Cretaceous Research 73 (2017) 47–59

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

The first dinosaur tracksite from Abruzzi (Monte Cagno, Central Apennines, Italy)

Paolo Citton [a, *], Marco Romano [a, b], Roberto Carluccio [c], Francesca D'Ajello Caracciolo [c], Iacopo Nicolosi [c], Umberto Nicosia [a], Eva Sacchi [a], Giulio Speranza [d], Fabio Speranza [c]

[a] Dipartimento di Scienze della Terra, Università di Roma "La Sapienza", Piazzale Aldo Moro, 5, 00185 Rome, Italy
[b] Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Invalidenstrasse 43, Berlin, Germany
[c] Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, 00143 Rome, Italy
[d] Dipartimento di Scienze, Università Roma Tre, Largo San Leonardo Murialdo, 1, 00146 Rome, Italy

ARTICLE INFO

Article history:
Received 19 October 2016
Accepted in revised form 11 January 2017
Available online 12 January 2017

Keywords:
Tracks
Dinosaurs
Cretaceous
Metatarsals
Crouching
Theropods

ABSTRACT

A new Lower Cretaceous (lower Aptian) dinosaur tracksite, from the eastern side of Monte Cagno (Abruzzi, Italy), is described. Different styles of track formation are represented on the site surface. Most of the footprints are preserved as deep tracks, produced by trackmakers sinking into soft mud. Some tracks, better preserved than the others, are characterized by metatarsal impressions and were interpreted as the resting traces of a crouching theropod (based on their orientation and three-dimensional morphology). The 135 cm length of the track with metatarsal impressions indicates huge pedal proportions and represents the largest theropod trackmaker ever documented from the Mesozoic peri-Adriatic platforms of Italy.

1. Introduction

A new dinosaur tracksite has been discovered in the Central Apennines (Italy). The track-bearing surface, about 25 × 12 m in area, crops out on the eastern side of Monte Cagno (42° 14′ 20″ N, 13° 28′ 26″ E), facing the small town of Rocca di Cambio (Monte Ocre–Monte Cagno ridge, L'Aquila, Abruzzi, Italy, Fig. 1), at a height of roughly 1920 m height above sea level (a.s.l).

The new discovery constitutes the first tracksite reported from the Abruzzi area and represents, to date, the fifth dinosaurian ichnosite from Central Italy, joining the tracksites of Sezze (Latium; Nicosia et al., 2007), Esperia (Latium; Petti et al., 2008a), Riomartino (Latium; Citton et al., 2015a; Romano and Citton, 2016) and Terracina (Latium; unpublished data). In addition to these ichnological discoveries, skeletal material referred to a basal lithostrotian titanosaur was recently reported from Rocca di Cave (Latium, central Italy) (Dal Sasso et al., 2016).

The Monte Cagno dinosaur tracks are exposed on a steeply inclined, barely accessible surface (Fig. 2A–C). As a consequence, it was not possible to carefully observe, measure, and interpret the tracks first-hand on the surface. In order to completely map the track-bearing surface and proceed with analysis of the footprints, an aerial photography campaign was undertaken. Aerial mapping has been successful in dealing with other difficult-to-study tracksites, using remote-controlled aeroplanes, blimps, or air balloons (Breithaupt et al., 2001; Breithaupt et al., 2004; Matthews et al., 2006). Different portions of the surface and some individual footprints of interest were photographed at close range by rappelling down the slope during surface setting operations (Fig. 2D). A hexacopter drone, equipped with digital camera, was piloted in several flights around the tracksite taking photographs at different angles around the surface. Digital photogrammetry, an increasingly popular tool for studying difficult-to-access tracksites (e.g., Bates et al., 2008a, 2008b) and preserving significant geological and palaeontological context (Cipriani et al., 2016), was after applied to the photo dataset and a complete, high-resolution model of the track-bearing surface was produced. Track analysis was performed starting with the study of their distribution on the surface, and then trying to evaluate preservational features and diagnostic characteristics of individual footprints.

The new site constitutes a meaningful 'window' in the context of dinosaur ichnology, as it preserves different dynamics of track

* Corresponding author.
E-mail address: paolo.citton@uniroma1.it (P. Citton).

http://dx.doi.org/10.1016/j.cretres.2017.01.002
0195-6671/

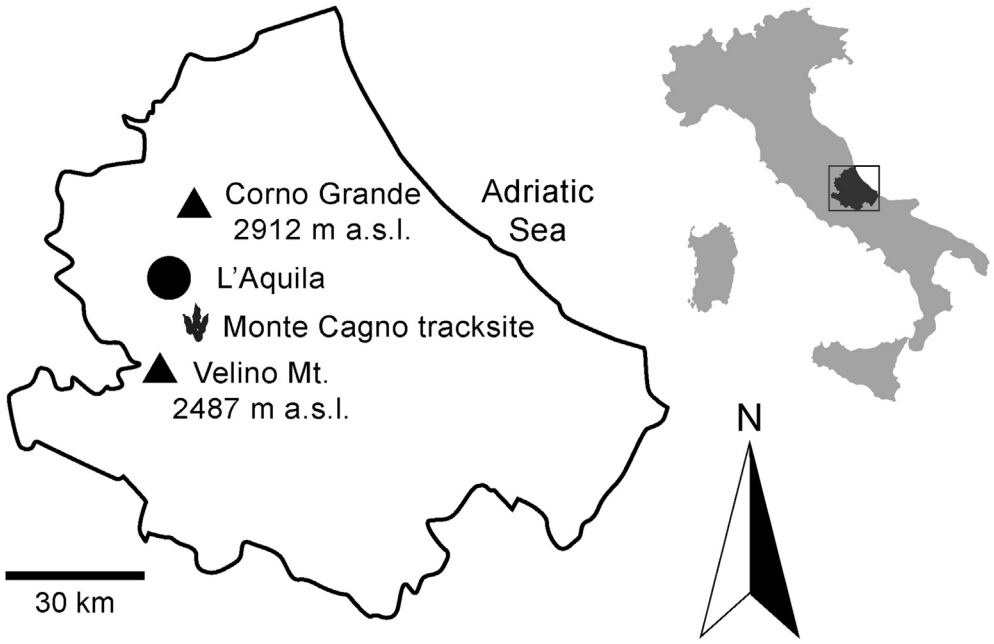

Fig. 1. Location map of the Monte Cagno ichnosite.

