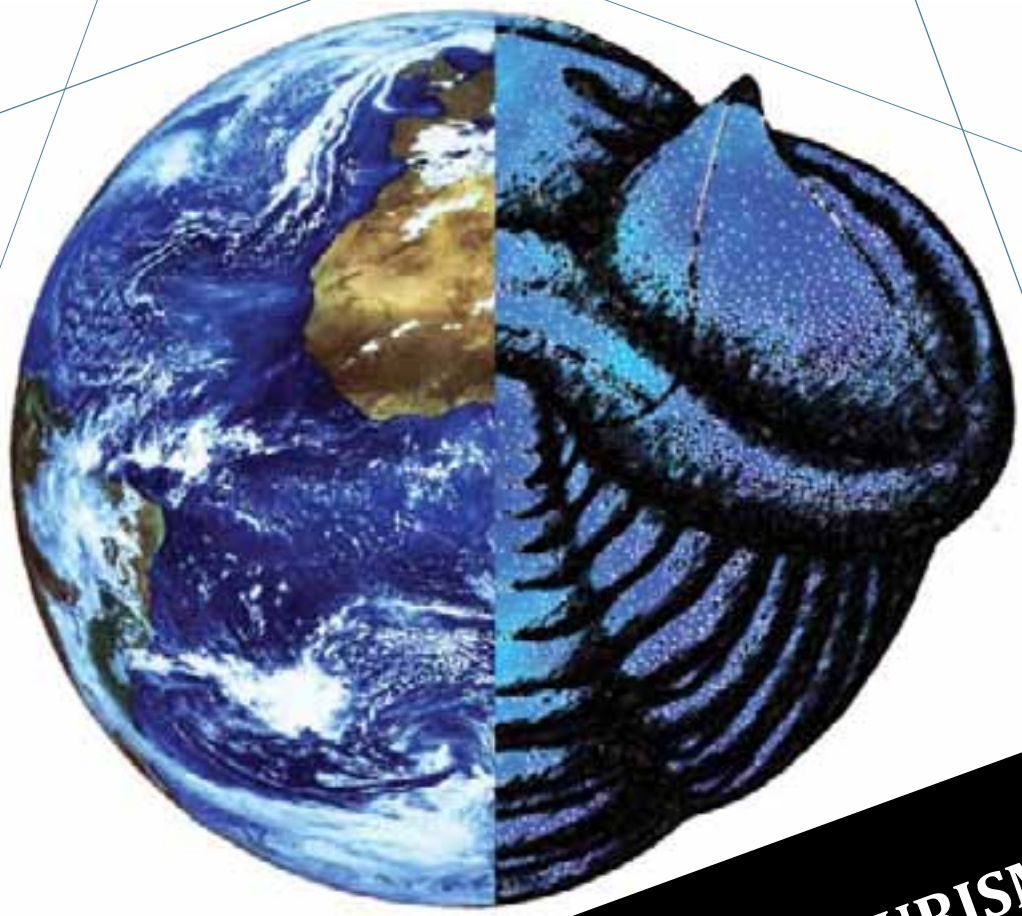

NEW CHALLENGES WITH GEOTOURISM

PROCEEDINGS OF THE VIII EUROPEAN GEOPARKS CONFERENCE

Idanha-a-Nova, 14-16 September 2009 (Portugal)

C. Neto de Carvalho & Joana Rodrigues (Eds.)

TITLE
New Challenges with Geotourism

EDITORS
Carlos Neto de Carvalho & Joana Rodrigues

EDITION
Idanha-a-Nova Municipality/ Geopark Naturtejo da Meseta Meridional

8th European Geoparks Conference Logo by
Andrea Baucon

DESIGN AND GRAPHIC COMPOSITION
ESCALA VERTICAL, Lda.
cristinafatela@gmail.com

PRINTED AND BOUNDING BY
PRINTMOR IMPRESSORES, Lda.

COPIES
500 ex.

LEGAL DEPOSIT
298910/09

ISBN
978-972-8285-52-4

ORDOVICIAN ICHNOFOSSILS: A NEW SCIENTIFIC AND EDUCATIONAL RESOURCE FOR THE AROUCA GEOPARK

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In the area of Arouca Geopark 41 geosites were identified, mainly related with Pre-Variscan and Variscan geological occurrences (Sá *et al*., 2008). One of the most impressive geopark' geosites is the "Valério's Quarry", where samples of the the biggest trilobite fossils have been recovered during the latest years (Gutiérrez-Marco *et al*., 2009). Regarding Variscan occurrences, geosites are mostly associated with plutonic rocks and with gold and wolfram mineralisation (Sá *et al*., 2008). From a paleontological point of view, Middle Ordovician and Lower Silurian invertebrate remains (Gutiérrez-Marco & Sá, 2006, 2008), as well as some trace fossils from the "Armorican Quartzite" (Gutiérrez-Marco & Sá, 2006; Sá *et al*., 2006, 2007; Aceñolaza *et al*., 2008) constitutes the most important fossil record of the Arouca Geopark.

