The Cambrian explosion in colorful, zoological context

The Cambrian Explosion: The Construction of Animal Biodiversity

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The Cambrian explosion is one of the chief mysteries of the fossil record. All of the phyla, and many lower taxonomic ranks, appear suddenly in the Cambrian. This is ¡the name for the 'geological period' right at the bottom of the Paleozioc era. Uniformitarians 'date' the Cambrian from about 541 to 485 Ma ago. Evolutionists struggle to explain it, while creationists understand it as the natural consequence of all forms of life being specially created, and not connected by evolutionary ancestry.

The title of this book, however, is a bit of a misnomer. This work is very detailed and covers much more than the Cambrian explosion. It also includes a great deal of Precambrian geology, zoology, evolutionary theory, taxonomy, and paleozoology. One striking, and visually attractive, feature of this book is the profuse use of illustrations in colour. Owing to this, as well as the profuse use of photographs, this book is visually appealing, and a pleasure to read.

Late Precambrian and early Cambrian geology

This work features a good deal of geology. It focuses on plate tectonics, U-Pb zircon dating, magnetostratigraphy, chemostratigraphy, and ancient (supposed) glaciations.

As in the Phanerozoic, all forms of dating and correlation are subordinate to biostratigraphy. For instance, Erwin and Valentine comment:

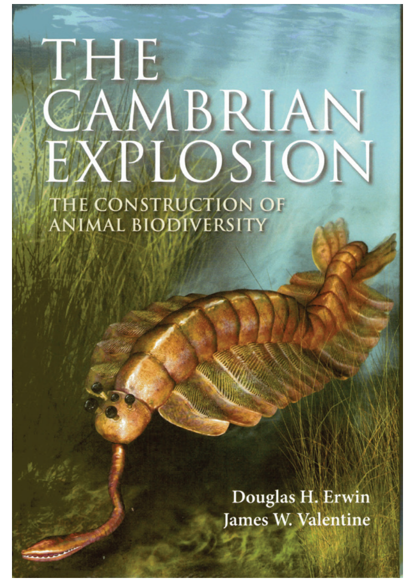
> "Magnetic reversals are sufficiently common during most of the past 600 million years that they provide a sort of bar code: match the sequence of reversals in one region to sequences of rocks from another, and the result is a potential correlation. In practice, the magnetic reversal record rarely provides unambiguous correlations, so confirmation through fossil biostratigraphy, radiometric geochronology, or shifts in carbon isotopes are required as well" (pp. 27–28).

The foregoing statements correct those creationists who want to 'import' conventional magnetostratigraphy directly into creationist models—treating it as something independent from the evolutionary-uniformitarian system of dating. Clearly, it is not.

'Global' isotopic and geochemical anomalies have their own problems. Their global extent had been inferred from sampling only a few locations, and more recent evidence points to 'regional variations' in these records (p. 56).

The odd world of the Ediacaran fauna

The Ediacarans are a group of enigmatic fossils that just predate the Cambrian explosion. They do not readily fit together with each other, or with any other known form of life. This work is a bonanza of photographs of, and discussions about, the many odd Ediacaran fossils. It also



elaborates on the geologic context of the Ediacaran fossils in some detail.

One of the Ediacaran genera is *Dickinsonia* (figure 1). It has a quilt-like construction, reminiscent of the air mattress. This, along with similar patterns among Ediacarans, has led to the hypothesis that the Ediacaran fauna functioned according to different 'rules' of development from those of all successive multicellular life. Instead of morphological specialization during ontogeny (e.g. arms, legs, respective body tissues and organs), the Ediacaran individual would undergo, during ontogeny, a series of fractal lateral repeats of simple structural motifs.

