
Chapter 8 Precambrian palaeontological sites

Introduction

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Precambrian palaeontology is a subject that less than half a century ago could have been dismissed in a few paragraphs. Palaeontologists had long been perplexed by the major faunal break at the base of the Cambrian and the Precambrian rocks below were regarded as non-fossiliferous. There was, however, a general recognition that the early Cambrian faunas, which are very diverse and of sudden and cosmopolitan appearance, must have had Precambrian ancestors. There were undoubtedly large areas of late Precambrian sedimentary rocks that appeared to have suffered no high degree of subsequent metamorphism, but they proved to be always unfossiliferous. The first Precambrian fossils to gain credence as truly organic in origin were stromatolites, now recognized as structures produced by cyanobacteria (blue-green algae). These were found in considerable numbers in the Proterozoic rocks of the Canadian Shield, and subsequently in other areas of the world, but there was little if any trace of remains that could be ascribed to animals. In fact when the first Precambrian animal fossils were found, they were initially dismissed as pseudofossils by most palaeontologists.

The first accounts of Precambrian fossils were those of Salter (1856, 1857) who described a series of impressions found in the late Neoproterozoic Longmyndian Supergroup rocks of the Long Mynd, Shropshire. Some of his figures and descriptions are over-optimistic interpretations of inorganic impressions and these have been rightly dismissed. But dismissal of all of Salter's material, such as was done by the Geological Survey (Greig *et al.*, 1968) and by other authors, is no longer tenable. Although many of the impressions are of unknown origin, their organic nature is emphasized by the fact that similar impressions are known from other parts of the world. They nevertheless appear always to be restricted to late Neoproterozoic and early Cambrian rocks and this provides the most convincing argument for their organic affinities.

The first records of Precambrian body-fossils were similarly dismissed as inorganic structures. The earliest of these was the discoid *Aspidella*, described by Billings (1872) from the late Proterozoic of Canada. *Aspidella* has been discredited by many authors and most have concluded that it was a pseudofossil; this view persisted until very recently following a major review by Hofmann (1971), but recently specimens have been found from the Avalon Peninsula of Newfoundland that show that the genus bears considerable similarities to *Cyclomedusa*, and *Aspidella* has been re-interpreted as a benthic medusoid (Narbonne and Gehling, 1998) thus confirming Billings' (1872) original contention that it was an animal fossil.

The Nama Group of Namibia was the next to yield Precambrian animal remains. Three genera of frondose organisms were initially described by Gürich (1929, 1933) as coelenterate grade animals. These fossils were subsequently redescribed by Richter (1955) who concluded that although the fronds of the genus *Pteridinium* were rather like a marine alga, they were more likely to be a colonial animal and possibly a gorgonoidean octocoral. However, this was not the view of the next to work on these specimens, Pflug, who concluded that these organisms could not be ascribed to any known group of animals, but instead belonged to an extinct phylum that he named the Petalonamae (Pflug, 1972). This group was regarded as metazoan, but totally separate from other metazoan phyla. Runnegar (1995) has shown that there are major problems with Pflug's interpretation of these fossils, and what appear to be nothing more than associations of pseudofossils and irregular granular structures were used by Pflug to construct hypothetical models of evolution of petalonaman colonies.

The most widely known Precambrian animal fossils are those that later came to be known as constituting the original Ediacaran Fauna. The first fossils were found in the Ediacara Hills in the Flinders Ranges of South Australia, some 450 km north of Adelaide. Sprigg (1947) recorded a fauna of medusoid fossils from the Pound Quartzite of Ediacara that he likened with those of the Lower Cambrian in other parts of the world. Sprigg's fossils were accepted as well-preserved Cambrian medusoids and were described as such in Volume F of the *Treatise on Invertebrate Paleontology* (Moore, 1956); it was not until some years later that Glaessner decided to look in more detail at these fossil remains. One of his

first conclusions (Glaessner, 1959) was that these fossils occurred a considerable stratigraphical distance beneath the earliest trilobites (Atdabanian), and the Pound Quartzite that yielded them was separated from the rocks above by a profound regional unconformity. The fossils were therefore unlikely to belong to the earlier (pre-trilobite) part of the Cambrian and instead must be of latest Precambrian age. Glaessner and his colleagues went on to describe other fossils from the Ediacaran sites including, in addition to a wide range of coelenterates that includes 'medusoids' and pennatulids, a diverse assemblage of polychaete worms, rare arthropods, and a range of other fossils of uncertain affinities (e.g. Glaessner and Wade, 1966). New fossils are still being found at Ediacara, the latest being sponges, which being among the most primitive multi-cellular animals had been long expected to have existed in Neoproterozoic times (Gehling and Rigby, 1996).

One of the next areas to yield Precambrian fossils was Charnwood Forest, Leicestershire, where a local schoolboy, Roger Mason, discovered a frondose impression in 1957. Ford (1958) subsequently described this as *Charnia masoni*. Initially the specimen was believed to be a complex marine alga, but later was re-interpreted as a pennatulacean coelenterate. This discovery prompted renewed interest in the Charnwood Forest Precambrian rocks and there have subsequently been many more discoveries in the area (see section on the Charnwood Forest GCR sites below for details).

