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NOTA BREVE - SHORT NOTE

FIRST REPORT OF SITTING *ANOMOEPUS* TRACKS IN EUROPEAN LOWER JURASSIC (LAVINI DI MARCO SITE - NORTHERN ITALY)

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Riassunto. Il sito paleontologico dei Lavini di Marco, presso Rovereto (Trento) rappresenta un vasto *tidal flat* fossile di età Giurassico inferiore (Formazione dei Calcari Grigi - Membro inferiore; Hettangiano - Sinemuriano inf.). Un largo insieme di impronte riferibili a dinosauri, vi è stato scoperto pochi anni fa ed esso è attualmente oggetto di estensivi studi icnologici e paleobiologici. Le impronte oggetto di questa nota sono riferibili al piede destro e sinistro di un medesimo individuo posti in posizione affiancata e subparallela in un atteggiamento di arresto e accucciamento. Le orme sono attribuibili ad *Anomoepus* Hitchcock 1848. Tra le orme finora documentate le maggiori affinità corrispondono a *Moyenisauropus dodai* Ellenberger 1974 (recte *Anomoepus dodai* Olsen & Galton 1984) del Lesotho mentre differiscono dalle forme attribuite ad *Anomoepus* identificate nell'emisfero settentrionale. Questo potrebbe confermare la parentela gondwanica per l'icnofauna di Rovereto già supposta nello studio di altri taxa.

Abstract. The palaeontologic site at Lavini di Marco, near to Rovereto (Trento), reveals a wide fossil tidal flat of Early Jurassic age (Calcari Grigi Formations - lower Member; Hettangian to lower Sinemurian). An extensive set of dinosaur prints were discovered a few years ago and are now the subject of ichnological and paleobiological studies. The prints which are described in present short note are believed to represent the right and left foot of the same individual, set in a side-by-side, sub-parallel, sitting posture. The prints can be classified as *Anomoepus* Hitchcock 1848. Amongst recognised ichnospecies, most of the charachteristics of the prints here described point to *Moyenisauropus dodai* Ellenberger 1974 (recte *Anomoepus dodai* Olsen & Galton 1984) of Lesotho. By contrast, the prints found at Lavini di Marco differ from the *Anomoepus* found in the Northern Emisphere. These characters would seem to confirm the Gondwanic origins of the Rovereto ichnofauna as previously supposed from the study of other taxa.

Introduction.

The Lower Jurassic tracksite at Lavini di Marco, near Rovereto (Northern Italy) is a large, fossil tidal flat (Lanzinger & Leonardi 1992; Leonardi & Lanzinger 1992; Leonardi & Avanzini 1994; Avanzini et al. 1997). The dinosaur footprints were discovered a few years ago and have been the subject of extensive ichnological and paleobiological studies (Lanzinger & Leonardi 1992; Leonardi & Avanzini 1994; Dalla Vecchia 1994; Leonardi & Mietto in press).

The paleoenvironment at Lavini di Marco, as deduced from sedimentology and geochemistry, is a relatively arid coastal zone lacking perennial freshwater reservoirs (Avanzini et al. 1997). There is evidence of fluctuations in vegetation density and difference over time documented by the occurrence of palynomorphs, among them *Corollina* sp. and *Porcellispora* sp., (Avanzini et al. 2000).

Regional scale stratigraphic and sedimentological characteristics allow reconstruction of the Early Jurassic setting, of a coastal environment that probably stretched southwards. The coastal belt was a tongue of tidal flats (Trento Platform), bordered to the west and to the east by basins developed as a consequence of the foundering of the Lombardy Basin to the west and the Belluno Trough to the east.

Trackways and footprints most commonly occur on six layers within one inter-to supratidal interval characterized by variable lateral thickness and facies (Lower Member of Calcari Grigi Formation, Hettangian to Lower Sinemurian in age). Detailed studies of the tracks are ongoing. With the present state of knowledge, tridactyl footprints are represented by theropod of *Grallator* Hitchcock, 1858 and *Eubrontes* Hitchcock, 1845 ichnotaxa. Other tracks are attributed to primitive sauropods (*Parabrontopodus* Lockley, Farlow & Meyer, 1994 and *Breviparopus* Dutuit & Ouazzou, 1980, ichno-

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genera) and small ornithischian dinosaurs (Leonardi & Mietto, in press). This association is similar to others found in the Lower Liassic.

