Recovery of Ecosystems After the Permian-Triassic Mass Extinction

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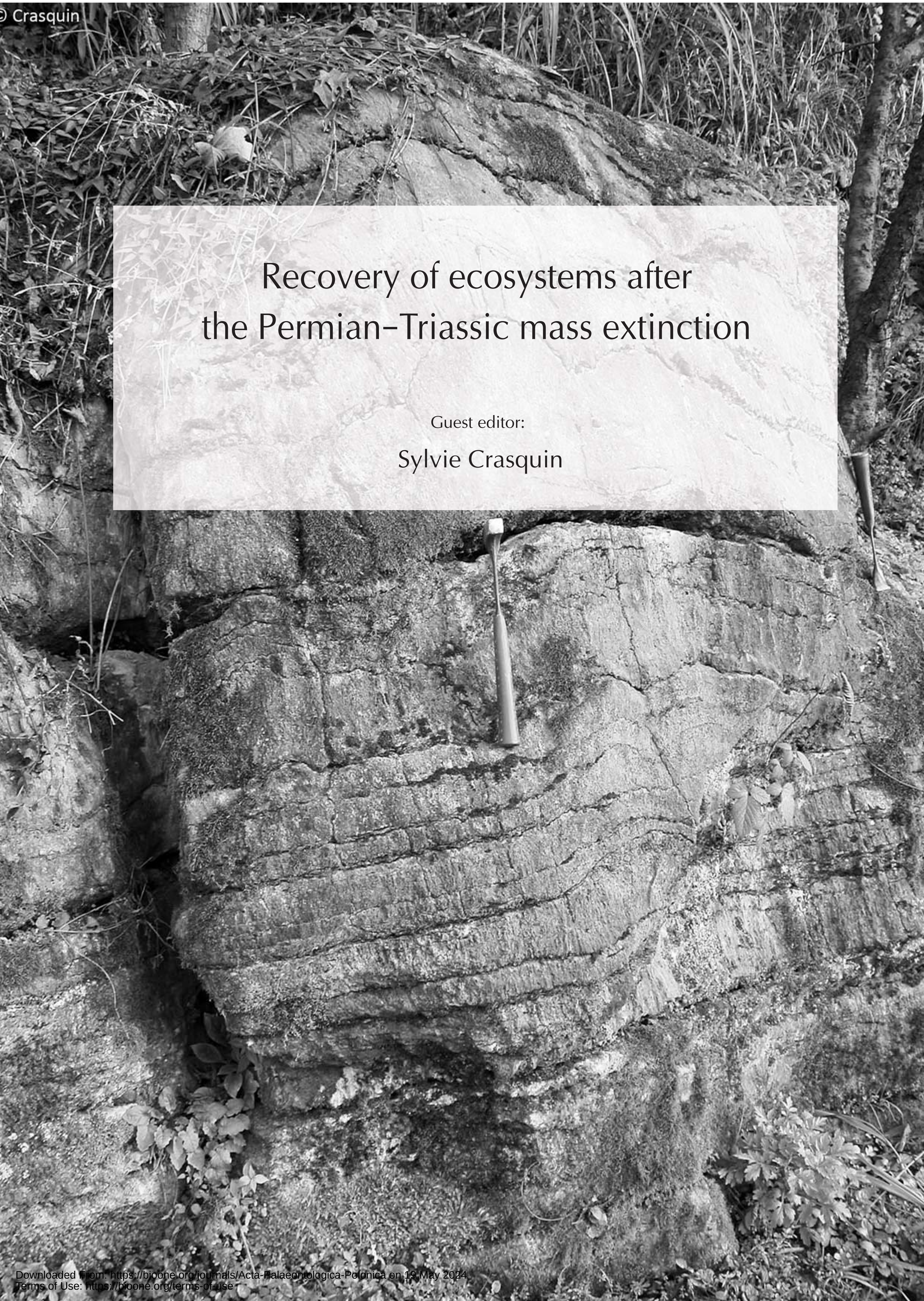
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Guest editor:

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We present here one of several publications arising from the IGCP 572 programme, "Recovery of ecosystems after the Permian-Triassic mass extinction" (2008–2012). The aims of IGCP 572 were to investigate the recovery of marine ecosystems following the end-Permian mass extinction (EPME) through analysis of the rock and fossil records. The four papers presented here illustrate part of the effort realised during the last four years in the analysis of recovery patterns of different fossil groups (micro- and macroinvertebrates, vertebrates) in large palaeogeographic areas (from western Palaeotethys to Eastern Panthalassa through NW Palaeotethys).

