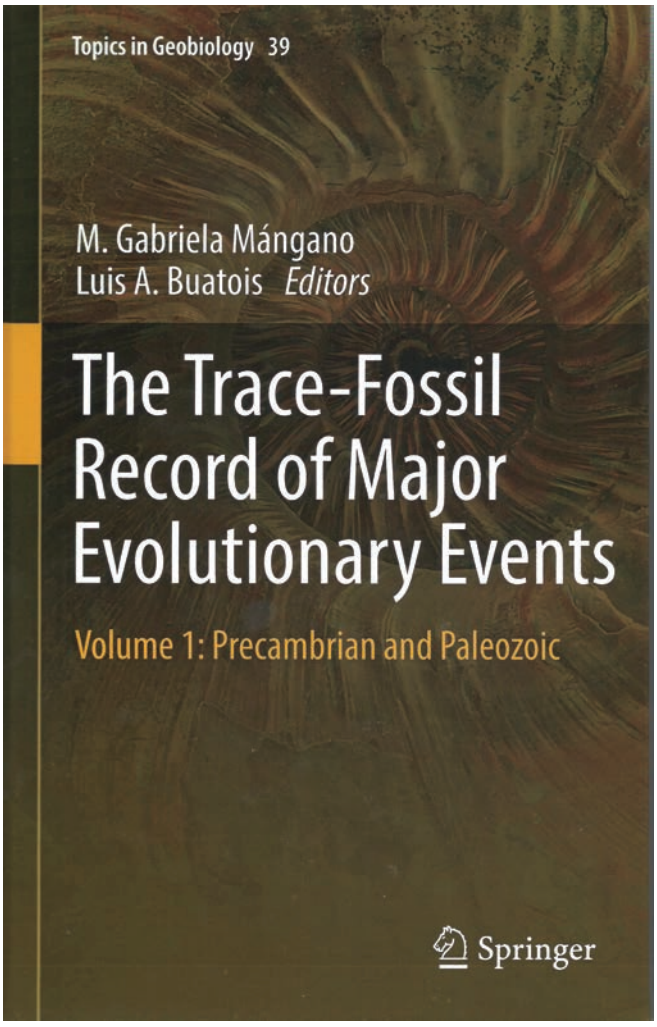
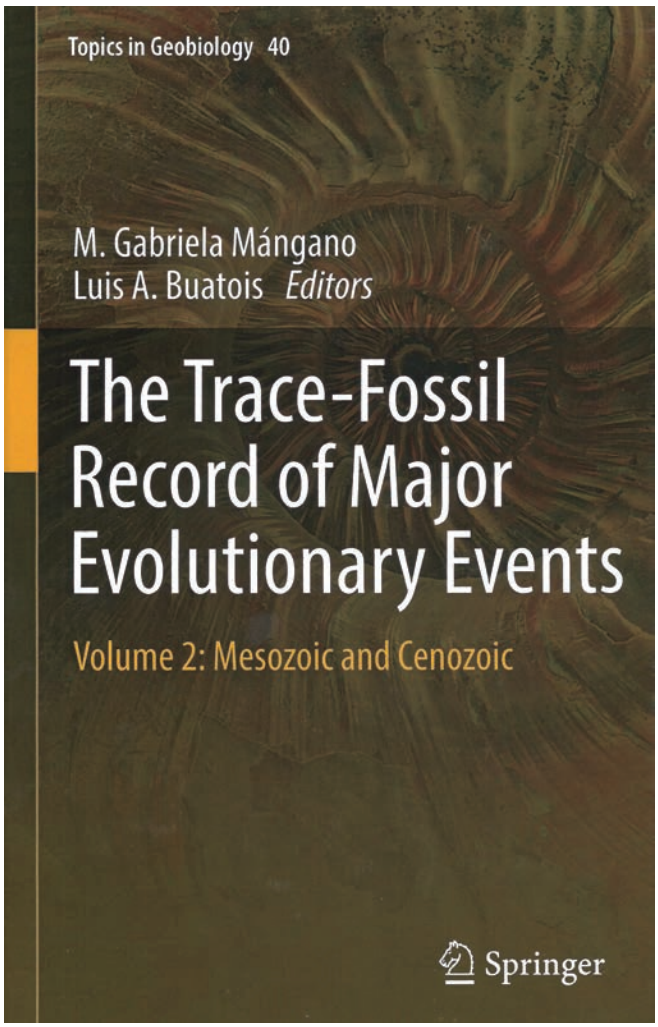
SPANISH JOURNAL OF PALAEONTOLOGY

BOOK REVIEW

M. Gabriela Mángano & Luis A. Buatois (eds) (two volumes). 2016. *The trace-fossil record of major evolutionary events. Volume 1: Precambrian and Paleozoic*. Springer. Topics in Geobiology, 39, 358 pp. (ISBN 978-94-017-9599-9).
The trace-fossil record of major evolutionary events. Volume 2: Mesozoic and Cenozoic. Springer. Topics in Geobiology, 40, 485 pp. (ISBN 978-94-017-9596-8).