Inside the European Geoparks Network, Paleozoic trace fossils have also particular scientific, educational importance in the Naturtejo Geopark (Ordovician, Portugal) and in the English Riviera Geopark (Permian, UK). Regarding the Arouca Geopark, previous and recent research shows that the Ordovician trace fossils have high scientific and educational value because they supply important data about the behaviour of organisms that lived more than 465 million years ago. In the Arouca Geopark seven geosites with trace fossils have been identified so far, six of them in Lower Ordovician rocks (Meitriz, Mourinha, Cabanas Longas, Vilarinho, Gralheira d'Água and Vila Cova) and one in Middle Ordovician rocks (Valério's Quarry).

The Floian (Lower Ordovician) icnofossils occur in the Santa Justa Formation (a local equivalent of the Armorican Quartzite) developed within the *Skolithos* and *Cruziana* ichnofacies. This formation was deposited in coastal marine environments with shallow waters during a transgressive event. The ichnological record corresponds to diverse ichnogenera interpreted as locomotion, feeding, dwelling and resting traces, such as *Arenicolites*, *Bergaueria*, *Cruziana*, *Daedalus*, *Didymaulichnus*, *Diplocraterion*, *Monocraterion*, *Monomorphichnus*, *Palaeophycus*, *Planolites*, *Rosselia*, *Rusophycus* and *Skolithos.* Amongst these traces, the ones with particular interest are *Cruziana imbricata*, a rare age-diagnostic Floian form, and *Rosselia socialis* because it represents the second Portuguese record of the ichnospecies. Some of these occurrences were identified in vertical strata forming hypichnial surfaces of several square meters, which allow the visitors to understand the intense biological activity on the old marine bottom.

The rocks of the Valongo Formation (Darriwilian, Middle Ordovician) are represented by massive shales and slates formed in neritic, disaerobic environments, that gradually changed to more oxygen-rich conditions. The trace fossils recorded in

the slates are concentric pascichnia traces (*Rotundusichnium*), complex branched burrows (*Chondrites*, *Cladichnus*?, *Phycodes*), single burrows sometimes with meniscate infill (*Taenidium*) and aggregates of fecal pellets (*Tomaculum*). In more oxygenated sediments the trace fossils assemblage changed into single, burrows (*Palaeophycus*, *Sericichnus*?), irregular burrows coloured by iron oxides (*Trichichnus*), and intricate

