k22 The roots of Phanerozoic metazoans < DNA clock >

the earth exists
to grow toadstools for him
to sit under
the sun to give him light

by day and the moon
and wheeling constellations
to make beautiful
the night for the sake of
warty bliggens

That toad "considers himself to be the center of the universe" said archy,
the cockroach, to mehitabel. —Don Marguis (1878-1937).[1]

A molecular clock's tick (mutation frequency with each mutation, naturally random in occurrence but of different mean wait-time between each in different living materials) can be calibrated for living groups of animals by looking at the fossil record for their oldest (radiometrically dated) member.[2] Vertebrate fossils have such a good fossil record that they have been the most studied. How much variation exists in a gene among each group is a measure of how much that gene changed in time (in million year units). The first "timepieces" counted substitutions of amino acids in the protein products of the DNA code.[3] Newer timepieces count letter changes in stretches of the four-letter (A, T, C, G) DNA code. Using the latter, the "splitting" of the phyla is (***Figure k22.1***): echinoderms (starfish & sea urchins) and chordates (fish & humans) went their separate ways 1 billion years ago and before then, around 1.2 Ga, echinoderms branched away from arthropods (which came to include insects & crustaceans), annelids (leeches & worms), and mollusks (squid & clams). The clarity of the gene picture, and its agreement with decades of research into anatomy, is strong evidence, claims Jeffrey Levinton, that before the putative Cambrian "explosion" (read "revelation") a separate evolution of these two groups had been under way for half a billion years.[4] Even so, molecular-based phylogenies illuminate neither the anatomies of the putative stem groups nor what to known body plans the functional transitions were. Fossils are needed. Candidates, recently found, are trace fossils in sandstone, Van Horn region, Texas, that dates 1.25 Gy. Although, John Breyer will allow that these could be "bazaar and unique cyanobacteria" or they could be, he and his coworkers suggest, "Vendian-type body fossils."[5] In clearer agreement with molecular data are horizontal burrows in 1.1 billion year old Chorhat Sandstone, Vindhyan Supergroup, Son valley, central India. Here centimetric storm-sands topped by oscillation ripples remain separated even when there are no mud drapings between them. An erosion-resistant coating is implied and this could have been a leathery algal coating. A few millimeters below these implied shallow-water mats are burrows that record fairly large (up to 5-mm-wide) triploblastic (ectoderm, endoderm, and mesoderm) metazoans. "Apart from branching and tier-keeping, their makers had not yet developed the systematic search behaviors (meandering and so forth) that one observes in later undermat miners" noted Adolf Seilacher, Pradip K. Bose, and Friedrich Pflüger in 1998. And: "Because pore water below biomats tends to be in a reduced state, we must also consider that these animals used the mat not only as a food source but also as an oxygen mask." [7] ❑

Figure ***k22.1*** [6] Divergence of Phyla before the Cambrian indicated by their DNA differences