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# EARLY CAMBRIAN PHYTOPLANKTON RADIATIONS AND APPEARANCE OF METAZOANS

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The global compilation of the Lower Cambrian acritarch records set in biochronological frame of the integrated acritarch and faunal zonation (Vidal and Moczydlowska, 1997) shows the succession of taxonomically distinctive associations changing through time coincidently with major metazoan diversification events. The diversification of acritarchs was relatively fast, each association lasting a few millions of years (3-9 Ma). The taxonomic turnovers seem largely independent of lithofacies or any major environmental fluctuations (Moczydlowska, 1998). The only obvious relation to changing palaeoenvironments is the increase of biodiversity with prograding marine transgressions. Acritarchs, as any planktonic autotrophs, were dispersed in the upper photic layer and thus not restricted to any particular zone in marine basins, following the favourable temperature, nutrient-rich and oxygenated water masses. The phytoplankton radiations preceded the appearance and each diversification event of major metazoan clades and the best-studied trilobites. This is established by tracing the first appearance datum of phytoplankton *vs.* metazoan taxa in the rock successions comprising both groups of fossils.

The global trend of phytoplankton diversity during the Early Cambrian Epoch shows a progressive increase, though minor extinctions happened meantime, up to the terminal *Protolenus* biochron. Only a handful number of species from the diverse Neoproterozoic association trespassed the Neoproterozoic-Cambrian boundary. The phytoplankton extinction at the end of the Ediacarian Epoch was probable caused by the anoxic event at the onset of the transgression. The novel radiation of acritarchs occurred in the *Platysolenites* biochron, when over 20 species appeared globally (Moczydlowska, 1991). In terms of faunal evolution, this biochron is characterized by the first diversification of sclerite-bearing and shelly metazoans. Among the earliest skeletal metazoans were tommotiids, halkieriids, sponge, monoplacophorans, hellcionellids and other primitive molluscs, hyoliths and some problematic groups. Another distinguished feature of evolutionary innovations during the *Platysolenites* biochron is the increased abundance and complex pattern of ichnofossils documenting radical divergence in bilateral animals and their advanced behavioural activity.

The second Early Cambrian radiation of phytoplankton during the *Schmidtiellus* biochron

