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SHORT COMMUNICATION

A distinctive crouching theropod trace from the Lower Jurassic of Poland

Gerard D. GIERLIŃSKI, Martin G. LOCKLEY and Grzegorz NIEDŹWIEDZKI

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A well-preserved, essentially complete and distinctive trace fossil of a crouching, medium-sized theropod dinosaur is reported from the northern slope of the Holy Cross Mountains, Poland. Crouching theropod traces are rare, and currently known from only six specimens from the Jurassic of North America and Asia. Thus, this new specimen adds a seventh specimen to the dinosaur track record. The specimen was found in the Early Jurassic (Late Pliensbachian) sandstones mined in the Szydłówek quarry, in the vicinity of Szydłowiec.

Gerard D. Gierliński, Polish Geological Institute–National Research Institute, Rakowiecka 4, PL-00-975 Warszawa, Poland; JuraPark, ul. Sandomierska 4, PL-27-400 Ostrowiec Świętokrzyski, Poland; e-mail: gierlinski@yahoo.com; Martin G. Lockley, Department of Geology, University of Colorado at Denver, P.O. Box 173364, Denver, CO80217-3364, USA; Grzegorz Niedźwiedzki, Department of Zoology, Faculty of Biology, University of Warsaw, S. Banacha 2, PL-02-097 Warszawa, Poland (received: June 09, 2009; accepted: September 09, 2009).

Key words: Poland, Holy Cross Mountains, Lower Jurassic, dinosaur crouching trace.

INTRODUCTION

A new dinosaur-sitting trace was found by two of us (G. D. G. and M. L.) at the Szydłówek site, in the Holy Cross Mountains of Poland, in August 2008. The first dinosaur tracks at this locality were discovered a year earlier by Joanna Roszkowska, Urszula Meissner and Zbigniew Remin. Those previous finds were reported by Niedźwiedzki and Remin (2008), and Niedźwiedzki *et al*. (2009). Tracks are found in the so-called "Szydłowiec Sandstones" mined in a small quarry located at GPS coordinates N 51°14.298' and E 020°53.040'. "Szydłowiec Sandstones" (informal regional lithostratigraphic unit) belongs to the Drzewica Formation of late Pliensbachian age and represents the sixth sequence of the epicontinental Lower Jurassic deposits in Poland. This part of Drzewica Formation represents a succession comprised of (from the oldest to youngest) nearshore-foreshore-backshore/eolian facies (Pieńkowski, 2004).

A few previous finds of sandstone slabs with dinosaur footprints were destroyed during regular quarrying activity (e.g., Fig. 1A). However, most of the discovered specimens, including the one reported here with the catalogue number J484, were bought by *Stowarzyszenie "Delta"* (Delta Association) and protected in the *JuraPark* theme park complex in Bałtów (e.g., Fig. 1B–F). Specimens were recently stored in a specially designed open-air exhibit named Sabathówka, in memorial of late Polish palaeontontologist Karol Sabath.

Only five previously known specimens of crouching theropod tracks have been reported in the literature. These specimens are from the Lower Jurassic of Massachusetts (USA), St. George (Utah, USA) and the Lower or Middle Jurassic of China (Gierliński, 1994; Lockley *et al*., 2003; Milan *et al*., 2008; Milner *et al*., 2009). A sixth, previously undocumented specimen, was discovered in 2004 at a site in the Lower Jurassic Glen Canyon Group of the Glen Canyon (Lake Powell) National Recreation area, Utah. This specimen is illustrated here for the first time (Fig. 2), but is not described in detail; a mold and replica are housed at the University of Colorado at Denver, in the Dinosaur Tracks Museum (CU 183.84). Finally, the new Szydłówek find represents the seventh example, and most importantly is among the most complete and best preserved.

TRACK DESCRIPTION

The dinosaur-sitting trace fossil is preserved as a natural cast on the fine-grained sandstone slab and associated with numerous bivalve resting traces of *Lockeia*. The dinosaur

