morphic rocks of southwest Norway carrying crystals, 20–80 μm in size[7], generated when carbon-bearing sedimentary rocks were carried down to mantle depths temporarily during plate collision (with Scandinavia) and subsequently brought up to crustal levels. Some geologists doubt this, as they consider that crustal rocks are too buoyant to be carried down to mantle depths, and according to Stephen E. Haggerty, the well-known authority on diamonds, they were perhaps produced by a process akin to current industrial practice of making thin films of diamonds by chemical vapour deposition (CVD technique).

Even though the rather varied modes of occurrence of diamonds in nature have jolted conventional ideas about their genesis and exclusive association with kimberlites, the latter rock types still appear to be sole repositories for commercially viable crystals. Their ubiquitous existence and ability to survive over long geological time spans is of considerable significance as they can provide valuable information about impact structures and give 'access to events that occurred (and possibly carbon reservoirs that existed) in the early history of Earth when bombardment by meteorites was at its most intense'.

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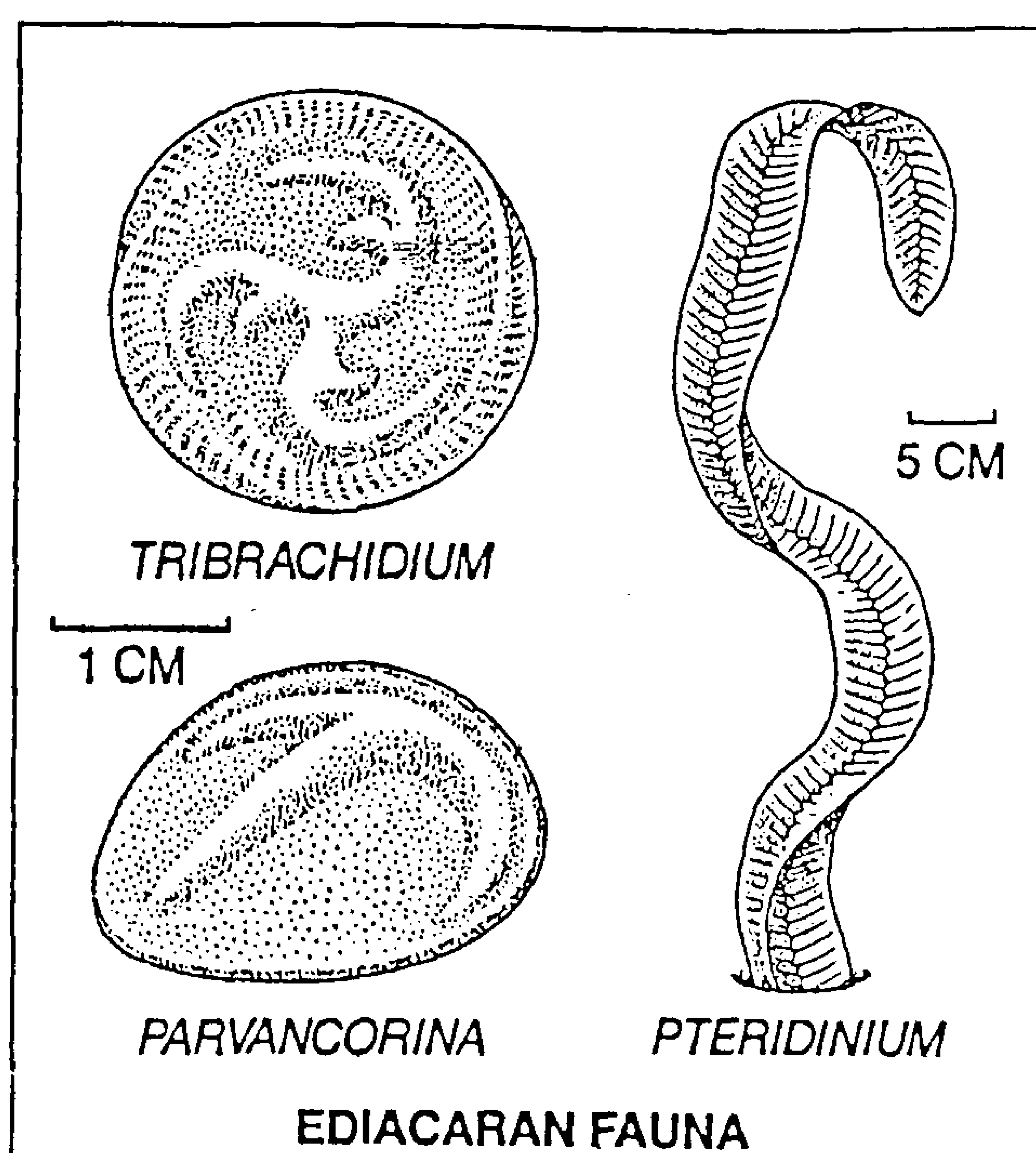
Ediacaran fossils – lichens?

