



The 4th International Congress on Ichnology: outstanding progresses in space and time

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Under the scope of the United Nations Decade for Biodiversity, following the aims of the Geosciences International Program of UNESCO-IGCP, and mainly the subject Global Change and the Evolution of Life - Evidence from the geological record, and at the closing of the Decade of Education for Sustainable Development, the 4th International Congress on Ichnology was a joint organization of the International Ichnological Association, the Geopark Naturtejo da Meseta Meridional - UNESCO Global Geopark and the National Museum of Natural History and Science of the University of Lisbon. This congress, under the general theme “Ichnology for the 21st century” was held for the first time in Portugal at the Technical University of Castelo Branco, College of Management at Idanha-a-Nova. 150 ichnologists coming from 30 countries from all continents attended to one more successful ichnological congress.

The theme provided a discussion among peers upon traces (fossils) as biological behavior patterns preserved in sediments and rocks, including innovative applications of trace fossils in multidisciplinary research and the in loco protection of the ichnosites fostering sustainable development of the regions where they are found and projected as new interpretive tools for schools and tourists. Beyond that, trace fossils recall the response of organisms to environmental physical and chemical dynamic parameters, as well as the interaction with other members of the same population or community as part of the (palaeo)ecosystem where they belong to. Ichnology as scientific discipline of Palaeontology is devoted to the study of behavior and its evolution in the fossil record, through the trace fossils. The Palaeolithic-to-present societies of hunter-gatherers have been applying techniques and reasoning that are basically part of modern Ichnology. The scientific background of this science comes back to Leonardo da Vinci and includes the pioneer palaeontologist and geologist in Portugal, the General Nery Delgado, in the 1800s as one of the backbones for the development of modern Ichnology. As scientific area that constantly bridges Geosciences with Biological Sciences, Ichnology shows significant importance for the modern Society including a range of interests as broad, cutting-edge and sensational, as oil and groundwater reservoirs prospection and exploitation, the development of dynamic

models for biological evolution and mass extinctions, to the reconstitution of the steps made by the first hominids and the conservation of historical and archaeological materials. The protected ichnological sites may also show strong revenue for education in science and social and economic development of local communities, through the burst of a responsible and sustainable niche of Nature Tourism which is Geotourism. It is worth to mention in Portugal several dinosaur tracksites nature monuments and invertebrate fossil sites protected in Geoparks recognized by UNESCO.

The invitation addressed by the International Ichnological Association to the editors of the present Thematic Issue of BSPI to organize the 4th International Congress on Ichnology resulted from the work that has been carried out by the team of the Geological Survey of Idanha-a-Nova together with several external experts, both national and from abroad, with several contributions in the latest years for Ichnology as scientific discipline, in general, and for the Ichnology of Portugal, in particular, namely in the research and protection of Penha Garcia Ichnological Park. With the inclusion of Naturtejo Global Geopark in the UNESCO Global Geoparks for which decisively contributed the protection and valuing of this geological heritage, Penha Garcia is nowadays getting both national and international recognition and appreciation. In this way, with the organization of the 4th International Congress on Ichnology, the Organizing and Scientific Committees brought Ichnology closer to Portuguese Academy and Society, by creating the good environment for innovation to the challenges that presently the country and society are facing, and that are included under the purposes of the equation Science, Technology, Society, Environment for science education, thus contributing for smart and inclusive growth sustained in the strategy Europe 2020.

The Thematic Issue of the BSPI comes by natural selection after the great results of Ichnia 2016. Following the challenge of the Società Paleontologica Italiana, with the very professional support and rigorous work of BSPI's Editor-in-Chief, Annalisa Ferretti, this Thematic Issue has a broad geographical spectrum and brings a wide range of ichnological subjects, starting from the

history of Ichnology and covering the Phanerozoic till the application of innovative techniques in neoichnological research. The volume starts by celebrating 100 years' contribution of Portugal to the study of dinosaur ichnology (Santos, this issue) and is followed by an analysis of the Edward Hitchcock's interpretations on the origin of the treptichnids in the "Age of Fucoids" (Goldstein et al., this issue). Then the Thematic Issue is organized by stratigraphic order which begins with the *Diplocraterion* from the Middle Cambrian of Henan, China, occurring in intertidal deposits and showing equilibrium behavior (Zhang et al., this issue); the Lower Ordovician siliciclastic Lashkerak Formation from Northern Iran provides a great opportunity to discriminate the environmental factors affecting benthic communities, reflected in ichnocoenoses, between wave-dominated open marine and wave-influenced delta settings (Bayet-Goll & Neto de Carvalho, this issue); the Middle Ordovician Volkhov carbonate hardgrounds from St. Petersburg, Russia are considered of cyanobacterial biofilm or incipient mat origin (Rozhnov, this issue); the ichnogenus *Herradurichnus* is revised in its type section Balcarce Formation, from the early Silurian of Argentina (Gutiérrez et al., this issue); finally, an exceptional occurrence of a completely articulated chiton at the end of its trail is described for the first time and found in the Visean of the Moravia-Silesia Region, Czech Republic (Mikuláš et al., this issue). For the Mesozoic Era, and after decades of neglect, the Subeng ichnosites from the Upper Triassic lower Elliot Formation, Lesotho, are restudied in light of the advances in ichnological methods (Bordy et al., this issue); a new dinosaur ichnosite was found in one of the summits of the Dolomites belonging to the Lower Jurassic Calcarei Grigi Group in Italy, which expands the area of movement of these vertebrates in the Trento Platform (Belvedere et al., this issue); theropods with bird-like feet are described in the Imilchil Formation (Middle Jurassic) from Central High Atlas, Morocco resembling forms described in the lower Elliot Formation of Lesotho (Gierliński et al., this issue); image digital analysis techniques are applied for the identification of an ornithopod footprint in the Lower Cretaceous Papo-Seco Formation from Portugal (Figueiredo et al., this issue); in the upper Maastrichtian of Central Poland was found the exceptionally preserved, rosette-shaped, endolithic trace fossil *Dendrina belemniticola* (Schnick, this issue). Already in the Cenozoic, a rich ichnocoenosis allows to differentiate bottom nepheloid layers from typical muddy turbidites in the Eocene of Scaglia Toscana Formation, Italy (Monaco et al., this issue); lower frequency of turbidite events in the transition from submarine slope to basin plain is responsible for a high ichnodiversity in the upper Eocene Ceylan Formation, NW Turkey (Demircan & Uchman, this issue); Based on the finding of anthropic artifacts in the Roccamonfina volcano, Central Italy, it is discussed the importance of a multidisciplinary approach to the study of human tracks, based on some, sometimes convincing, human-like tracks which proved to have had an anthropic, or man-controlled origin (Panarello et al., this issue); finally, a case study in unconsolidated carbonates on San Salvador Island, The Bahamas, utilized high-frequency georadar imaging demonstrating rapid and effective assessment of the spatial distribution and gross

geometry of comparable biogenic structures in a variety of environments and substrates (Kopcznski et al., this issue).

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