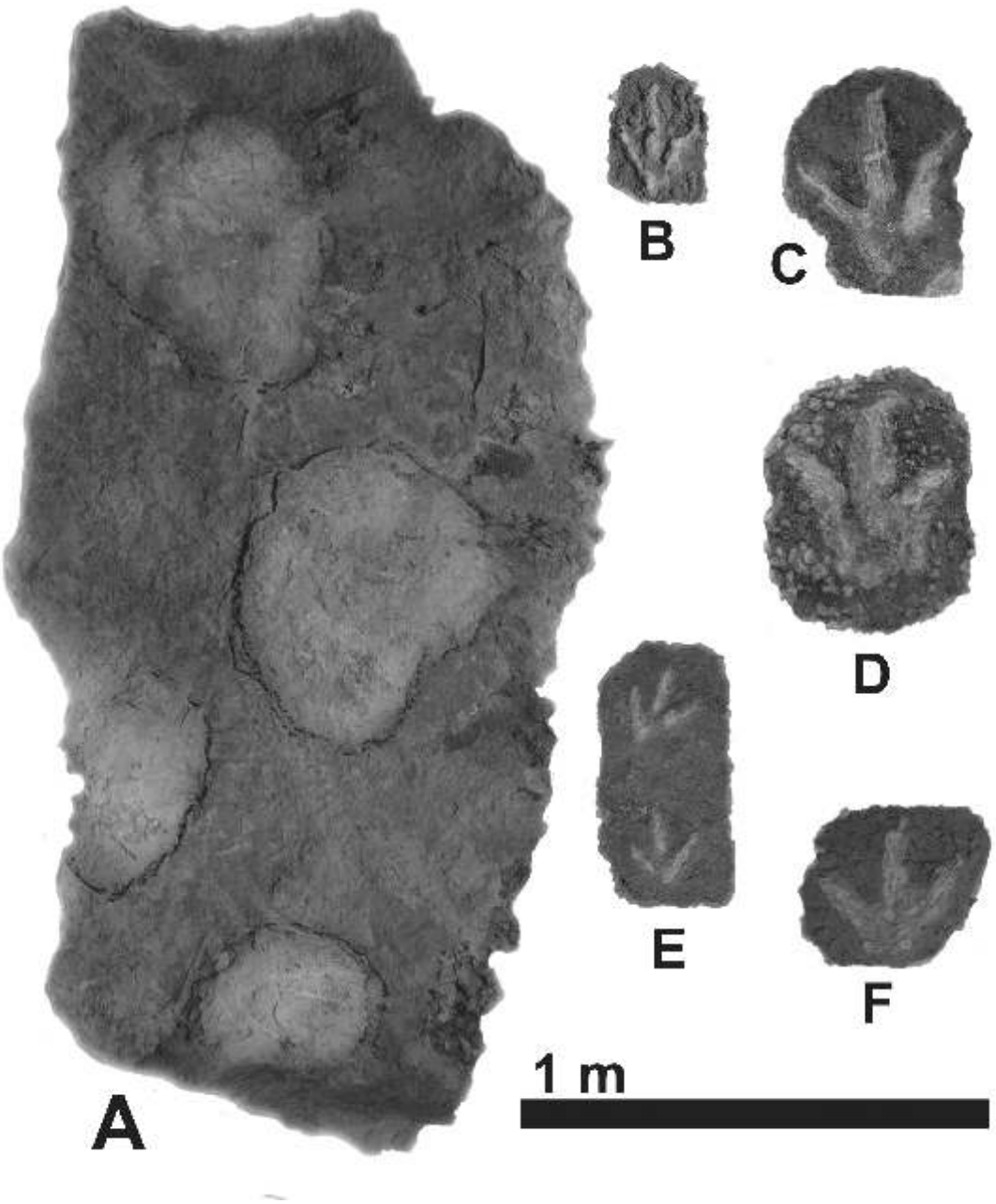

Fig. 1. Late Pliensbachian track assemblage from Szydłówek, Poland

A — *Parabrontopodus* trackway; **B** — *Anchisauripus* sp.; **C** — *Kayentapus* sp.; **D** — *Eubrontes* sp.; **E** — *Anomoepus* trackway; **F** — *Moyenisauropus* sp.

ichnite is comprised of an ischial trace (Fig. 3C), left and right pes (Fig. 3B), and left and right manus (Fig. 3A). The manus tracks are much smaller than the pes and slightly wider (5.0 cm) than long (4.5 cm). The manus is tridactyl and digits increase in length in the sequence: I, II, III. The ischial trace is tear-shaped, longer (12 cm) than wide (6.5 cm). The ischiadic callosity trace is located almost midway between the metatarsal proximal ends.

The pedal tracks are mesaxonic, tridactyl and plantigrade. The phalangeal portion of the footprint is 23 cm long, whereas the entire footprint (including the metapodium) is 37 cm long. Angles between the digit axes are: II–III = 13–18°, III–IV = 7–22°. The third pedal digit is the longest one. The ratio of the third pedal digit projection beyond the lateral toes to the length of the pes phalangeal portion equals 0.33. The ratios of the digits (entire lengths) are: III/II = 1.17 and III/IV = 1.11. However, these ratios measured according to the method of Olsen *et al.* (1998) are: III/II = 1.37 and III/IV = 0.89, which possibly reflect the ratios of the combined lengths of trackmaker phalanges III2 + III3 + III4 to II2 + II3 and IV1 + IV2 + IV3 + IV4 + IV5.