Precambrian rocks of other areas of the world also began to yield fossils, and faunas were recorded from Sweden (Strand and Kuhling, 1972), the Ukraine (Palij, 1969), Siberia (Sokolov, 1973) and Newfoundland (Misra, 1969). Faunas discovered in the White Sea area of northern Russia (Keller *et al.*, 1974) included several species in common with Ediacara. The discovery of an Ediacaran fauna in South Wales (Cope, 1977) appears to be unique in that it was the Ediacaran fossils that proved the Precambrian age of the rocks, which had been mapped by the Geological Survey (Strahan *et al.*, 1909) as of early Ordovician (Arenig) age (see below).

By the late 1970s knowledge of Ediacaran faunas was extensive and with it came recognition that this was a cosmopolitan fauna that had existed shortly before the 'Cambrian explosion'. No biozones have been erected for these fossils, although there appear to be some differences between the 'early' faunas of Wales (Coed Cochion GCR site) and Newfoundland, and the 'late' faunas of the White Sea and Ediacara, which contain a greater diversity of forms. Differences between the Charnwood Forest Precambrian faunas and those found worldwide are discussed later in this chapter. With the renewed interest in early Cambrian fossils there arose the question of the relationship between Ediacaran animals and Cambrian forms. Was it correct to ascribe the Ediacaran fossils to extant groups of coelenterates and annelids, for instance, or did the Ediacaran faunas represent a short-lived experiment in animal design? Views became polarized on these questions and the whole subject came in for renewed controversy following Seilacher's (1989) hypothesis that many of the Ediacaran animals were totally unrelated to modern phyla; the 'Vendozoa' were represented as unique quilt-like organisms that were filled with plasmodial fluid and that were immobile. Other Ediacaran organisms he did relate to extant phyla, but interpreted the wormlike forms as producing medusoid-like trace fossils, whereas others were sand-filled polyps (Psammocorallia of Seilacher, 1992). Retallack (1994), however, proposed an entirely different hypothesis, namely that the Ediacaran fossils were lichens. Neither of these hypotheses has gained wide acceptance and Runnegar (1995) concluded that the Ediacaran fauna was a sample of Neoproterozoic biodiversity. This view was reinforced by Conway Morris' (1993) description of Ediacaran-like fossils from the Middle Cambrian Burgess Shale, thereby dispelling the belief that Ediacaran organisms were confined to the Vendian. Subsequently Jensen *et al.* (1998) described Ediacaran fossils from what undoubtedly are early Cambrian rocks in South Australia. Despite this extension of Ediacaran faunas into the Cambrian, it is not always possible to construct evolutionary paths, linking them to Cambrian organisms. Some authors have nevertheless concluded that certain Ediacaran taxa, such as *Charniodiscus*, may have direct Phanerozoic counterparts (Conway Morris, 1993; Crimes and McIlroy, 1999). The essential feature of these latter assemblages, setting them apart from Ediacaran forms, is the abundance of exoskeletons in trilobites, brachiopods, molluscs etc..

Examination of the organizational level of the Ediacaran fauna leaves no doubts that there must have been earlier animals. Reliable dates of the Ediacaran faunas are few, but include 565 ± 3 Ma (Benus 1988) from Newfoundland down to younger than 543 ± 1 Ma from southern Namibia (Narbonne *et al.*, 1997). We thus have a range of some 22 Ma virtually up to the base of the Cambrian, with the more complex Ediacaran assemblages believed to all lie close to the latter date (Narbonne *et al.*, 1997). Several earlier Precambrian animal fossils have been occasionally recorded from

various localities worldwide, but on investigation these have thus far mainly proved to be either incorrectly dated animal remains, or to be inorganic. However, predictions of the divergence of animal phyla based on the evidence of molecular work (e.g. Knoll, 1994) suggest that this may date back to 1000 Ma. This date is appropriate too, as it coincides with a decline in stromatolite diversity that is widely attributed to the effects of extensive metazoan grazing (e.g. Walter and Heys, 1985).

Thus of particular interest are examples of the trace fossil *Neonereites uniserialis* recorded from the Dalradian Bonhaven Formation of Islay, Scotland, by Brasier and McIlroy (1998). This ichnofossil was interpreted by those authors as being the faecal pellets of a coelomate animal capable of peristalsis. This is of significance since the age of the rocks that yielded the fossils is 600 Ma, so these fossils, suggested Brasier and McIlroy, could represent one of a series of animals that was responsible for removing suspended organic material from the sea water. This would allow deeper submarine penetration of sunlight, which in turn promoted oxygenation of the water. With the enormous current research interest in the Proterozoic, it can be confidently predicted that further traces of pre-Ediacaran animal fossils will be found in the near future.

All of the Precambrian fossils known from England and Wales are from the upper part of the Neoproterozoic. When one considers the scale of the outcrops of the Precambrian rocks of England and Wales and the generally poor exposure of the rocks in inland outcrop, it is perhaps remarkable that three areas have yielded Precambrian fossils, and these from both shallow- and deep-water environments. Furthermore, the amount of palaeontological information obtained from them is considerable and there is clearly more to come.

[References](#)