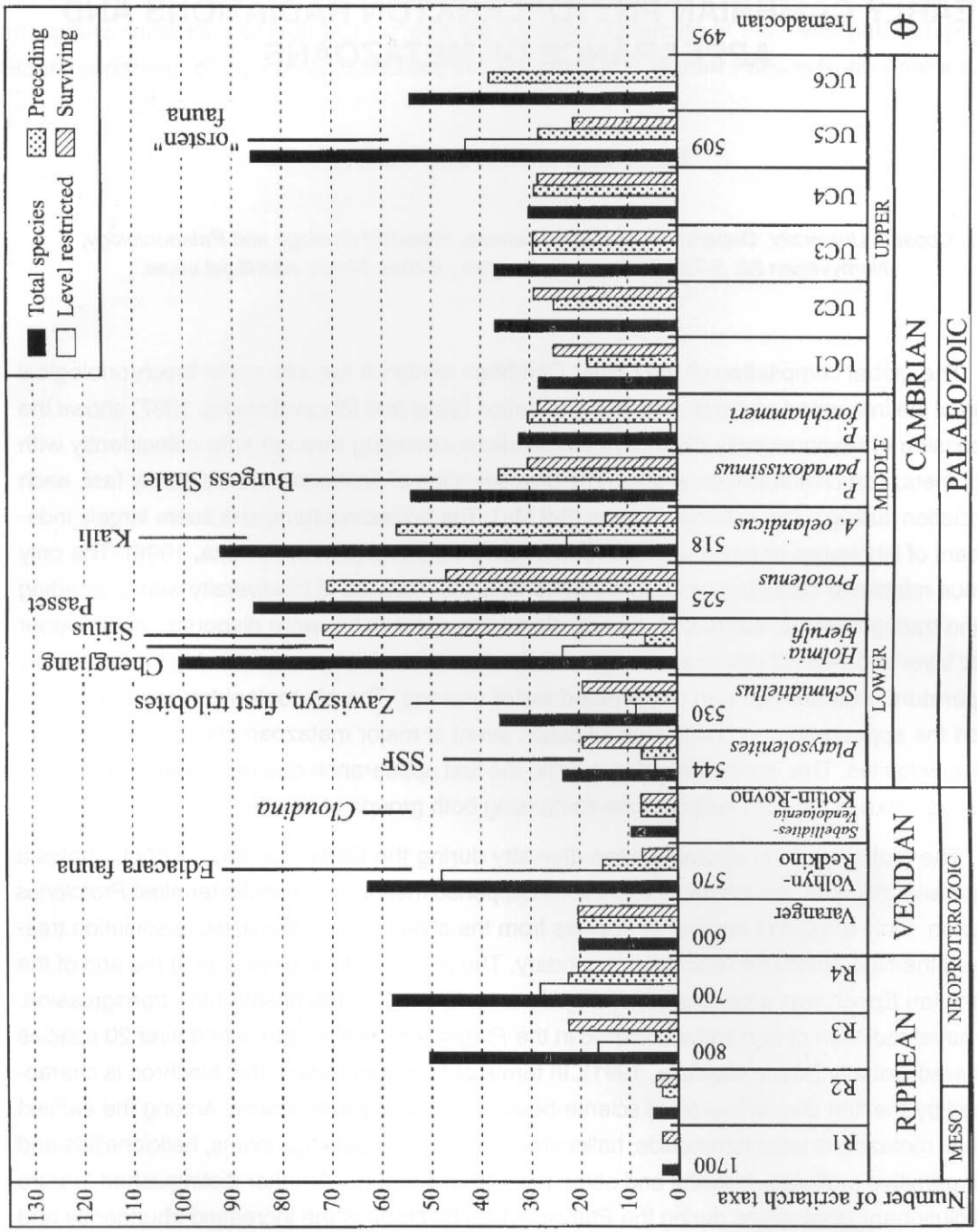


Fig. 1. Global compendium of phytoplankton species diversity during late Proterozoic and Cambrian (after Vidal and Moczydlowska, 1997) and major events in metazoan diversification. SSF stands for small shelly fossils, UC for Upper Cambrian trilobite zones.

resulted in appearance of 19 new species and multiplication of number of species in the global records to 40. During this interval, spanning *ca.* 3 Ma, 8 species extinct and 8 were level restricted. The acritarch radiation slightly preceded the first appearance of trilobites in Baltica and Gondwana (and in a close time proximity in the world) and the next significant diversification of shelly metazoans. Various arthropod-like ichnofossils became common and the earliest known Burgess Shale-type fauna (the non-mineralised arthropods *Anomalocaris* and *Liwi*a, from the Zawiszyn Formation in Poland) appeared, as re-assessed herein.

The phytoplankton diversity level reached in the *Holmia* biochron was the highest ever in the Cambrian Period, exceeding one hundred species during this *ca.* 3 Ma lasting biochron. About 50 new species radiated at the beginning and 30 extinct at the end of the biochron. Many species were long lasting and perhaps 23-25 level restricted. This phytoplankton radiation was followed with a short time lapse by the evolutionary burst in early metazoans, notably shown by the Chengjiang and Sirius Passet faunas. The taxonomic turnover in phytoplankton was paralleled, as noted in the global compendium, by the highest trilobite speciation and palaeogeographic differentiation in the Early Cambrian Epoch.

The *Protolenus* biochron is characterized by decline in phytoplankton diversity and for the first time, and the only occasion in the Early Cambrian Epoch, the rate of acritarch extinction surpassed the rate of speciation marking the Early-Middle Cambrian extinction. Due to a substantial number of long-lived species co-existing the total number of species was still high and close to 90 during this perhaps 7 Ma lasting biochron. The trilobites and other faunas of the time seem also to be in decline caused probable by the global regression and deterioration of habitats, in particular of benthic communities.

All these somehow "synchronized" radiations of phytoplankton and metazoans during the Early Cambrian are not an artefact or coincidence in the fossil record but true reflection of the relationships between evolving primary producers and consumers and the ecological development of complex marine ecosystems. The impact of acritarchs, being the predominant primary producers in marine ecosystems during the Cambrian, on the early metazoan diversification was essential due to their role in generating nutrients at the base of food web on which all consumers rely. The increasing disparity and abundance of acritarchs expanding into broader shelf and offshore environments must have enlarged the biomass production and its widespread distribution in the global ocean. This in turn might have caused the change in the feeding strategy of metazoans from passive suspension- and detritus-feeding in benthic nearshore realm (Neoproterozoic) into active filter-feeding, browsing and predating in pelagic realm in offshore environments (Early Cambrian), and thus their divergence from radial to bilateral symmetry and appearance of many new clades.

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