In 1946, Precambrian fossil impressions of simple, soft-bodied organisms believed to be related to jelly-fish were described[1] from Ediacara Hills in Southern Australia and similar fossils were later found in Namibia, Ireland, China, Siberia, New Foundland, British Columbia, N. Mexico and in India[2–7] (claimed to date 600 million years, and hence, oldest Ediacaran fossil). These organisms were globally distributed and belong to late Precambrian period, almost after 90% of geologic time had lapsed, during which life on Earth was represented by bacteria, algae and unicellular organisms. These soon gave way to larger and complex forms which were collectively called Ediacaran fossils and the period prior to Cambrian times were dominated by these forms so much that it came to be known as 'Ediacaran' marking the early Phanerozoic (greek for visible plus animal life)[5] characterized by these oldest known multicellular life (metazoans). Martin Glaessner, 'the father of modern micropalaeontology', has provided detailed descriptions of these fossils, barring a few of which, most of them became scarce by about 500 million years. The fossils exhibited three dimensional preservation as sediment-filled moulds (i.e. body shape infilled with sediments without any trace of anatomical features) and without substantial flattening. Though palaeontologists initially classified them as animals, later researchers had expressed views that they may be plants or giant single-celled organisms or even as an unsuccessful evolutionary experiment completely different from known life on Earth. In fact they were considered enigmatic for quite a long time.

However, recently a novel idea has come up that the Ediacaran fossils are remains of large lichens which had widespread development in the Precambrian and they were believed to be living symbiotically with algae and bacteria of those times[8,9]. The animal–jellyfish connection suspected by the earlier discoverers was dismissed by experimentally proving that soft-bodied animals like jellyfish cannot leave any fossil impression as the weight of rocks piling over would have squeezed them much flatter and hence the Ediacaran fossils must have had structural strength and rigidity of the large plants having chitin. Like plants, they produced their own food and had microscopic tube-like structures similar to modern lichen filaments. These views have been discounted by other palaeontologists some of whom consider that the author had insufficient data and his conclusions based on structural strengths are flimsy as all Ediacaran fossils are merely impressions in rock and not fossilized remnants; also, their resemblance to sea-anemones (instead of jelly fish as earlier put forward) would be more apt as they had stiffer body. On anatomical grounds too, most of them



A few forms of the Ediacaran fossils.

bore resemblance to 'animals' though some forms like *Tribrachidium heraldicum* with three-fold symmetry, not seen in modern organisms, do not fit into any category. The biological enigma about these Ediacaran fossils still persists. Perhaps they belong to diverse groups – some resembling corals, some the mobile animals, while a few others, acellular; in fact they can be interpreted to represent a whole spectrum of organisms.

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Paucity of preserved old crust

Though Earth's oldest crust formed more than 4 billion years ago, today researchers are baffled by the paucity of early continental crust. Different models have been put forward by them to explain this. According to one view, oceanic crust gets recycled into the mantle by plate tectonics while the continental crust, being too buoyant to be drawn back into the mantle, had persisted and got weathered soon. Another view assumes that continental crust grew very gradually and their scarcity is due to their smaller size during Earth's early times and perhaps the creation of new crust and destruction of old ones had balanced since then.

An answer to the riddle about the rarity of early crust has come out of recent studies by Bowring and Housh[1] who through Sm–Nd isotopic studies have proved that indeed large segments of continental crusts have been recycled into the mantle during 4 billion years of Earth's evolution. They have used the progressive variation in the Sm–Nd ratios in the mantle reservoir through time as the basis for distinguishing older from later or 'juvenile' crust. The variation in the Sm–Nd ratio is brought about during the mantle differentiation which results in the formation of a buoyant crust. In this process, the newly formed crust gets preferentially enriched in Nd causing depletion of this element in the mantle reservoir through time. Thus the older of the early continental crusts will have ratios closer to the initial Sm–Nd ratios of the mantle and the younger ones, the products of mantle reservoir with depleted Nd, will correspondingly reflect the later Sm–Nd ratios. The analysis of fragments of early Archaen rocks indicate that even though large amounts of continental crusts formed early in Earth's history, they were subsequently destroyed and replaced by 'juvenile' rocks.

Direct unambiguous evidence of such recycling of early crust has come up recently in the find[2] of a diamond from a kimberlite pipe in N. E. Swaziland in Africa having as an inclusion, a crustal mineral – staurolite (an Fe–Al silicate). This mineral is typically developed in metamorphosed clay-rich sediments and never reported from the mantle. This staurolite was apparently carried down into the mantle by subduction and later became encapsulated by diamond when the latter nucleated around it. The diamond was subsequently brought to the surface through the kimberlite magma. In another recent report[3], a large chunk of peridotite in crustal gneiss in Alpe Arami region (Swiss Alps) has been found and this is considered yet another evidence of recycling of continental crust. Here, the large chunk of peridotite is believed to have been picked up by the continental gneiss of this region during its transit deep into the mantle (300 kms or more), when the gneisses were subducted during plate collisions, and subsequently brought back to the surface driven by buoyancy forces accompanying their warm up. In the process the gneisses underwent some metamorphism by the heat and pressure of the mantle. Fresh evidences are steadily coming up, establishing that recycling was an important process during the early history of the Earth and that the 'preserved continental crusts comprise of fragments that escaped recycling'.

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