Life came closest to complete annihilation during the end-Permian mass extinction (EPME). Pattern and causes of this great dying have long been disputed, although many exciting results have been recently published. Similarly, there is also some debate on the recovery rate and pattern of marine organisms in the aftermath of the EPME. Some clades recovered rapidly, within the first 1–3 Myr of the Triassic. For example, ammonoids and conodonts diversified in the first 2 Myr of the Early Triassic, reaching apparently stable local diversities. Further, some earliest Triassic body and trace fossil assemblages are more diverse than predicted. The best example comes from foraminifera in the South China sections, where recovery began 1 Myr into the Triassic, and was not much affected by Early Triassic crises. Others, ie. Brachiopods, corals etc., however, did not rebound until the early Middle Triassic. In addition, although ammonoids recovered relatively rapidly, reaching a higher diversity by the Smithian than in the Late Permian, much of this Early Triassic radiation was within a single clade, the Ceratitina, and their morphological disparity did not expand until the end-Spathian.

Here, I like to broaden the modern ecological network model to explore the complete trophic structure of fossilized ecosystems during the Permo-Triassic transition as a means of assessing the recovery. During the Late Permian and Early Triassic, primary producers, forming the lowest trophic level, were microbes. The middle part of the food web comprises primary and meso-consumer trophic levels, the former dominated by microorganisms such as foraminifers, the latter by opportunistic communities (i.e. disaster taxa and some tracemakers), benthic shelly communities, and reef-builders. These were consumed by invertebrate and vertebrate predators, the top trophic level.

Latest Permian ecosystems usually had a healthy trophic structure from primary producer to top predator. These ecosystems seem not to be completely destroyed within one event, but collapsed following a stepwise model. Marine ecosystems immediately after the extinction were either microbialite buildups, formed from microbes associated with tiny gastropods and ostracods or high-abundance, low-diversity communities dominated by disaster taxa. Thus, marine ecosystems were degraded to a low level, typified by primary producers or opportunistic consumers.

In the Spathian, marine ecosystems comprised ever more diverse trace fossil assemblages, as well as biodiversity increases of some clades, coupled with the emergence of some high-tiering organisms such as crinoids, as well as rare predatory fishes and the first ichthyosaurs. However, benthic communities were still of low diversity and high abundance. In the middle-late Anisian, marine ecosystems were characterized by the common occurrence of reptile- and fish-dominated communities such as the Luoping biota in Yunnan, Southwest China, in which marine reptiles (ichthyosaurs, pachypleurosauras, thalattosaurs, prolacertiforms) diversified as top predators. With these top predators, Middle Triassic ecosystems added a new trophic level not seen in the Permian, when sharks, and not reptiles, had been top predators. Thus, ecosystems were constructed step by step from low level to top trophic levels through the early to middle Anisian, some 8–9 Myr after the crisis. Importantly, this was the time when the ‘coral gap’ and the ‘coal gap’ occurring in most areas ended. It should be noted that some elements representing the top trophic level of marine ecosystem structure rebounded rarely in Early Triassic, they constructed incomplete and unstable ecosystems, which could not develop sustainably and thus did not occur repetitively in younger strata.

In addition, the contrast between the extrinsic and intrinsic models exemplifies a wider debate about macroevolution — whether the key driver is the physical environment or biotic interactions. The ‘Red Queen’ model, the idea that large-scale evolution is driven mainly by ecosystem-scale biotic interaction, contrasts with the ‘Court Jester’ model, in which macroevolution is driven by unpredictable perturbations in the physical environment. Case studies on microbe-metazoan interactions and stratigraphic distributions in microbialite and matground ecosystems reveal that microbial bloom seems to have set an agenda for metazoan diversification in the aftermath of the EPME. This means that intrinsic dynamics may have played a crucial role driving marine ecosystem’s restoration following the EPME.