Alien Beings Here on Earth

Adolf Seilacher, a paleontologist at the University of Tübingen, Germany, says that if we are curious to know what alien forms of life might look like—that is, life built to a completely different architectural plan from the ones we see all around us—we need not look to distant planets. They exist—or rather existed—right here on planet Earth.

In a bold reassessment of the earliest complex life forms to appear in the fossil record—known as the Ediacaran fauna, after the South Australian locality where it was first discovered in 1947—Seilacher suggests that these creatures were not precursors to the great Cambrian explosion of species diversity and number that half a billion years ago marked the establishment of nearly all the major body plans we are familiar with today, but instead represent a widespread, but ultimately failed, biological experiment.

The experiment involved one solution, now rare, to the problem of efficient transport of gases and metabolites in expanding body sizes. In modern organisms, systems of internal tubes—vascular networks, lungs, and digestive tracts, for instance—effectively increase surface areas over which gaseous and food exchange can take place, thus allowing the growth of bulky bodies. If Seilacher is right, the Ediacaran fauna went the alternative route of maintaining body volume low relative to external body surface area: in their many different forms they remained flat, leaflike, and sometimes quilted, like air mattresses.

This simple, foliate type of body structure, which apparently characterizes the Ediacaran organisms, cannot be considered ancestral to the more radical solution of bodies with internal tubes, says Seilacher. In which case the transition from the Ediacaran fauna to that of the Cambrian period was not simply an early point on the trajectory of a long, continuous, and accelerating radiation. It was the extinction of one highly unusual group of organisms and its complete replacement by another: it was the first major extinction of many that have punctuated the long history of multicellular organisms, and it removed a form of life that was alien to all that followed.

An Ediacaran "sea pen"

The Cambrian radiation, which began about 550 million years ago, included the characteristic trilobites and signaled the first widespread appearance of a diversity of animals with hard body parts. The great rate and extent of this radiation has impressed biologists since Darwin's time, and it is often called the Cambrian explosion in recognition of its dimensions. A persistent question has been, what came before the Cambrian fauna?

In addition to a brief interval of micromollusc-like organisms—the Tommotian fauna—that just preceded the Cambrian, the discovery of the relatively diverse series of soft-bodied, shallow-water organisms known as the Ediacaran fauna seemed to provide the ideal evolutionary precursors. These organisms, which apparently arose some 670 million years ago, have traditionally been placed in one of three groups of modern organisms: jellyfish, certain corals, and worms. And since their initial discovery in Australia, they have been found in South Africa, England, the Soviet Union, and Newfoundland. Clearly, they were no local aberration.

Seilacher, whose principal interest is in trace fossils, such as tracks and burrows preserved in soft sediments, started to study the Ediacaran fauna primarily as a problem of preservation. Soft-bodied organisms, if they become fossilized, usually do so as flattened impressions in soft, fine sediments. The Ediacaran organisms, by contrast, were typically preserved in coarse, sandy sediments. As there is no sign of this type of fossilization after the beginning of the Cambrian, Seilacher first approached the problem as an extinction of a mode of preservation. He then realized from the conformation of the Ediacaran fossils that the organisms had been bounded by a cuticle that for some reason escaped rapid degradation: these organisms were truly unusual, he saw, and he therefore reformulated the problem as the extinction of an entire fauna.

Another German paleontologist, Hans Pflug, had remarked a decade ago on the leaflike architecture of much of the Ediacaran fauna: the jellyfish types, corals (or sea pens), and worms—all were flattened or quilted. Nevertheless, Pflug continued to allocate the various forms to modern categories of body plan. Seilacher, however, began to see beyond the repetition of flattened bodies to a generalized uniformity of unusual functional architecture. He noted in some cases at least that the flattened shape was not for capturing light as in photosynthesis, as some of the creatures lived at depths below which light does not penetrate. Perhaps the large surface area to volume ratio that flattened, quilted bodies produce was for external exchange of metabolites, he wondered. The absence of signs of a mouth in some of the meter-long "worms" is consistent with the idea. So, too, is the quilted structure of the fronds of the sea pen–like organisms, some of which had a foot for anchorage, some not.

Seilacher wants to keep an entirely open mind about the nature of these creatures, even to the point of not assuming that they were multicellular. He is recruiting the help of one of Germany's most famous architects, Frei Otto, in analyzing what biomechanical forces the typical Ediacaran structures were being optimized for. And he has just traveled to Australia where he plans to study the original Ediacaran material and the trace fossils of wormlike organisms with which they were contemporary. It now seems more likely that these faint images, not the Ediacaran animals, represent the ancestors of the later Cambrian fauna.—ROGER LEWIN