester, UK by schoolboy Roger Mason (Fig. 2). Ediacarans have subsequently been found in Africa, North America and Asia. Consisting of a diversity of soft-bodied organisms, the preservation of these almost worldwide demonstrates the development of complex metazoans for a brief interval—now called the Ediacaran. Palaeontologists still puzzle over their form and function.

The Burgess Shale has the right to the claim that it is the most important and well-known Lagerstätte formed around 510 million years ago. The early Cambrian marine environment preserved is rich in diverse organisms (Fig. 3), some of them bizarre, and the study of this deposit continues to exercise the minds of palaeontologists world-wide.

The Ladyburn starfish bed is an important Ordovician fossil locality that yields rich, well-preserved, including large complete trilobites and starfish.
Fig. 1. Palaeogene Fossils from southeast London: these shells were buried, and preserved together in a lagoon that was forming in the area 55 million years ago. (Image: P. Doyle).

Fig. 2. Cast of Charnia masoni, a late Precambrian Ediacaran found by schoolboy Roger Mason in Charnwood Forest, Leicestershire. (Image: P. Doyle).
Fig. 3. Marella, common fossil from the early Cambrian Burgess Shale (Image: Paul Selden).