100 YEARS AGO

The Fourth Dimension. **By C. Howard Hinton, M.A. A book bearing the present title may be reasonably expected to contain certain things. In the first place it should have a clear exposition of Descartes's applications of algebra to geometry, and conversely of geometry to algebra, the logical conclusion of which consists in the removal of all restrictions as to the conceivable number of dimensions of space. In the second place it should contain clear, concise, and exactly worded statements of the peculiar and distinctive geometrical properties which are characteristic of spaces of two, three, four, or more dimensions respectively… Now such things as these are either entirely absent from the book or else they are mixed up with such a mass of irrelevant and discursive matter as to render it often quite impossible to make out what the author is driving at… There is a certain class of individual, far too common in this country, who busies himself in pestering his mathematical friends with long and rambling letters on such questions as "What is the fourth dimension?" or "What is the ether?" Such people very rarely know anything about the three dimensions of the space they live in, but Mr. Hinton's book will, it is to be hoped, give them something to think about which will at least amuse them and keep them occupied.**

From *Nature* 21 July 1904.

50 YEARS AGO

It is firmly believed by most theoretical physicists that the antiparticle to a proton can exist… This particle should bear the same relation to a proton as does the positron to an electron. Should it be possible to create such a particle by a proton–nucleon collision, the incident proton will require a kinetic energy of at least 5.6×10^9 electron volts. At present only one particle accelerator, the Berkeley 'Bevatron', exists which is designed to reach this energy. At this energy the production of antiprotons is not expected to be very copious, and their abundance relative to other particles formed will probably be far smaller than in many cosmic ray phenomena which have already been extensively investigated. The problem of the conclusive identification of the antiproton may be a difficult one for some time to come.

From *Nature* 24 July 1954.

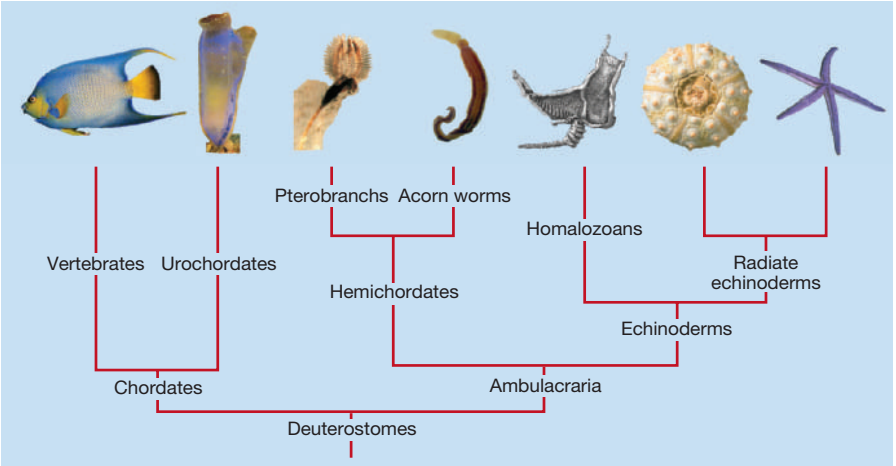

Figure 2 **The main deuterostome groups. Shu *et al.*[1] interpret their vetulocystid fossils as an offshoot of the echinoderm lineage that branched off before the division between the now-extinct homalozoans and the radiate echinoderms. According to this view, the vetulocystids have affinities with another mysterious group, the vetulicolians, which may have diverged from the deuterostome line before the division between the chordates and ambulacraria.**

deuterostomes. They have the characteristic skeleton of an echinoderm and a strongly asymmetrical development. But homalozoans never display even a hint of radiate symmetry and, more importantly, they have gill slits and a post-anal muscular appendage. These last two traits are probably primitive features common to all deuterostomes. So do the vetulocystids take us even further back towards the root of echinoderms?

Faced with such fossils, the first step is to define front and back, and identify the major body openings — mouth and anus, gill slits, and the pores involved in water circulation or reproduction (gonopores) are all possibilities that must be considered. Here the problems really start because fossils do not come ready labelled. Pictures of the fossils themselves, and the interpretations of Shu *et al.*, appear in Figs 1–3 of their paper (pages 423–425).

In the best-preserved vetulocystid material there is evidence for a straight gut running to the posterior along a possibly segmented tail-like structure, as in vetulicolians[3], and this presumably led to a terminal anus. The sack-like anterior part, or theca, has two large and more or less identical openings, both circular and taking the form of a low pleated cone. The anterior of the two circular cones is taken to be the mouth and the posterior may be the anus or gonopore. Towards the base of the theca there is a rhomboidal structure, which Shu *et al.* interpret as respiratory in function and possibly a gill. The identification of the vetulocystids as a 'basal' echinoderm group hinges on this interpretation, with the presence of a single rather than paired 'gill' implying echinoderm-like developmental asymmetry. There is no calcite plating.

But other interpretations are possible. The two circular structures could be gill openings (they are in a similar position in vetulicolians[3]), the mouth anterior and forming the elongate recessed zone, and the rhomboidal structure a folded epithelial zone for gaseous exchange (analogous to those of certain primitive stemmed echinoderms) rather than a gill. That would make the echinoderm affinities of vetulocystids much more dubious. Vetulocystids and vetulicolians share many similarities and are clearly closely related, but quite where they fit within the deuterostomes remains ambiguous because of these alternative possibilities. Such is the way with fossils.

There is now direct fossil evidence that all of the major deuterostome groups were established by about 520 million years ago. Fossil vertebrates (yunnanozoans[4]), tunicates (*Shankouclava*[5]) and both asymmetric and radiate echinoderms (homalozoans, helicoplacoids) have all now been discovered in early Cambrian deposits. *Phlogites*, a tentacle-bearing early Cambrian fossil of uncertain affinity[5], might even be a hemichordate or part of the common ancestral lineage of echinoderms and hemichordates. So, if deuterostome divergence occurred around 575 million years ago, as recent molecular-clock studies suggest[6], there is a 50-million-year gap in the fossil record between the origin of deuterostomes and their appearance in the fossil record. In the jigsaw of deuterostome evolution, vetulocystids represent another piece to be fitted into a puzzle where many of the pieces are still missing. ■

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