The Cambrian explosion in colorful, zoological context

The Cambrian Explosion: The Construction of Animal Biodiversity
Douglas H. Erwin and James W. Valentine
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John Woodmorappe

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 Paleozoic 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 specialisation 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
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 presum-
ably 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 origina-
tion 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 ex-
losion 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 Cam-
brian 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 exist-
ence 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 sud-
den 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

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

Photo: Wikimedia/Verisimilus
not a pattern commonly observed among the bilaterian metazoa” (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).
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).

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