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AN EXAMINATION OF LIFE HISTORY AND BEHAVIORAL EVOLUTION ACROSS THE EDIACARAN–CAMBRIAN TRANSITION

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With the 1859 publication of *On the Origin of Species*, Charles Darwin posed contention against his synthesis on the history of life. His dilemma specifically regarded that the geologically sudden appearance of complex shelly invertebrates at the Cambrian Explosion followed an incomprehensible absence of a long-standing gradual transition to such forms. Indeed, as quoted from Chapter 10 of the sixth edition, "To the question why we do not find rich fossiliferous deposits belonging to these assumed earliest periods prior to the Cambrian system, I can give no satisfactory answer… the difficulty of assigning any good reason for the absence of vast piles of strata rich in fossils beneath the Cambrian system is very great… The case at present must remain inexplicable; and may be truly urged as a valid argument against the views here entertained" (p. 286–288). In the 155 years since this assertion, paleontologists focusing on the strata of the Ediacaran–Cambrian transition have uncovered a rich evolutionary history prior to the radiation of animals, but our resulting discoveries have neither been without debate nor unraveled the intricacies suggested by Darwin's dilemma. While we are continuing to learn from both geological and paleontological records, the organisms, their expanding ecosystem intricacy, and the increasing complexity of their behaviors during the Ediacaran and Cambrian periods are yet not well understood. With rapidly growing data and ideas, this transition in evolutionary history has become one of the intellectually richest periods in our record of life on Earth.

Stemming from our topical session, *Fossil preservation, biological evolution, and environmental change at the dawn of animal radiation*, at the 2012 Geological Society of America Annual Meeting, we offer a compilation of new ideas and novel fossil discoveries within the Ediacaran and Cambrian periods, reaching from northwestern Canada and the western United States to Africa, South China, and Australia. The work presented herein focuses on two overarching themes within this transition: taphonomic and taxonomic detail of newly discovered and previously enigmatic fossils, and the evolution of behavioral complexity as witnessed in the trace fossil record. Of the 18 contributions herein, 14 were solicited directly from presentations given during our topical GSA session, and the other four were selected from thematically related submissions to the *Journal of Paleontology*. Of the solicited 14, the Ediacaran taphonomic and taxonomic contributions include: presentation of an exciting view of Ediacaran ecological complexity in a deep-water paleoenvironment from the Sheepbed Formation at Sekwi Brook in the Mackenzie Mountains of northwestern Canada (Narbonne et al., 2014); explication of the enigmatic taphonomic regime of mass-flow deposits via examination of the classic Ediacaran organism *Pteridinium simplex* from the Nama Group, Namibia (Meyer et al., 2014); description of a newly discovered benthic tubular organism, *Plexus ricei*, from the Rawnsley Quartzite, Australia (Joel et al., 2014); and presentation of a new branching and cellularly preserved algae, *Elainabella deepspringensis*, from the Esmeralda Member, Deep Spring Formation, Nevada, U.S.A. (Rowland and Rodriguez, 2014). In addition, Grazhdankin (2014) contributes a synthesis on the evolution of Ediacaran biotas, suggesting faunal turnover as a result of ecosystem engineering due to the evolution of bilaterian animals, which gradually outcompeted Ediacara organisms. Gehling et al. (2014) expound upon *Kimberichnus teruzzii*, the paired radular grazing scratches produced by and found in association with death masks of the trace-maker *Kimberella quadrata* in both Australian and Russian localities. Macdonald et al. (2014) illustrate complex U-shaped feeding traces from the Omkyk Member, Zaris Formation, Nama Group, Namibia. To close the Ediacaran contributions, Carbone and Narbonne (2014) depict a view of increasing trace fossil behavioral complexity through a continuous section of Ediacaran–Cambrian sediments from the Sheepbed through Ignta formations in northwestern Canada.

Passing into the Cambrian, but keeping with the theme of increasing trace complexity, Mochizuki et al. (2014) present analysis of a diachronous increase in trace fossil size and complexity in Cambrian successions in Newfoundland, South China, and western Mongolia. In addition, the contributions in Cambrian paleontology include: taphonomic and taxonomic analysis of simple discoidal fossils, akin to some Ediacaran forms such as *Tirasiana disciformis*, from the Taozichong Formation, Guizhou, South China (Yang et al., 2014); portrayal of two phosphatized small shelly fossils from basal Cambrian strata in southeastern Shaanxi Province, China (Moore et al., 2014); report of a new occurrence of the bivalved fossil *Apistoconcha* from the Xinji Formation, also in southeastern Shaanxi Province, China (Li et al., 2014); taphonomic and taxonomic discussion of possible animal embryos from the Shuijingtuo Formation, Hubei Province, South China (Broce et al., 2014); and assessment and description of the dithecoid graptolites *Archaeolafoea monegettae* and *Mastigograptus* sp., reported for the first time from the Wheeler and Marjum formations, respectively, of Utah, U.S.A. (LoDuca and Kramer, 2014).

