17 December, 2016

Coprolite Evidence on the Permian–Triassic Extinction Event

[¡Léalo en español!] [Przeczytaj to po polsku!] [pdf file v. 21.12.2016]

Coprolite of a large carnivore, possibly an archosauromorph, from the Early Triassic of Australia (photo P. Bajdek)

Newest Russian and Australian Papers

So-called mass extinctions are full of mystery and used to constitute one of the most thrilling topics for anyone interested in the history of life. Today, I'll focus on two recent publications treating the topic of the end-Permian mass-extinction (Niedźwiedzki et al., 2016a) and the recovery of life after this extinction (Niedźwiedzki et al., 2016b). I am the second author of both of these papers and you can see the name of Grzegorz Niedźwiedzki who was our team leader.

Coprolite Diversity and Mass-Extinctions

First, I'd like to mention another interesting study which actually is not mine. Probably the most famous, yet not the largest, mass extinction occured at the end of the Cretaceous Period (around 66 million years ago), when the dinosaurs among many other creatures died out. In 2012, came out a paper of five researchers from the New Mexico Museum of Natural History and Science. The team of Thomas L. Suazo studied the diversity of coprolites, i.e. fossil feces, in five geologic formations of New Mexico: three of them Upper Cretaceous (Campanian and Maastrichthian) and two of them Cenozoic (Paleocene and Eocene) in age.

In contrast to what some may expect, the researchers found out that coprolite morphologies do not change significantly across the Cretaceous–Paleogene boundary and concluded: „This suggests that either none of the preserved coprolites are dinosaurian, or that dinosaurian coprolites are homeomorphic with those of some other vertebrates, such as crocodyles."

A basic problem in the study of coprolites is that feces used to provide few taxonomic information about their producers. Distinct animal groups sometimes produce quite similar feces, whereas feces of just one individual may vary a lot in appearance and all this is altered by the fossilization process. Comparison of coprolite morphotypes from clearly different paleobiologic contexts, as e.g. distinct geologic periods, may result particularly misleading.

In contrast, the recent study of our team (Niedźwiedzki et al., 2016a) focuses on the diversity of coprolite morphotypes across the Permian–Triassic boundary in several geologic profiles of just a single locality. Noteworthy, the end-Permian mass-extinction (around 252 million years ago) is considered the most severe extinction event ever, with up to 96% of all marine species and 70% of terrestrial vertebrate species becoming extinct.

I have already talked about coprolites from the Vyazniki site, Russia, as they provided possible evidence of hair in therapsids and yielded a great diversity of other microfossils. Rocks of the Vyazniki region allow us study the fauna of the latest Permian and the earliest Triassic. In the new study, we grouped the analyzed specimens (coprolites and possibly some cololites) into nine morphotypes and documented in detail their stratigraphic ranges and the type of sediments their are found in.

We found out that there was indeed a reduction of coprolite diversity. In the earliest Triassic, only three of the nine morphotypes present in the sediments of the uppermost Permian reappeared. However, no taphonomic explanation, such as a significant change in the sedimentation process could be found to explain this reduction of coprolite diversity. In other words, it appears that most of the animals that produced the feces disappeared.

Recovery of Life After the Great Permian Extinction

Coprolites tells us also about the recovery of life after the end-Permian mass-extinction. The second paper of my authorship which I would discuss in this blog post (Niedźwiedzki et al., 2016b) describes coprolite material recovered from the Bulgo Sandstone which crops out along the coastal cliffs at Long Reef in the northern suburbs of Sydney, Australia. These rocks are lower Olenekian

(Lower Triassic) in age what means that the coprolites we studied have been produced by animals that lived just around one million years after the Great Permian Extinction.

We distinguished eleven recurring morphotypes of tetrapod coprolites, as well as one fish bromalite specimen. Some of the coprolite morphotypes were ascribed most likely to archosauromorph reptiles and others to temnospondyl amphibians, whose bone remains are under study now. Undoubtedly, such a diversity of vertebrate fauna is interesting taking in consideration that these animals lived so shortly after the Great Permian Extinction. Let's now say that by the Early Triassic the Sydney region was located close to the southern polar circle…

In the Early Triassic the climate was actually warmer than it is today and there were no polar ice caps, yet there must have been a reduced insolation at high latitudes. Biotic responses might have included reduced activity levels and estivation in burrows, or perhaps other behavioral and physiological mechanisms such as migration and homeothermy. Moreover, already in 2005, Caroline Northwood described diversified coprolites from the Lower Triassic Arcadia Formation, Queensland. Interestingly, some researchers suggested that Antarctica was a refugium for terrestrial tetrapods from the end-Permian mass extinction.

Piotr Bajdek

References

Niedźwiedzki, G., Bajdek, P., Qvarnström, M., Sulej, T., Sennikov, A.G., Golubev, V.K., 2016a. Reduction of vertebrate coprolite diversity associated with the end-Permian extinction event in Vyazniki region, European Russia. Palaeogeogr. Palaeoclimatol. Palaeoecol. 450, 77–90. doi: 10.1016/j.palaeo.2016.02.057

Niedźwiedzki, G., Bajdek, P., Owocki, K., Kear, B.P., 2016b. An Early Triassic polar predator ecosystem revealed by vertebrate coprolites from the Bulgo Sandstone (Sydney Basin) of southeastern Australia. Palaeogeogr. Palaeoclimatol. Palaeoecol. 464, 5–15. doi: 10.1016/j.palaeo.2016.04.003

Northwood, C., 2005. Early Triassic coprolites from Australia and their palaeobiological significance. Palaeontology 48, 49–68.

Suazo, T.L., Cantrell, A.K., Lucas, S.G., Spielmann, J.A., Hunt, A.P., 2012. Coprolites across the Cretaceous/Tertiary boundary, San Juan Basin, New Mexico. NMMNH Bull. 57, 263–274.

Written by Piotr Bajdek Leave a comment Posted in in English Tagged with Australia, biodiversity, coprolites, Cretaceous, mass extinctions, Permian, Russia, Triassic, USA