Systematic Ichnology.

The footprints that are the subject of the present report are imprinted on the surface of stromatolitic bindstone level (layer 106). This layer was dolomitized in the early stages of diagenesis under semi-arid climatic conditions, where evaporation exeeded precipitation. In particular the trampled layer was characterized by a succession of plastic semiliquid mud and partially lithified sediments, capped by elastic cyanobacterial laminites (Avanzini 1998). The footprints are poorly preserved, as commonly occurs for footprints impressed in carbonate sediments. Poor preservation is also due to karst corrosion of the surface.

Order Ornithischia Seeley, 1888
Ichnofamily Anomoepodida Lull, 1904
Ichnogenus *Anomoepus* Hitchock, 1848

Description. The prints belong to the right and left foot of the same individual, and are arranged in a side by side, and diverging slightly distally. Unfortunately the left footprint is partly eroded, but three digit impressions and the outline of the heel are visible. The right footprint, which is better preserved, is clearly tridactyl, and there is marked elongation close to the axis of the third digit, which can be interpreted as the impression of the metatarsal area (Fig. 1).

Pes: tridactyl with digits II-IV impressed. Low values of projection of digit III beyond II and IV(2.5 cm). The pes is longer than wide. Digit IV is longest.

Footprint length, 12.3 cm; with the metapodium, 24.9 cm.

Footprint width, 11.3 cm.

Divarication of digits II-III, 34°; III-IV, 23°; II-IV, 55°.

Length of digit II, 7.5 cm; of III, 9.5 cm; of IV, 10.0 cm.

Phalangeal pads are not well defined. Metatarsal-phalangeal pads of digits III and IV made two isolated posterior impressions. On the distal end of digits are preserved impressions of stumpy and rounded claws. The metapodium print is 12.6 cm in length and 4.5 cm in width. The proximal end shows a marked asymmetry with the lateral part being larger than the medial.

Manus: Close to the right foot, the impression of three parallel furrows set in front of an elongated depression can be recognised and in a central position between the rear limbs there is another print in which two probable short, and robust digits are visible. These incomplete prints are 4.5-5 cm long and 4-5 cm wide. It is not completely clear whether or not these tracks can be attributed to the front limbs. However, some of these (i.e. the central print) show characteristics which indicate that the prints may have been left by the hands, when the subject was exploring the ground before stopping.

Comparison.

The size and general morphology of these footprints assign them to ichnotaxon *Anomoepus* Hitchcock, 1848. The main features of ichnogenus *Anomoepus* are: broad pes with toes tending to be broadly splayed (divarication II-IV ~ 70°), relatively large width of digits, low values of projection of digit III beyond the other toes, digit II, III and IV subequal in length but the pedal digit IV is always slightly longer than others (Olsen & Galton 1984; Demathieu 1990; Thulborn 1990; Farlow & Lockley 1993). The manus impression when present, has four or five subequal toes and is sometimes rotated outwards (Olsen & Galton 1984). *Anomoepus* trackways are usually bipedal. Some tracks shows that the animal sometimes switched from bipedal to quadrupedal progression and even to a stationary crouching position. In resting tracks all four feet, along with the metatarsal and sometimes the ischiadic callosity and the belly are impressed.

The size of the feet, the relative length of the digits and the metatarsal lengths of the specimen described, are similar those of some African specimens as i.e. *Moyenisauropus dodai* Ellenberger 1974 (recte *Anomoepus dodai* Olsen & Galton, 1984): L=14 cm, 24cm with heel, W=125-115 cm, digit I (non functional), digit II = 7.0 (with metatarsal-phalangeal pad = 10 cm), digit III = 9 cm (with metatarsal-phalangeal pad =10.5cm), IV= 10 cm. Projection of digit III= 4.5 cm (Ellenberger 1974). The total angle of divarication II-IV is similar to that described by Ellenberger (1974) for the type of this ichnospecies; in track 70°, in resting pose 55°, (II-III, 30°, III-IV, 40°). Typical North American material differs from our specimen in having shorter digits and gen-

Fig. 1 - *Anomoepus* sp. footprints at Lavini di Marco reveal evidence of crouching (A). Specifically note the metatarsal prints arranged in a side by side, and diverging slightly distally (B). The right footprint (D), shows the main features of ichnogenus *Anomoepus*: broad pes with digit II, III and IV subequal in length and broadly splayed, relatively large width of digits and low values of projection of digit III beyond the other toes. Interpretative drawing shows other prints on the same surface (C). Some of these may have been left by the hands. Scale bar = 10 cm.