In their paper, M.B. Forel et al. analyse one of the most complete Permian–Triassic boundary (PTB) sections, located in the Bükk Mountains (Hungary). The Bálvány North section was sampled for ostracod study. Seventy-five species belonging to twenty genera are recognized. The number of superfamilies/families does not change from the Permian to the Triassic, although a decrease is recorded for the number of genera (from 17 to 14 genera) and species (from 54 to 36 species). At Bálvány North, the specific extinction rate is 74% (40 species extinct at PTB). It is significantly lower than the 99% recorded from the Meishan section in China, Global Stratigraphic Section and Point of the PTB. The loss of ostracod diversity is confined to the genus and species levels. Two successive patterns can be distinguished here among the surviving species: the first is documented by species which cross the PTB but disappear a few centimetres above the PTB; the second is recorded by seven (?nine) species with a longer range within the Early Triassic. It reflects two successive phases of survival for the ostracods that are associated with the stromatolites/microbialites at the Bálvány North section. The Bálvány North section exhibits the lowest extinction rate of all PTB sections studied for ostracods, and this is associated with a high level of endemism. Comparison of the Bálvány North section with the Meishan section (Zhejiang Province, South China) reveals discrepancies linked to the environmental setting and particularly to bathymetry.

In their paper, the analysis of Early Spathian benthic fauna from western United States allows Richard Hofmann et al. to establish that the oceanographic conditions at that time enabled ecosystems to rediversify after the Permian– Triassic events without major abiotic limitations. The Virgin Formation of SW Utah, USA contains the most diverse benthic fauna known in the Early Triassic, with bivalves, gastropods, brachiopods, echinoderms, and poriferans. A quantitative analysis of the fauna in close relationship with the environment allows the authors to discriminate between the effects of the EPME and the local environment on alpha diversity and ecological structure of the Virgin Formation fauna. Four associations and one assemblage delineate an environmental gradient from intertidal to subtidal habitats. There are no unusual environmental conditions during the Early Spathian that could impact on the rediversification of ecosystems. The generalised nature of the biota reflects low levels of competition rather than stressful environmental conditions.

In their paper, Zakarov and Mousavi Abnavi provide evidence for the recovery of ammonoids after the EPME in the Iran-Transcaucasia area, Siberia, Primorye, and Kazakhstan with original and published data. The Late Permian ammonoid assemblage changed drastically during the latest Permian. In Far East Russia, some Palaeozoic forms were recovered during the early Induan. This demonstrated the survival of these groups through the PTB and very fast migration to high latitudes with some representatives of typical Mesozoic families. Induan–Olenekian ammonoid assemblages illustrate the high rate of Early Triassic ammonoid recovery both in the Tethys and Boreal realms.

In the final paper, five new specimens of coelacanths are reported from the Middle Triassic of Yunnan, South China by Wen et al. Two new genera and species of Coelacanthiformes are described. Intrauterine embryos close to birth are observed in one specimen, the earliest evidence of ovoviviparity in coelacanths. A peak in the abundance of coelacanths in the Early Triassic when compared to the Late Permian and Middle Triassic could represent a preservational artifact, but it is interpreted here as evidence that coelacanths, rather unexpectedly, may have been post-extinction disaster taxa. There is no reason to suppose that Triassic coelacanths had physiologies and modes of life similar to the living form, but modern *Latimeria* lives in low-oxygen conditions, and there is substantial evidence for repeated episodes of anoxic sea-bottom conditions through the Early Triassic.

This small collection of papers provides novel evidence from around the world of conditions during the EPME, through the PTB, and during the crucial phases of recovery in the Early and Middle Triassic. These times, as has often been noted, represent one of the most important episodes in the history the Earth and of life. With current concerns about climate change through global warming, and loss of species following human activity, this largest of all mass extinctions can provide key evidence of how the Earth and life can respond to major and catastrophic environmental change.

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