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Special Issue "Renaissance for Paleozoic evolution studies: radiation and extinction": Preface

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Familiar landscapes with diverse biota first appeared on our planet through rapid biodiversification immediately after the termination of the Precambrian world, about 540 Myr ago. Since then the first 300 Myr of the Phanerozoic, i.e., the Paleozoic Era, witnessed irreversible changes in global environment in association with the expansion and diversification of eco-spaces, both on land and in the oceans. The causes and processes of this unidirectional evolutionary history during the Paleozoic have often been attributed to multiple punctuated episodes, each of which triggered global-scale environmental changes to constrain the direction of evolution. For example, the Cambrian explosion, the Great Ordovician Biodiversification Event (GOBE), and three major mass extinctions, at the end of the Ordovician, Devonian, and Permian, respectively, are attractive *clichés*/concepts for these unusual changes that have become extremely popular, not only among professional scientists, but also with journalists. Such elevated interest in Earth history was ignited by some iconic contributions; i.e., the Cambrian Explosion (Gould, 1989), the bolide impact story for the end-Cretaceous timing (Alvarez *et al.*, 1980), the visualization of long-term biodiversity patterns in a clear diagram (Raup and Sepkoski, 1982), and the snowball Earth hypothesis (Kirschvink, 1992; Hoffman and Schrag, 1998).

The search for possible causes/drivers of these "big events" of the Paleozoic has continued, yielding numerous scientific articles. In addition to extraterrestrial impact, several stimulating ideas such as ocean redox change and intermittent supervolcanism were proposed as possible key mechanisms during the 1990s; nonetheless, interest started to decline in this century. What remains at present is a huge pile of similar data produced by the same analytical techniques, particularly with various geochemical/isotopic proxies, and many similar discussions from almost the same viewpoints. This may reflect the current overemphasis on quantitative measures for evaluating research, such as the number of citations and journal impact factors, in the scientific community (Garfield, 1983; Bachhawat, 2002), or perhaps "groupthink" in academia.

To date, various proposed scenarios for biodiversification/extinction are yet not fully satisfactory, with too many *ad-hoc* assumptions; thus other explanations cannot be ruled out. To move forward from the currently saturated status of research, this field needs recharge of energy and reexamnination of fundamental assumptions.

This special issue of Paleontological Research is based on the symposium titled "**Renaissance for Paleozoic evolution studies: radiation and extinction**," which was held on February 7, 2020 at the Komaba Campus of The University of Tokyo. The main purpose of the symposium was to explore new approaches to old conundrums concerning the evolution of Paleozoic life, and, in particular, those major changes often described as episodic diversification and extinction events. By drawing attention to current research and its problems, the five papers in the special issue challenge old ideas and propose new perspectives. The special issue consists of two parts: Part 1, with the first three articles, in the current issue, and Part 2, with the remaining two papers, in a forthcoming issue. Here, I introduce the first three articles.

Zhang *et al.* (2021) point out the significance of the Cambrian ecosystem as a whole, and the utility of the facies-dependent integrative approach with regard to biodiversity, ecological network, climate, environmental trio, and biogeochemical cycles. As previous research on the early Cambrian biodiversification focused too much on metazoan evolution, we may have overlooked invisible but significant interactions between the abiotic and biotic (including microbial) realms during that time.

Servais *et al.* (2021) challenge recently published views concerning the Great Ordovician Biodiversification Event (GOBE). They criticize the naive dependence on apparently popular statistics, particularly on the diversity trend of various fossil groups, during the Ordovician time. By pointing out the crucial paleogeographical bias in the databases, they conclude that the GOBE was not a

single short-term event, as has been recently emphasized, but rather a more prolonged saga.

Lucas (2021) reviews the five major mass extinctions plus one in the Phanerozoic, concluding that no coeval extinction can be identified between marine and non-marine organisms, except perhaps for the end-Cretaceous case. He emphasizes that a large uncertainty still exists in taphonomic bias and resistance/resilience of terrestrial organisms, and that further analyses are therefore required.

Most of these messages may sound like anti-populism in paleontology, but these new notions are without doubt stimulating for opening new windows in the study of the evolution of Paleozoic life. For the attendees, the symposium was unforgettable in two ways. First, we could enjoy non-orthodox talks one after another, which enlightened and enlivened many young paleontologists in Japan; that is quite untraditional for the traditional Palaeontological Society of Japan. Second, it was challenging to run the symposium on site, particularly under the serious situation due to the emerging COVID-19 pandemic in early February 2020 in Tokyo. At that time, nobody could predict the subsequent lockdown of Tokyo for a long period, but for the sake of safety the organizing committee reluctantly decided to ask Prof. X. L. Zhang (Northwest Univ., China) to refrain from visiting Tokyo to attend the symposium. He kindly agreed with this request and instead prepared a high-quality video for his presentation. On the other hand, Profs. T. Servais (CRNS Univ. Lille, France), S. Lucas (New Mexico Mus. Natur. Hist., USA), and O. Obut (Trofimuk Inst. Petrol. Geol. Geophys, Siberian Branch, Acad. Sci., Russia) will be remembered as the last three brave foreign paleontologists to successfully visit Tokyo and return home in 2020 immediately before the Corona-outbreak. I would like to express my sincere thanks again to all the speakers (authors), the audience, the organizing committee of the symposium, and the Palaeontological Society of Japan.

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