formation, likely triggered by variable substrate conditions, and track morphologies representing both passive and active trackmaker behaviour. Moreover, the new discovery further enriches the dinosaur track record of Italy, repeatedly discussed in terms of its palaeogeographical significance (e.g., Nicosia et al., 2007; Petti et al., 2008a, 2008c; Sacchi et al., 2009; Citton et al., 2015b), and also sheds light on open questions about the composition of the peri-Adriatic Cretaceous dinosaur fauna.

2. Geological setting

The sedimentary succession exposed in the Monte Cagno area pertains to the 'Apenninic Carbonate Platform' domain (hereafter abbreviated as ACP), i.e., the Latium-Abruzzi and Campania platforms considered as a unitary palaeogeographic domain (Mostardini and Merlini, 1986; Pescatore et al., 1999) within Adria (i.e., Central-Southern Tethyan belt – Smith, 1971; Channel et al., 1979; Zarcone et al., 2010). This palaeogeographic domain (i.e., ACP) currently constitutes part of the Apennine fold-and-thrust belt (Tavarnelli et al., 2001) and the sedimentary succession recording its evolution during the Late Triassic-Late Cretaceous time interval is mainly represented by neritic carbonate sediments (Chiocchini et al., 1984; Accordi et al., 1988). In such a palaeoenvironmental setting, there was extensive variation in carbonate deposition and preservation as the results of eustatic oscillation, subsidence, uplift and sediment compaction. Short emersion events, mostly documented in the early Aptian-Cenomanian time interval (Accordi et al., 1988; Chiocchini et al., 1994, 2012; Centamore et al., 2007) produced the necessary conditions for tracks formation and preservation.

The area of Monte Cagno falls within the Sheet 146 'Sulmona' (scale 1:100.000, Reale Ufficio Geologico, 1942) and the Sheet 359 'L'Aquila' (scale 1:50.000 – Servizio Geologico d'Italia, 2006). At Monte Cagno, the Cretaceous portion of the ACP succession crops out and is represented by the 'Calcari ciclotemici a requienie' (referred to as 'CIR' in the Sheet 146 'Sulmona') unit (Fig. 3). This lithostratigraphic unit is mainly composed of brown and nutty mudstones, almost lacking microfossils, which are organized in peritidal cycles at a metric scale. In the central and upper portion, these lithotypes are replaced by white mudstones with abundant requienids, whereas in the uppermost portion the unit is characterized by bauxite horizons filling karst cavities and, locally, by collapse breccias. On the whole, the age of these rocks is referred to the upper Aptian-lower Albian p.p. (Servizio Geologico d'Italia, 2006).

Very few strata can be sampled at the outcrop, which dips in the same direction as the mountain slope and makes up a hangingwall anticline forelimb. Pervasive recrystallization affects the rocks, obliterating their original fabric and complicating attempts at microfaunal census or any useful petrographic observation.

Dinosaur tracks are preserved on an inclined surface (bed attitude – dip/dip angle – is 50°/65°) made of light grey to hazelnut mudstone and wackestone. The microflora is composed of very abundant *Salpingoporella dinarica* and rare *Thaumatoporella* sp., whereas the microfauna is represented by *Haplophragmoides* cf. *globosus*, Miliolidae, other benthic Foraminifera (including specimens tentatively referred to as *Glomospira* cf. *urgoniana*, *Glomoinvolutina* cf. *apuliae*, and Nezzazatidae indet.), and indeterminate shell fragments (Fig. 4).

Haplophragmoides cf. *globosus* Lozo 1944 has been reported from the upper Barremian (*?Cuneolina scarsellai* and *Cuneolina camposaurii* biozone) and the lower Aptian (*S. dinarica* biozone) of the Aurunci Mts. (Southern Latium, Italy) in association with *Arenobulimina cochleata*, *?Cuneolina scarsellai*, *Praechrysalidina infracretacea*, *Salpingoporella dinarica*, Miliolidae, shell fragments and other benthic Foraminifera (Chiocchini et al., 2012, Pl. 23, p. 45, Pl. 50, p. 72 and Pl. 55, p. 77).

Salpingoporella dinarica Radoicic 1959 (Berriasian-Albian) is a well-known marker from Barremian to lower Albian carbonate platform sediments in the Southern Tethyan Domain (according to Carras et al., 2006, this taxon can be considered a typical marker of the Aptian in the Dinaric-Hellenic area). In central Italy, the species has been reported from the lower Aptian (*S. dinarica* biozone) of the Ausoni Mts. (Southern Latium, Italy) co-occurring with *Debarina hahounerensis*, Miliolidae and other benthic Foraminifera (Chiocchini et al., 2012, Pl. 32, p. 54). Sirna (1963) reported *S. dinarica* in association with *Orbitolina* sp. and charophytes from a clayey-marly level, Aptian in age, close to the town of Pico (Southern Latium, Italy). This taxon is also reported from lower