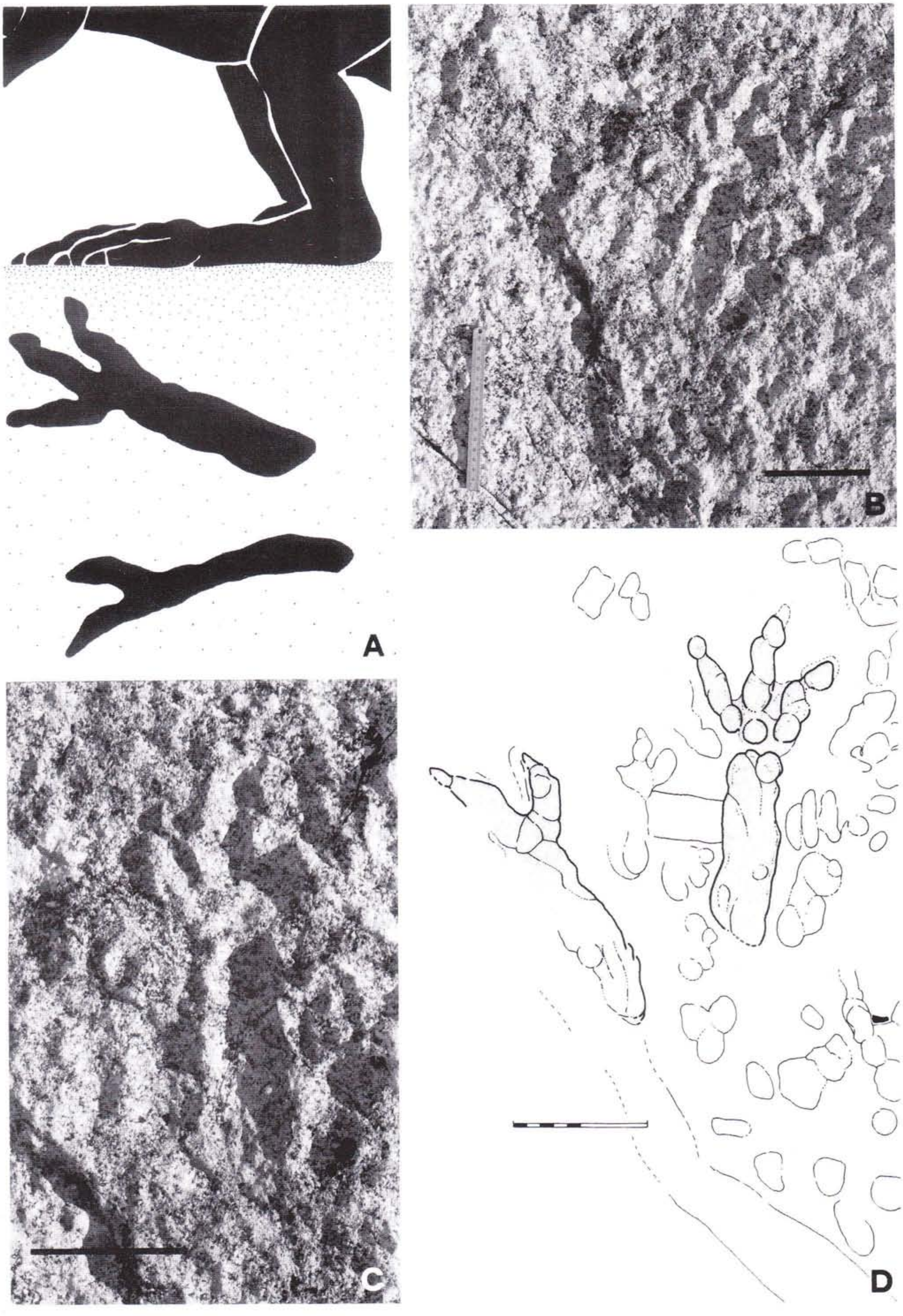
A
B
C
D

Fig. 2 - New specimen of *Anomoepus pienkovskii* Gierlinski, 1991 (Muz. PIG 1662.II.1) from the Hettangian of Giliany Las (Poland), which was left during a plantigrade gait. Scale bar = 5 cm.