Over time, ichnology has become a very important tool both in palaeontology as in sedimentary geology (e.g. ecologic, stratigraphic, sedimentological, facies analysis, sequence stratigraphy and/or palaeoenvironmental studies). From pioneer descriptive attempts (right or not) to their modern conception, trace fossils have attracted the attention of many scientists from both sedimentological as biological points of view (Baucon *et al.,* 2012). Once trace fossils were considered and globally accepted as the manifestation (on or within a substrate) of different types of fossil behaviours, one of the key moments in the ichnology´s history was the proposal of the 'ichnofacies model' by Seilacher (1954; see also Buatois & Mángano, 2011 and references therein). From this model, i.e. 'groups of trace fossils (ichnocoenoses) produced under similar palaeoenvironmental conditions and recurrently through time', the time concept was introduced in ichnology as a key to use trace fossils as facies indicators. Over the years, this model has been expanded and refined, and constituted an essential tool on ichnological studies (see Buatois & Mángano, 2011 and references therein).

By contrast, less attention has been paid to those studies focused on the relation of trace fossils and evolutionary processes as well as to those concentrated on the different

https://doi.org/10.7203/sjp.32.1.17041

'tracemaker-substrate' interactions occurred through time. Additionally, since one of the 'ichnological principles' (e.g. Ekdale *et al.,* 1984) stated that the stratigraphic range of trace fossils is commonly long, its respective use (with exceptions) on these topics has been limited (e.g. in biostratigraphy). In that sense, the new book "The trace-fossil record of major evolutionary events", edited and coauthored by M.G. Mángano and L.A. Buatois, fills that void and constitutes a new essential contribution in the study and understanding of ichnology in relation with the evolutionary events occurred through life´s history.

The book consists of two meticulous volumes: volume 1 with 358 pages, 109 figures and 5 tables; and volume 2 with 485 pages, 93 figures, and 7 tables. Both volumes are clearly and perfectly structured in chronological order.

The first volume, entitled *'Precambrian and Paleozoic'*, is divided in seven chapters. In Chapter 1, Minter *et al.* carry out a clear and concise exposition about the current conceptual and methodological framework of ichnology, providing the reader with the basis for understanding the rest of the book. After this first introductory chapter, the reader may feel like *H. George Wells* (Rod Taylor in the science fiction film *The time machine,* 1960) traveling aboard his time machine and jumping from era to era; fortunately for the reader, the 'subterranean beings' that we will find throughout this time travel/book are much less dangerous than *morlocks*. Having said that, Buatois & Mángano (Chapter 2) go back to the Precambrian and expose an updated review of the Ediacaran trace-fossil record in order to provide new insights on the knowledge of this awakening animal life and its respective Neoproterozoic ecosystems. In Chapter 3, since the body-fossil record is shown as discontinuous and/or incomplete along the Ediacaran-Cambrian boundary, Mángano & Buatois discus about the importance of the ichnological record (much more continuous) in the understanding of the Cambrian explosion from a chronological and palaeoenvironmental point of view and basing on changes observed in ichnodiversity and ichnodisparity along this transition. In Chapter 4, Mángano *et al.* review the Great Ordovician Biodiversification Event from an ichnological perspective, i.e. changes in burrowing and boring behaviors, colonization of new infaunal habitats, patterns on sedimentary palaeoenvironments or best understanding of unpreserved soft-bodied organisms. Chapter 5, by Minter *et al.,* examines all details related to the different behavioural interactions between animals and sediments that took place, during the Ediacaran to Ordovician, as early attempts to colonize the land. After these first steps onto land, Minter *et al.* (Chapter 6) perform an exhaustive review of the Silurian-to-Permian trace-fossil record, emphasizing those aspects related to the gradual establishment of continental ecosystems and the subsequent behavioural changes occurred in order to colonize these new infaunal ecospaces. Finally, this volume ends with Chapter 7, wherein Hofmann reviews the most dramatic and devastating event in the life's history, the end-Permian mass extinction, from an ichnological point of view and with special emphasis on its relationship with geochemical, biological and modern-day ecological aspects.

