New techniques are providing glimpses into a key episode in the history of life. **Philip Wilby, John Carney, Ian Wilkinson** and **Michael Howe** describe recent work on the 'Ediacara biota'.

Life just got complicated

The fossil record of ancient life is, in general, poor. Certainly, fossils are abundant in many rock successions and may reveal remarkable details about evolution and environmental change, but they typically consist of disarticulated or broken skeletal material, such as shells, bones and teeth. Even worse, the record of entirely (or largely) soft-bodied organisms, such as jellyfish and worms, is extremely scant, despite the fact that such animals dominate modern marine environments and presumably did so in the past. The reason is obvious — such organisms are highly susceptible to post-mortem decay and typically decompose more rapidly than the 'normal' processes of fossilisation operate. This significantly blurs our view of ancient life, with obvious consequences for those interested in understanding evolution and past ecosystems.

Fortunately, there are numerous examples of exceptionally well-preserved biotas — so-called fossil Konservat Lagerstätten. Perhaps the best known are insects in amber and the Cambrian Burgess Shale, but others are scattered throughout the fossil record. They provide stunning insights into apparently fleeting interactions, such as mating and feeding behaviour, or preserve remarkable, even subcellular, anatomical details which allow ancient organisms to be 'dissected' as if they were still alive. Such windows on the past gain increasing importance the further back in time we look, because it becomes progressively more difficult to apply what we understand of modern ecosystems to those that were populated by more and more unfamiliar organisms.

The late Precambrian was one of the most turbulent periods in Earth's history, witnessing the break-up of a supercontinent, repeated massive glaciations (the so-called 'snowball Earth state'), and dramatic shifts in the composition of the atmosphere and oceans. Yet it was against, or perhaps because of, this backdrop that the first large, morphologically complex organisms evolved, and some of the more familiar characteristics of modern

Two of the bizarre inhabitants of the Ediacara world, preserved in situ *having been engulfed by a mass-flow of sediment. Plaster-cast of rock surface, about 1 m wide.*

animals first developed (e.g. mobility). Collectively referred to as the 'Ediacara biota', many fundamental aspects of these early organisms and their communities are enigmatic. Some possessed body plans and/or symmetries that are entirely alien, and their likely physiology, histology, feeding mode and reproductive strategy remain hotly debated. Indeed, some workers consider them unrelated to any known group (living or extinct) and view them as evolutionary dead-end experiments.

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The Ediacara biota dominated the oceans for more than 20 million years but, being entirely soft-bodied, it only left a record at a handful of exceptional fossil sites.

BGS geologists power-cleaning a fossiliferous surface prior to moulding it with silicone rubber. The fossils are virtually invisible in situ *and are best studied under low-angle light in the laboratory.*

The UK is fortunate to host several of these sites, the most important being in Charnwood Forest in the English East Midlands. A new phase of research, using novel techniques, is providing new insights into every aspect of Ediacara biology and ecology. Silicon rubber moulding of one site — the largest moulding exercise attempted anywhere in the world — has led to the discovery of over a dozen new species, including bizarre feather-like forms which stood more than a metre tall. They lived in deepwater settings on the sides of active volcanic islands where they became instantly fossilised beneath turbulent flows of ash that episodically engulfed the slopes. As a result, entire communities are preserved intact and *in situ*, revealing every aspect of their structure and development. All the new evidence suggests that these nascent communities, far from being simple, had a complex structure as a result of competition for resources. Many of their occupants have a fractal-like internal organisation which would have acted to greatly increase their surface area and may signal that they made their living by directly absorbing nutrients from the surrounding water column. Similarities between widely separated assemblages suggest dispersal around the oceans via a planktonic stage, while differences imply that ecological specialisation was already well developed more than 560 million years ago.

BGS geologists and contractors undertaking the world's largest single silicone rubber moulding exercise, using more than half a tonne of rubber, and suspended by rope up to 20 metres above the ground.

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