erally smaller dimensions, but divarication angles II-III and III-IV are similar to those of *Anomoepus scambus* Hitchock, 1848 (35°, 23°). Among the Northern Hemisphere anomoepodids, the most similar form is *Anomoepus pienkowskii* Gierlinski, 1991 from the Lower Jurassic of Poland. However, Polish *Anomoepus* tracks have a more robust general structure with the shorter metatarsal imprints, which appared in the new discovered specimen Muz. PIG 1662.II.1 (Fig. 2).

Discussion.

Anomoepus is a distinctive classic Early Jurassic track type first reported from the Connecticut Valley (Hitchcock 1848; Lull 1904, 1953; Olsen 1980a; Olsen & Galton 1984) but now also known from Europe, Africa and Australia (Olsen & Galton 1984; Thulborn 1994; Lockley & Hunt 1995; Lockley & Meyer 2000).

The Early Jurassic assemblage from the Newark Supergroup and Glen Canyon Group of North America is predominantly composed of Late Triassic survivors (mainly large sized *Grallator*, and extremely rare *Rhynchosauroides*), with the addition of *Anomoepus* (Welles 1971; Olsen 1978, 1980 a-c; Clark & Fastovsky 1986; Olsen & Padian 1986; Olsen & Baird 1986, Silvestri 1996).

The ichnogenus *Anomoepus* is an abundant ichnite in the Lower Jurassic Stormberg Group of Lesotho (Ellenberger 1972, 1974; Olsen & Galton 1984; Colbert 1986; Haubold 1986) and Early Jurassic prints, attributed to small ornithischian dinosaurs (*Anomoepus gracillimus*) have been reported in the Carnarvon Gorge, Queensland (Thulborn 1994).

Anomoepus is also present in Central Europe. The Polish ichnofauna described by Gierlinski (1991, 1994, 1995, 1996a-b, 1997), Gierlinski & Sawicki (1998) and Gierlinski & Pienkowski (1999), comes from the northern slopes of the Holy Cross Mountain, located about 150 km south of Warsaw, from the Zagaje Formation, Skoloy Formation and Przysucha Ore-Bearing Formation. Floristic remains and sequence stratigraphy correlation indicate a Hettangian age of all these formations. They represent various continental and marginal-marine environments. Fluvial and lacustrine sediments dominate in the continental Lower Zagaje Formation, while the nearshore and deltaic facies are present in the Sholoy Formation, Upper Zagaje Formation and Przysucha Ore-Bearing Formation. Various ornithischian, sauropod and theropod tracks occur in these sediments (Gierlinski & Pienkowski 1999; Lockley & Meyer 2000). The presence of early ornitischians in Europe of is particularly significant to interpretation of the Lavini di Marco ichnoassociation. Gierlinski (1991, 1999) contends that the Polish ichnospecies of *Anomoepus pienkovskii* differs from the classic Connecticut forms in being larger and having a larger manus print. However, *Anomoepus pienkovskii*, Gierlinski, 1991, differs also from the prints described in this report.

Taking into account the distribution of *Anomoepus*, and considering the concept that Early Jurassic faunas are cosmopolitan (Hunt et al. 1996), it is interesting to note that the *Anomoepus* observed at Lavini di Marco is the most similar to the forms documented in Lesotho, slightly different from the Polish specimens and substiantially distinctive among the other Northern Hemisphere anomoepodids. This fact could suggest that the ichnofauna of Rovereto may have Gondwanian origins, as previously postulated by Leonardi and Mietto (in press) from the study of other taxa. It is also noteworthy that the Hettangian tracks of Poland, robust anomoepodids and sauropod tracks (Gierlinski 1997; Gierlinski & Pienkowski 1999; Gierlinski & Sawichi 1998), remain stronger similarities to the distinctive Italian assemblage than to other Laurasian ichnofaunas.

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