The Ediacarans thus, according to the Vendozoa hypothesis, were an early, failed experiment in multicellularity (p. 131). However, this seems to smack of an outdated, 'progressivist' view of evolution. Saying that the Ediacarans were a failure owing to their replacement by modern multicellular life is like saying that the dinosaurs were a failure owing to their replacement by mammals. After all, the Ediacarans and dinosaurs each 'ruled the earth' for many millions of years according to the evolutionary-uniformitarian timescale. Finally, this fauna just


Photo: Wikimedia/Verisimilus

Figure 1. Dickinsonia, one of the enigmatic Ediacaran fossils.

multiplies the problem for evolution—paleontologists have recently identified another ‘explosion’ in the fossil record in the Ediacaran ‘period’, which they dubbed the ‘Avalon explosion’ (‘dated’ 635–542 Ma ago).[1,2]

Cambrian explosion—its reality

To gauge the magnitude of the Cambrian explosion, first in terms of the sudden appearance of many kinds of life, let us first consider the presumably high-resolution time scale that is based on U-Pb zircon dating (p. 25). The Cambrian itself (also its Stage 1) began 543 Ma ago. The corresponding start dates for Cambrian Stage 2 and 3, respectively, were 529 and 519 Ma ago. A great deal of evolutionary origination and diversification took place in only about 15 Ma, as elaborated in the next two paragraphs.

At the Precambrian-Cambrian boundary, the number of phyla jumped from two to nine. The number of classes and class clades ballooned from zero to 16. By the beginning of Stage 2, the latter further more than doubled to 36 and, by the beginning of Stage 3, this more than doubled again to 73 (p. 156).

The reality of the Cambrian explosion is also evident on a finer, more detailed scale. One of the most complete segments of the relevant Cambrian strata occurs in southern China. Even so, the explosion is vividly evident. The numbers of genera of small shelly fauna jump numerically, between Stage 1 and Stage 2, from 11 to 162. There are zero trilobite genera in Stage 1 and Stage 2, but the number explodes to 113 in Stage 3 (p. 215).

Cambrian explosion—minimal antecedents to appearing life forms

Living things appear in the Cambrian without ancestors, not only in a literal ancestor-descendant sense, but also in a cruder sense of morphological antecedence. The authors state that, “Thus, the major nodes on the tree of life that separate large clades (such as those ranked as phyla or other higher taxa) do not indicate the origin of the body plans that characterize them today” (p. 296).

Not surprisingly, in the absence of ancestral states, evolutionists have to invent such states. In fact, Erwin and Valentine aptly call them “ghostly ancestors”, comparing them to lost ancient books whose one-time existence is inferred by their mention in recent books.

> “Decades of molluscan specialists, for example, have discussed the putative characteristics of the ‘hypothetical ancestral mollusk’, better known as HAM. Based on characters that seemed to be shared by the major classes of mollusks, HAM served as a foundation for discussions of molluscan evolution in the days before phylogenetic analysis” (p. 293).

Continuing the theme of ‘seeing ghosts’ (their term), the authors fall back on inferred ‘revolutions’ in genomic systems to explain (or explain away) the Cambrian explosion: “Those data help clarify how the explosive appearance of many independently evolving lineages—occurring within a narrow geological time span—lay well within the capability of these incredibly flexible genomic systems” (p. 317).

Evolutionary theory suffers not only the difficulty of accounting for the sudden appearances of the animal phyla in the Cambrian, but also the fact that the phyla have been very conservative, in an evolutionary sense, since then. Erwin and Valentine acknowledge that:

> “The patterns of disparity observed during the Cambrian pose two unresolved questions. First, what evolutionary processes produced the gaps between the morphologies of major clades? Second, why have the morphological boundaries of these body plans remained relatively stable over the past half a billion years? After all, there is no *a priori* reason clades could not display a pattern of rapid exploration of morphologic space, coupled by a subsequent expansion of that space during the Phanerozoic, but it is

> not a pattern commonly observed among the bilaterian metazoans" (p. 330).

The *ad hoc* nature of evolutionary explanations, for the Cambrian explosion, is illustrated by the plethora of hypothetical explanations: "Another plausible hypothesis may explain the conservative and clumpy nature of body plans besides that of developmental constraint, one that relies on the adaptive zone aspect of ecospace" (p. 332).

One old standby has apparently been falsified. In the past, some evolutionists had suggested that the Cambrian explosion was an illusion caused by the hypothesized long-precedent ancestral forms lacking hard parts, and thus leaving no fossils. However, soft-bodied forms can sometimes be preserved as body fossils—as exemplified by the Burgess Shale fauna of British Columbia, Canada. In addition, completely soft-bodied animals often leave behind trace fossils in the sediment. Pointedly, tracks, trails, and burrows show much the same explosion in diversity and behavioral complexity as do the body fossils (p. 140). Erwin and Valentine (pp. 5–6) conclude that, notwithstanding potentially valid objections, the Cambrian explosion is real.

