ICHNOLOGICAL EVIDENCE FOR GIANT ORNITHOPOD DINOSAURS IN THE LATE JURASSIC LOURINHÃ FORMATION, PORTUGAL

Octávio MATEUS\textsuperscript{1,3} and Jesper MILÂN\textsuperscript{2}

\textsuperscript{1}Museu da Lourinhã, Rua João Luís de Moura, 2530-157 Lourinhã, Portugal, e-mail: omateus@museulourinha.org; \textsuperscript{2}Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark, e-mail: milan@geol.ku.dk; \textsuperscript{3}Universidade Nova de Lisboa, Faculdades de Ciências e Tecnologia, Centro de Estudos Geológicos, Monte de Caparica, Portugal.

The Late Jurassic Lourinhã Formation contains a diverse dinosaur fauna comprising theropods, sauropods, stegosaurs, ankylosaurs and several genera of ornithopods. The sedimentology in the area favours preservation of footprints, and footprints from most of the dinosaurs represented by skeletal remains are present in the area. During fieldwork in the summer of 2003 a new, large, tridactyl footprint was found at the beach of Vale Frades, approximately 6 km north of Lourinhã, Portugal. The footprint was found together with a stegosaur footprint on a clay bed exposed within the tidal zone. The footprints were preserved as sandstone casts standing on a pedestal of clay. This unusual type of preservation is the result of the footprints having first been emplaced in clay, and then filled with sand. During the present day erosion from the sea, the harder sandstone cast of the footprints protects the subjacent clay layers from erosion. Owing to the immediate danger of erosion of, the footprint was collected and is now on display at Museu da Lourinhã (ML 1000). The footprint is 70 cm long and 69 cm wide, the toes are short and broad, with indications of short blunt claws. The divarication angle between the outer digits is close to 90 degrees. The dimensions and general morphology of the footprint identifies it as deriving from an ornithopod dinosaur with an estimated hip height of 4.13 metres. Although very large ornithopods are known from the Cretaceous, the largest known Jurassic ornithopod is \textit{Camptosaurus} from USA, and the largest known from Portugal is the camptosaurid \textit{Draconyx loureiroi}. Neither of these reached the body size suggested by the new footprint. So far the footprint described herein is the only evidence for a Jurassic ornithopod of that size.
The Lourinhã Formation (Portuguese pronunciation: [loɾiˈɲẽ] ([listen])) is a fossil-rich geological formation in western Portugal, named for the municipality of Lourinhã. The formation is Late Jurassic in age (Kimmeridgian/Tithonian) and is notable for containing a fauna especially similar to that of the Morrison Formation in the United States and a lesser extent to the Tendaguru Formation in Tanzania. There are also similarities to the nearby Villar del Arzobispo Formation. The stratigraphy of the “Dinosaur skeletons and even the fragile bones of early birds have been found at ancient high-latitudes before. Yet, to date, no directly attributable integumentary remains have been discovered to show that dinosaurs used feathers to survive in extreme polar habitats,” said Dr. Benjamin Kear from Uppsala University in Sweden, a leading author on the study. “These Australian fossil feathers are therefore highly significant because they came from dinosaurs and small birds that were living in a seasonally very cold environment with months of polar darkness every year.” The fossil scenes and dinosaurs. In the rst stage of any commission he takes the fossil evidence and consults with specialists in their eld and works out a number of sketches to build up an overall picture of structure, surface detail, and behavior. From his base in England he has provided images for books, popular magazines such as the National Geographic, and televi-sion documentaries, as well as museum exhibits and one-man shows of original artwork. For this book he has provided 223 pieces of original art. To the instructor. Occasionally the fossilized feces of dinosaurs and other vertebrates are found. Called coprolites, these sometimes impressive relics can give an intestineâ€™s-eye view of dinosaurian diets. Abstract-The Upper Jurassic Lourinhã Formation (Lusitanian Basin, Portugal) contains a diverse dinosaur fauna comprising theropods, sauropods, stegosaurs, ankylosaurs and several genera of ornithopods. The sedimentology in the area favours preservation of tracksways, and tracks from most of the dinosaurs are also represented by skeletal remains. ORYCTOS vol. 8, 2008 47. Ichnological evidence for giant ornithopod dinosaurs in the Upper Jurassic Lourinhã Formation, Portugal. Octávio Mateus1,2 & Jesper Milà n3. Late Jurassic dinosaurs from the Morrison Formation, the Lourinhã and Alcobaça Formations. (Portugal), and the Tendaguru Beds (Tanzania): a comparison. In Foster, J.R. & Lucas, S. G. (eds.) Ichnological evidence for giant ornithopod dinosaurs in the Late Jurassic Lourinhã Formation, Portugal. O. Mateus, J. Milàn. Geology. A review of vertebrate track assemblages from the Late Jurassic of Asturias, Spain with comparative notes on coeval ichnofaunas from the western USA: implications for faunal diversity in siliciclastic facies assemblages.