Finally, the four thematically related reports include: microstructural and biogeochemical description of the soft-bodied and tubular *Sabellidites cambriensis* from the terminal Ediacaran Period (Moczydłowska et al., 2014); two accounts of new exceptionally preserved organisms from the Chengjiang Lagerstätte, Yunnan Province, South China, including a helmetiid arthropod, *Haifengella corona*, (Zhao et al., 2014) and a priapulid, *Eximipriapulus globocaudatus* (Ma et al., 2014); and discussion of the ontogeny of a new trilobite species, *Liostracina tangwangzhaiensis*, from the Gushan (Kushan) Formation, Shandong Province, North China (Park et al., 2014).

The integrated views into taphonomy, taxonomy, and behavioral complexity as presented herein will undoubtedly further expand our understanding of the interconnected facets contributing to the Cambrian Explosion, one of the most spectacular events in the evolutionary history of animals. It is our hope that this volume will stimulate continuing research and discoveries surrounding the Ediacaran–Cambrian transition, and will continue to strengthen the geological and paleontological foundation in an effort to elucidate the questions that had perplexed Darwin over a century and a half ago.

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REFERENCES

Broce, J., J. D. Schiffbauer, K. Sen Sharma, G. Wang, and S. Xiao. 2014. Possible animal embryos from the lower Cambrian (Stage 3) Shuijingtuo Formation, Hubei Province, South China. Journal of Paleontology, 88:385–394.

Carbone, C. and G. M. Narbonne. 2014. When life got smart: The evolution of behavioral complexity through the Ediacaran and early Cambrian of northwestern Canada. Journal of Paleontology, 88:309–330.

Gehling, J.G., B. N. Runnegar, and M. L. Droser. 2014. Scratch traces of large Ediacaran bilaterian animals. Journal of Paleontology, 88:284–298.

Grazhdankin, D. 2014. Patterns of evolution of the Ediacaran soft-bodied biota. Journal of Paleontology, 88:269–283.

Joel, L.V., M. L. Droser, and J. G. Gehling. 2014. A new enigmatic, tubular organism from the Ediacara Member, Rawnsley Quartzite, South Australia. Journal of Paleontology, 88:253–262.

Li, G., Z. Zhang, H. Hua, and H. Yang. 2014. Occurrence of the enigmatic bivalved fossil *Apistoconcha* in the lower Cambrian of southeast Shaanxi, North China Platform. Journal of Paleontology, 88:359–366.

LoDuca, S. T. and A. Kramer. 2014. Graptolites from the Wheeler and Marjum formations (Cambrian, Series 3) of Utah. Journal of Paleontology, 88:403–410.

Ma, X., R.J. Aldridge, David J. Siveter, Derek J. Siveter, X. Hou, and G. D. Edgecombe. 2014. A new exceptionally preserved Cambrian priapulid from the Chengjiang Lagerstätte. Journal of Paleontology, 88:371–384.

Macdonald, F. A., S. B. Pruss, and J. V. Strauss. 2014. Trace fossils with spreiten from the late Ediacaran Nama Group, Namibia: Complex feeding patterns five million years before the Precambrian–Cambrian boundary. Journal of Paleontology, 88:299–308.

Meyer, M., D. Elliott, J. D. Schiffbauer, M. Hall, K. H. Hoffman, G. Schneider, P. Vickers-Rich, and S. Xiao. 2014. Taphonomy of the Ediacaran fossil *Pteridinium simplex* preserved three-dimensionally in mass flow deposits, Nama Group, Namibia. Journal of Paleontology, 88:240–252.

Mochizuki, T., T. Oji, Y. Zhao, J. Peng, X. Yang, and S. Gonchigdorj. 2014. Diachronous increase in early Cambrian ichnofossil size and benthic faunal activity in different climatic regions. Journal of Paleontology, 88:331–338.

Moczydłowska, M., F. Westall, and F. Foucher. 2014. Microstructure and biogeochemistry of the organically preserved Ediacaran metazoan *Sabellidites*. Journal of Paleontology, 88:224–239.

Moore, J. L., S. M. Porter, and G. Li. 2014. Two unusual small shelly fossils from the lower Cambrian of southeastern Shaanxi Province, China. Journal of Paleontology, 88:348–358.

Narbonne, G. M., M. Laflamme, P. W. Trusler, R. W. Dalrymple, and C. Greentree. 2014. Deep-water Ediacaran fossils from northwestern Canada: Taphonomy, ecology, and evolution. Journal of Paleontology, 88:207–223.

Park, T.-Y., J.-H. Kihm, I. Kang, and D. K. Choi. 2014. Ontogeny of a new species of the Cambrian Series 3 (middle Cambrian) trilobite genus *Liostracina* Monke, 1903 from North China and the taxonomic position of the superfamily Trinucleoidea. Journal of Paleontology, 88:395–402.

Rowland, S. M. and M. G. Rodriguez. 2014. A multicellular alga with exceptional preservation from the Ediacaran of Nevada. Journal of Paleontology, 88:263–268.

Yang, X., Y. Zhao, W. Wu, Z. Sun, H. Zheng, and Y. Zhu. 2014. Affinities and taphonomy of a Cambrian discoid from Guizhou, South China. Journal of Paleontology, 88:339–347.

Zhao, F., S. Hu, H. Zeng, and M. Zhu. 2014. A new helmetiid arthropod from the early Cambrian Chengjiang Lagerstätte, southwest China. Journal of Paleontology, 88:367–370.