Cambrian explosion—minimal 'variation on a theme' between life forms

The appearance of many kinds of life during the Cambrian explosion is not only sudden. It also fails to display the characteristics of an adaptive radiation (that is, evolutionary modification of a theme). Erwin and Valentine comment:

> "Morphologic evolution is commonly depicted with lineages more or less gradually diverging from their common ancestor. New features arise along the evolving lineages, and diversification turns those features into synapomorphies of new clades while new apomorphies appear among the morphologically diverging branches. Gould (1989, 38) characterized this pattern as the 'cone of increasing diversity', but neither the fauna of the Cambrian nor the living marine fauna display this pattern. In fact, metazoan morphologies are quite clumped—undispersed is the technical term—into clades with unique body plans and with significant gaps in architectural style between them, and this pattern continues among classes within phyla and to some extent even among orders within classes" (p. 340).

This pattern, at least at the level of phyla, continues through the fossil record and into the present. The authors comment:

> "The clearest explosion trends involved diverging branches that lead to higher taxa in a Linnaean sense. Although morphospace within the early disparity ranges of higher taxa are commonly filled by later branchings, the separation and distinctiveness of higher taxa seem on balance no less today than in the Cambrian, although cases of convergence do occur" (p. 339).

Cambrian explosion—zoological implications of systematic discontinuities

The difficulties that evolutionists have in 'connecting' the animal phyla in an evolutionary relationship, to each other, are stark. The authors comment:

> "In hindsight, it is easy to see why systematists have sometimes been misled by morphological criteria when attempting to establish a tree of phyla. First, there are many parallels in design features among the superphyla … . At the level of phyla, the gaps in the tree are numerous and commonly so broad that we often have to extrapolate between body plans that were connected in life's history by ancestral forms that had little in common with the descendant body plans" (p. 104).

Consider the foregoing in terms of cladistics language. The phyla share many plesiomorphic (general and broad-based) features, as well as apomorphic (phylum-specific specialized) ones, but few synapomorphic features (phylum-to-phylum shared derived traits capable of grouping clusters of phyla into evolutionary relationships).

What's more, many time-honoured evolutionary relationships have fallen by the wayside once contradicted by molecular evolution, which evolutionists deem more reliable. For instance, arthropods and annelids were, owing to both having segmentation, long believed to be relatively closely related (something I was taught as fact in zoology classes a few decades ago), but no longer are (p. 104; see also pp. 284–285).

Even the fundamental dichotomy of animal life into the two gross embryological-development categories, protostomes and deuterostomes (which I first learned as fact in high school biology), has been modified. For instance, thanks to molecular evidence, some members of Deuterostomia have been transferred to Protostomia (p. 87).

Cambrian explosion—early appearance of 'modern' traits

One of the major features of the Cambrian explosion is that it erases any evolutionary notion of increasing complexity (as defined by reference to extant life). Creationists in the past have focused on such things as the complex fully formed (not gradationally formed) trilobite eyes in the Cambrian.[3] Erwin and Valentine essentially concur with these premises—if anything stating them even more strongly—as they write,

> "The most remarkable pattern to emerge from any analysis of early Cambrian metazoan diversification is the extraordinary breadth of morphologic innovation. It is

> evident at many different scales, from the obvious generation of morphologically distinctive groups to diversity in anatomical details. For instance, one might expect that complexity and sophistication of eyes improved through the Phanerozoic, but the recent discovery of exquisitely preserved eyes from arthropods in the early Cambrian Emu Bay Shale in Australia illustrates that highly advanced, compound eyes with more than 3,000 ommatidial lenses had evolved very early in the history of the clade ... . Surprisingly, many of the recovered eyes preserve a 'bright zone' within the ommatidia that has higher light sensitivity and, perhaps, acuity. Such sophisticated eyes …" (p. 216).[4]

Conclusion

The Cambrian explosion features such things as the sudden appearance of the phyla, strong discontinuities between the phyla, difficulties in grouping phyla according to evolutionary relationships, and the early appearance of many essentially modern traits. Special creation remains the most parsimonious explanation for the Cambrian explosion.

References

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4. See also Sarfati, J., Giant compound eyes, half a billion years ago? *Creation* **34**(4):39, 2012.