The second volume, named *'Mesozoic and Cenozoic'*, comprises nine chapters. Barras & Twitchett begin this volume (Chapter 8) examining the terrestrial and marine trace-fossil record across the Triassic-Jurassic boundary as well as their subsequent changes (e.g. in diversity, architectural pattern, size, palaeoenvironment) after the Late Triassic extinction event. In Chapter 9, Buatois *et al.* carry out an extensive and thorough review of the tracemakers involved in the so-called Mesozoic Marine Revolution, its respective trace-fossil record and the related aspects inferred from behavioural, infaunal, environmental, and/or palaeogeographic changes. Following, Bernardi *et al.* (Chapter10) perform a chronological review of the Mesozoic reptile tracks, highlighting its importance in the understanding of palaeogeographic, palaeoenvironmental, and/or palaeobiological aspects such as the evolution of posture from quadrupedalism to bipedalism, evolution of locomotory mechanisms, estimation of trackmaker's speeds, or inference of social behaviours. Chapter 11, by Buatois *et al.,* inspects the body- and trace-fossil records during the commonly known as Mesozoic lacustrine revolution, and even its aftermath during the Cenozoic, in order to get a better knowledge on this major evolutionary event. They pay special attention on the evolutionary novelties and innovations that took place through such period/event. In Chapter 12, Labandeira *et al.* review one of the major crises in the history of life, the end-Cretaceous extinction, from an ichnological point of view and in relation to its consequences in the marine and continental realm. Next, Genise *et al.* (Chapter 13) carry out an exhaustive review of the evolution of paleosol ichnofacies during the Phanerozoic describing their respective trace fossil compositions and the typical sedimentary environments to which are associated. In Chapter 14, Krapovickas & Vizcaíno examine the Mesozoic and Cenozoic record of mammal footprints, with special emphasis on the Cenozoic radiation of mammals occurred in South America. Finally, our time travel ends with the study of the footprints left by our ancestors and by ourselves. Lockley *et al.* (Chapter 15) present all aspects related to the ichnological study of hominin evolution, from early bipedalism (Laetoli, Africa) to the boot tracks and traces left on the Moon and even Mars (traces produced by human-manipulated machines). To conclude this second volume and from a more generalist or nomothetic perspective, Buatois & Mángano (Chapter 16) discuss about the evolution of organism-substrate interactions through time, trying to identify possible recurrent trends or patterns in evolutionary palaeoecology.

In conclusion, together with the two volumes reviewed herein, previous books by Buatois *et al*. (2002) and by

Buatois & Mángano (2011), as well as recent works focused in the ichnodisparity concept (e.g. Buatois *et al.,* 2017), have consolidated the work of L.A. Buatois and M.G. Mángano (University of Saskatchewan, Canada) as one of the pillars of modern ichnology. Therefore, thanks to their active, prolific and high-quality scientific activity, these authors have amply met the expectations founded with this new book.

REFERENCES

Baucon, A., Bordy, E., Brustur, T., Buatois, L.A., Cunningham, T., De, C., Duffin, C., Felleti, F., Gaillard, C., Hu, B., Hu, L., Jensen, S., Knaust, D., Lockley, M., Lowe, P., Mayor, A., Mayoral, E., Mikuláš, R., Muttoni, G., Neto de Carvalho, C., Pemberton, S.G., Pollard, J., Rindsberg, A.K., Santos, A., Seike, K., Song, H., Turner, S., Uchman, A., Wang, Y., Yi-ming, G., Zhang, L. & Zhang, W. 2012. A history of ideas in ichnology. In: *Trace Fossils as Indicators of Sedimentary Environments* (eds Knaust, D. & Bromley, R.G.). Developments in Sedimentology, Elsevier, 64, p. 3–43.

Buatois, L.A. & Mángano, M.G. 2011. *Ichnology: Organism-Substrate Interactions in Space and Time*. Cambridge University Press, Cambridge.

Buatois, L.A., Mángano, M.G. & Aceñolaza, F.G. 2002. *Trazas fósiles: Señales de Comportamiento en el Registro Estratigráfico*. Museo Paleontológico Egidio Feruglio, Trelew, Argentina.

Buatois, L.A., Wisshak, M., Wilson, M.A. & Mángano, M.G. 2017. Categories of architectural designs in trace fossils: A measure of ichnodisparity. *Earth-Science Reviews*, 164, 102–181; doi: 10.1016/j.earscirev.2016.08.009.

Ekdale, A.A., Bromley, R.G. & Pemberton, S.G. 1984. *Ichnology, Trace Fossils in Sedimentology and Stratigraphy*. Society for Sedimentary Geology, Short Course Notes, 15.

Seilacher, A. 1954. Die Geologische Bedeutung Fossiler Lebensspuren. *Zeitschrift Deutschen Geologische Gesellschaft*, 105, 214–227.

Zain BELAÚSTEGUI
Dept. de Dinàmica de la Terra i de l'Oceà,
Facultat de Ciències de la Terra, Universitat de Barcelona, c/Martí i Franquès s/n.
08028 Barcelona (Spain)
zbelaustegui@ub.edu