j34 The Cambrian explosion < hard parts >

rebus sic santibus —"circumstances have changed." [1]

Evolutionary paleontologists do express their surprise by the name "Cambrian explosion" for the appearance within a few decades of geologic time after a wait of 4 billion years of: 1) multicellular animals in great number and diversity, 2) a great increase in diversity of unicellular organisms, and 3) the establishment of marine ecosystems of modern types.[2] The hard parts independently acquired by different phyla (even diploblastic, as sponges, that lack a true mesoderm) show early experimentation, which suggests that they were for a function (variously for better tissue anchorage, filtering, protection, chewing, locomotion, predation, ...)[3] and were not, merely, brought on by a change of seawater chemistry.[4] So said, nature's sublime patience or indifference to any needful agenda, must amaze one and all.

Unlike plants that remained single celled until the Silurian, almost all multicelled animal phyla (some count 30 in existence today) are represented by Cambrian species, but the greater number (some count 100) are unfamiliar because these are not represented by a great diversity of species, and because after the Cambrian there are no evident descendants of them. Ironically, the phylum Chordata, which came to encompass all vertebrates, is the most poorly represented, and for long it was thought to be absent. Chordate species were present but they were boneless and the only hard parts that they had were their teeth. These tiny fossil evidences do not feature in the attention grabbing descriptions of the Cambrian explosion which focus on the sudden appearance of easily visible macroscopic remains of mineralized metazoan exoskeletons (shells).[5]

Some standardization did come to be in the developed hard parts. The winning preference has been for calcite. Bryozoans have had calcite skeletons from when they first appeared in the Devonian. From that time, mollusk shells have also been completely or partially calcite in place of aragonite (mother of pearl) that was exclusively their shell material before. Sponge spicules, typically calcite and aragonite since the Cambrian were then more commonly with protein (spongin) and/or silica spicules. Trilobites stiffened their skeletons by the addition of a layer of calcite, as in giant *Paradoxides*, beneath what for Cambrian members had been exclusively chitin shells, as in *Ollenellus*. Calcite shelled articulate brachiopod appeared in the Cambrian but, then, the commonest type of brachiopods were inarticulate brachiopods with chitino-apatite (-calcium phosphate) shells. The first arthropod skeletons were made of chitin (nitrogenous sugar). But also a great variety of *soft bodied* metazoans appeared. Obrution deposits afford glimpses of these: the Middle Cambrian 505 million year old Burgess shale, British Columbia, Canada, the latest Lower Cambrian (Botomian stage) 515 million year old Chengjiang, China, Maotina Shatt, China, and Sirius Passet, Northern Greenland).[6]

Traditionally the "Cambrian explosion" was the sudden appearance in the Lower Cambrian (Atdabanian stage) 520-525 million years ago of a diverse and widely occurring skeletal animals, predominately trilobites and brachiopods, sometimes in association with archaeocyathids that were the first skeletal reef (calcareous bioherm and biostrome) builders. For that time, the designation Cambrian "explosion" lost some of its force when a prior several million year long history of tiny skeletal animals: the Tommotian fauna (***Footnote j34.1***), intruded themselves upon the describers awareness. The "explosion" was extended to include this tintinnabulation, making the whole event about a decade of million years in duration (***Figure j34.1***). But the tinkling of sedimenting shells had begun even earlier. Referred to in the literature as the SSF (small shelly fauna), are shed, or disarticulated, tiny calcareous spines, studs and plates.[7] Also likely was a long Precambrian history of this fauna,[8] unequivocal evidence being bedding-surface trail traces, both looping and spiraling, of bilaterally symmetrical animals described by James Godfrey (Jim) Gehling.[9] And certainly, not all species acquired hard parts at the time of the Cambrian explosion.[10] If the base of the Cambrian

is defined as the first appearance of infaunal burrows, then the 12 million year long Siberian Manykaian (or Nemakit-Daldynian) stage begins the Cambrian.