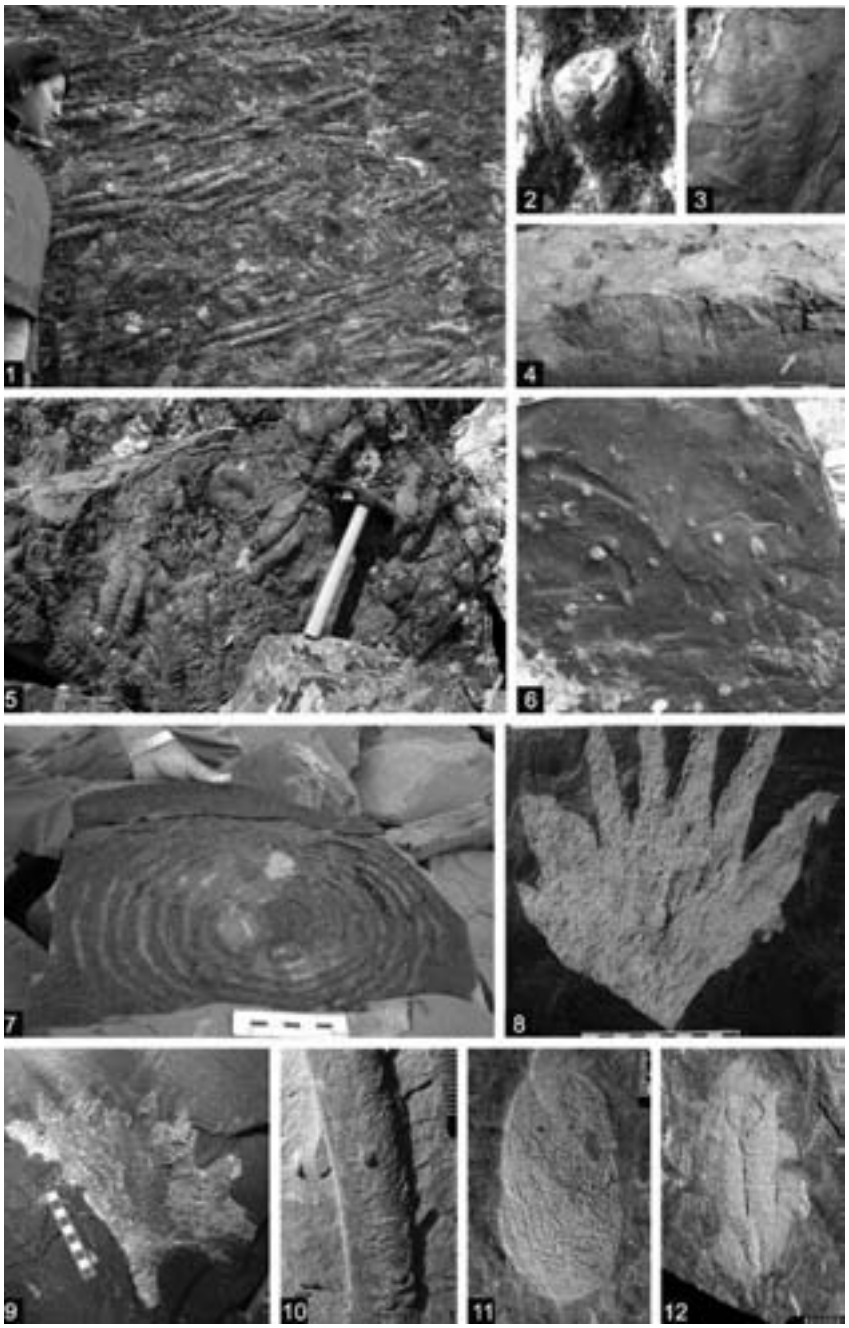

Figure 1: Ordovician ichnofossils of the Arouca Geopark. **1 -** Vertical hypicnial surface covered by *Cruziana* ispp.; **2 -** *Bergaueria radiata* Alpert, 1973 (x 0,6); **3 -** *Rusophycus carleyi* (James, 1885) (x 0,4); **4 -** *Rosselia socialis* Dahmer, 1937 (x 0,5); **5 -** *Cruziana rugosa* d'Orbigny, 1842 (x 0,1); **6 -** *Skolithos linearis* Haldeman, 1840 (x 0,2); **7 -** *Rutundusichnium* isp. (x 0,3); **8** and **9 -** *Phycodes noha* Mikulás, 1992 (8, x 25; 9, x 0,2); **10 -** *Taenidium* cf. *planicostatum* (Ksiazkiewicz, 1977) (x 0,8); **11 -** *Arachnostega gastrochaenae* Bertling, 1992 (x 0,5); **12 -** Praedichnion indet. (x 0,8).

galleries (*Arachnostega*), the last ones excavated in the infilling of mollusc shells and trilobites. There are also some evidences of bioerosion, represented by triangular bite marks on trilobites and mollusc remains, probably made by large predators like the orthoconic nautiloids. Among the mid-Darriwilian ichnofossils two ichnotaxa deserve special interest. The first one represents the oldest record for *Rotundusichnium*, a trace fossil previously known in deep sediments from Upper Cretaceous to Eocene. Thus, the Arouca record precludes in about 400 million years the normal record of the ichnogenus. The second remarkable trace fossil is *Phycodes noha*, an ichnospecies being so far recorded in the Klabava Formation (Floian – early Darriwilian) of Bohemia (Czech Republic). The Arouca specimens of *P. noha* are partially infilled by *Tomaculum problematicum*, which represents a novelty regarding the Bohemian specimens.

The richness and diversity of the Ordovician trace fossils (Fig.1) has a particular importance for science and for the new educational programs that will be implemented in the near future in the Arouca Geopark. The possibility for students and general public to act like "geodetectives" discovering not only the fossil organisms but also their behaviour throughout the study of its characteristic living traces, constitutes a major attraction that will be used to enhance the educational and touristic programs at the Arouca Geopark.

Acknowledgments

This work is a contribution to projects PTDC/CTE-GEX/64966/2006 (Portugal) and CGL2006-07628/BTE (Spain).

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