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landscapes show mandible morphologies of fast-swimming pelagic predatory taxa are poorly functionally optimized but strongly optimized for hydrodynamic performance. Conversely, shallow-water durophagous taxa were highly optimized for jaw strength, but poorly for hydrodynamics. A phylomorphospace was also constructed that showed a possible phylogenetic constraint, possibly reflecting niche partitioning or other factors. The results suggest hydrodynamics are a prime constraint on functional jaw morphology for fast-swimming taxa while the opposite is true for slow-swimming durophagous organisms, a trend that may apply to other secondarily aquatic tetrapod clades.

Evaluation of substrate affinities among phacopid trilobites in a phylogenetic framework

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Trilobites are an ecologically and morphologically diverse arthropod group occurring throughout the Palaeozoic with an excellent fossil record. This study focuses on a relationship between ecological affinity and species evolution among the trilobite family Phacopidae from the Ordovician–Devonian periods. Environmental factors are important as external regulations on morphological evolution; however, few studies have quantitatively tested their association within a phylogenetic framework. To see the distribution of substrate affinities (*i.e.* calcareous *vs* siliciclastic) along with phacopid evolutionary history, a phylogenetic analysis was conducted by compiling existing phacopid character matrices, which was followed by an overlaying of quantified affinity values at a species level. The data of substrate affinities are compiled from the primary literature and online databases such as the Paleobiology Database, Fossilworks and iDigBio, then a ratio of substrate types was taken for each species to calculate the affinity. The preliminary result suggests that the substrate affinities are dominated by carbonate settings, while a few species with strong siliciclastic affinities are seen in the Devonian period among phacopid trilobites. This study will be used to evaluate environmental constraints on the trend of morphological transitions such as heterochrony in future studies, which will contribute to our understanding of fundamental evolutionary processes.

Early Khvalynian ostracods in the northern Caspian region

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The northern Caspian region (Middle and Lower Volga sections particularly) is unique for our understanding of Caspian history and correlation of palaeogeographic events with the glacial–interglacial rhythm and global/regional climate changes. We carried out microfaunal analyses on chocolate clay deposits and found representatives of several ostracod families – widely represented were Candonidae, Cyprididae, Leptocytheridae and Loxoconchidae. Sand sediments rarely contain a great variety of ostracods. Only *Leptocythere pirsagatica* (Liv.) is distinguished. According to Yakhimovich *et al.* (1986) and Sedaykin *et al.* (1987), more than 80 species of ostracods were described in the Lower Khvalynian deposits. The dominant ostracod species are *Caspiolla gracilis* (Liv.), *Cyprideis torosa* (Jones), *Leptocythere bacuana* (Liv.), *L. marta* (Liv.), *L. quinquetuberculata* (Schw.), *Loxoconcha unodensa* (Mand.), *L. lepida* (Step.), *L. gibboida* (Liv.) and *Paracyprideis enucleata* (Karm.). The ecological conditions of these species are diverse. In general, the formation of the observed complex fauna took place under unstable hydrological conditions in a shallow basin. According to our data, Early Khvalynian basin salinity could have varied from brackish water (2–10 ‰) to slightly brackish water (0.5–3 ‰) conditions; typical marine species would be unable to live here because of insufficient salinity and freshwater ones.

A new approach to the step method for fractal ontogenies

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Fractal complexity is the number and configuration of self-similar subdivisions within a geometric entity. True fractals cannot exist in three dimensions; ammonite sutures sufficiently mimic fractals to be quantified geometrically via a method based on fractals. The step method, gleaned from the measurement of irregular coastlines, has historically been used to measure complexity of ammonite sutures. By generalizing the suture into its finite measurement intervals (steps), value is determined for the fractal dimension, D(f), of that suture. However, a smaller interval, or step length, yields greater accuracy: over ontogeny, length, as well as further subdivision is added to the suture line of ammonites. Using the old step method, measuring ammonites (or coastline) over an ontogenetic sequence, plottable values that do not accurately depict the absolute rate of ontogenetic change in complexity. This is due to an inconstant step length that decreases proportionally to the subject it is measuring as size increases during ontogeny. I circumvent the dimensional aspect of step-method measurement instead by fractal complexity, C(f), and demonstrate its greater accuracy in measuring ontogenetic change. The new method is proportional rather than dimensional, allowing it to remain constant relative to the stage of growth, and demonstrating the true rate of change.

UV-B radiation was the Devonian–Carboniferous boundary terrestrial extinction kill mechanism

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There is an unexplained terrestrial mass extinction at the Devonian–Carboniferous boundary (359 million years ago). The discovery in East Greenland of malformed land plant spores shows that the extinction was coincident with elevated UV-B radiation demonstrating ozone layer reduction. Mercury data through the extinction level proves that, unlike other mass extinctions, there were no planetary-scale volcanic eruptions. Significantly, the Devonian–Carboniferous boundary terrestrial mass extinction was coincident with a major climatic warming that ended the intense final glacial cycle of the latest Devonian ice age. A mechanism for ozone layer reduction during rapid warming is increased convective transport of naturally produced ozone destroying compounds. Hence, ozone loss during rapid warming is a possible process that is inherent to the Earth system. This leads us to the unavoidable conclusion that we should be alert for such an eventuality in the future warming world. Other suggested and now restated causes include a cosmic ray blast from an exploding star, *i.e.* a supernova.