The Cambrian "revelation" would be a more apt description of the event because before readily fossilizable hard parts were acquired, the diversity of life was already in place although it was mostly not recorded (remained hidden). Remarkably, eggs of two different kinds of animals have been discovered in two different regions: the Shaanxi Province in China, and the Aldan River (tributary of the Lena) in Yakutia.[11]

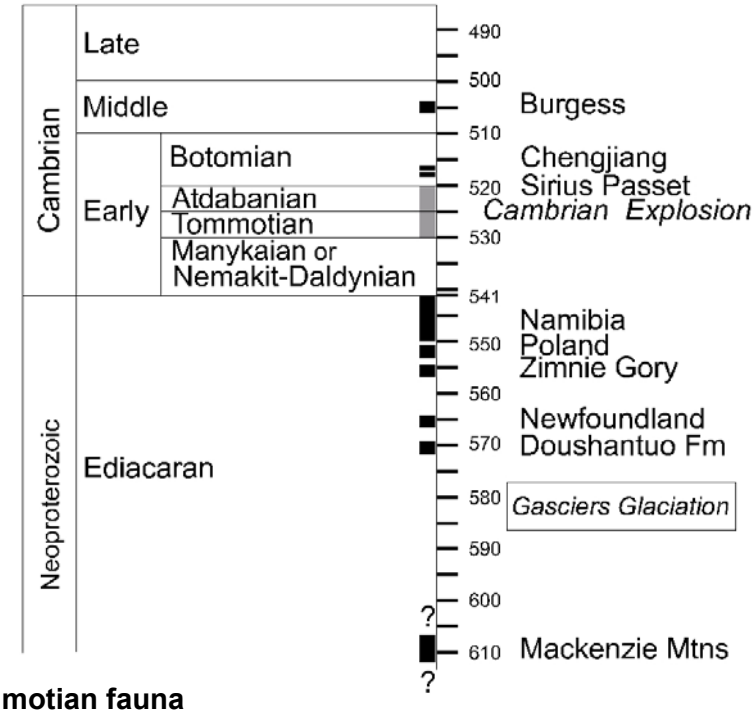
The appearance in the rock record of a great variety of life during a short interval (a couple of decades of millions of years) of geologic time as a result of fossilizable hard parts becoming a feature of many lineages of species for the first time began the Cambrian 541 years ago.[12]

Reprise How to recognize the base of the Cambrian has been revised three times. Originally, the Cambrian lower boundary was the occurrence of the first shelly macrofossils, then (beginning in the 1970s) small shelly fauna, and now (since 1991) the first appearance of ichnofossils, specifically infaunal ichnofossil *Trichophycus pedum* (as in the Manykaian stage) in the reference section at Fortune Head, southeastern Newfoundland (which belonged to the Cambrian paleoterrane Avalonia).[13] Such easy revisionism in geology gives a whole new meaning to the expression: "Written in stone." ❑

Figure j34.1 [14]
Metazoan early events in the fossil record

(In columns left to right:

Periods,
Epochs,
Stages,
Physical record,
Scale in Ma,
Identifiers.)



Footnote j34.1 **The Tommotian fauna**

The sudden appearance of trilobites as visible (because of their mineralized skeletons) and ubiquitous metazoan fossils inspired the designation "Cambrian explosion" However, Cambrian fauna of tiny shelly forms (and no trilobites) were in existence earlier. These SSFs (small shelly fossils), called the *Tommotian fauna*, occur in many localities around the world. They were first well described in Russia where their presence had long been known and where they define the Tommotian Stage that spans a duration of about 5 million years.

Tommotian time correlations are not certain. Provisionally, beginning in the 1970s, the lowest stratigraphic occurrence of Tommotian fauna in a locality permitted description of its Cambrian-Precambrian boundary stratotype. The I.G.C.P. (International Geological Correlation Programme) has since found against this application. One must look deeper, *before* the appearance of SSFs, for ichnofossils.