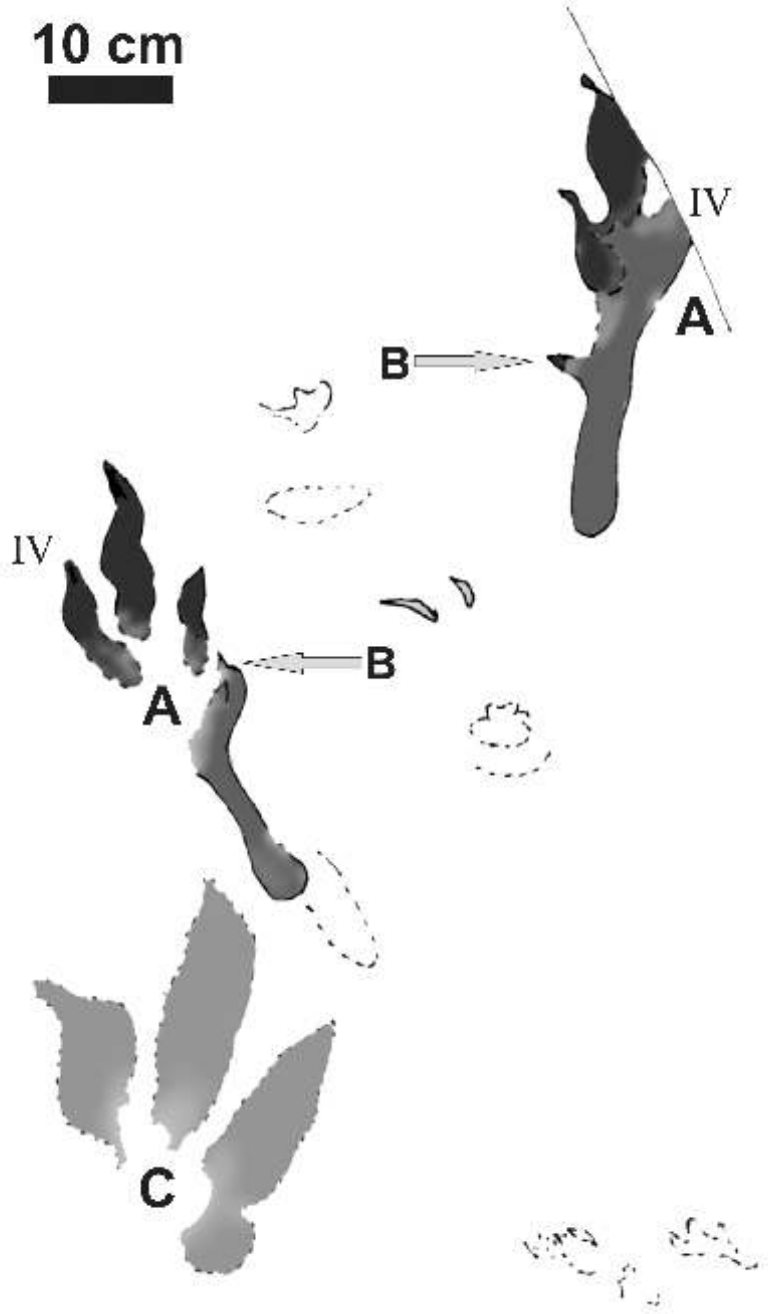

Fig. 2. Theropod crouching trace (specimen CU 183.84) from the Lower Jurassic, Glen Canyon Group, Utah

A — pes; **B** — hallux; **C** — other footprint of a large theropod (*Eubrontes* sp.)

DISCUSSION

As shown as shown in Figure 2, the Glen Canyon specimen is quite similar in size and morphology to the Szydłówek find, although part of the right pes is missing. The pedal tracks are similar in length (both specimens are ~40 cm, when including metatarsal traces), and comprise approximately 50% of the total length, and are width about ~12 cm. The most notable differences are that the Glen Canyon tracks lack manus traces, but have clearer hallux traces. In addition, the pes traces are more widely spaced and the right pes trace is located anterior to the left pes by the equivalent of about one-half of a track length (~20 cm).

The ratios of pedal digit lengths in the new Polish specimen (JuraPark J484) are similar to those given by Olsen *et al*. (1998) for the ichnospecies *Eubrontes giganteus* and *Anchisauripus sillimani*, as well as for the foot morphology of the basal theropod genera *Coelophysis* and *Dilophosaurus*. Thus, this is

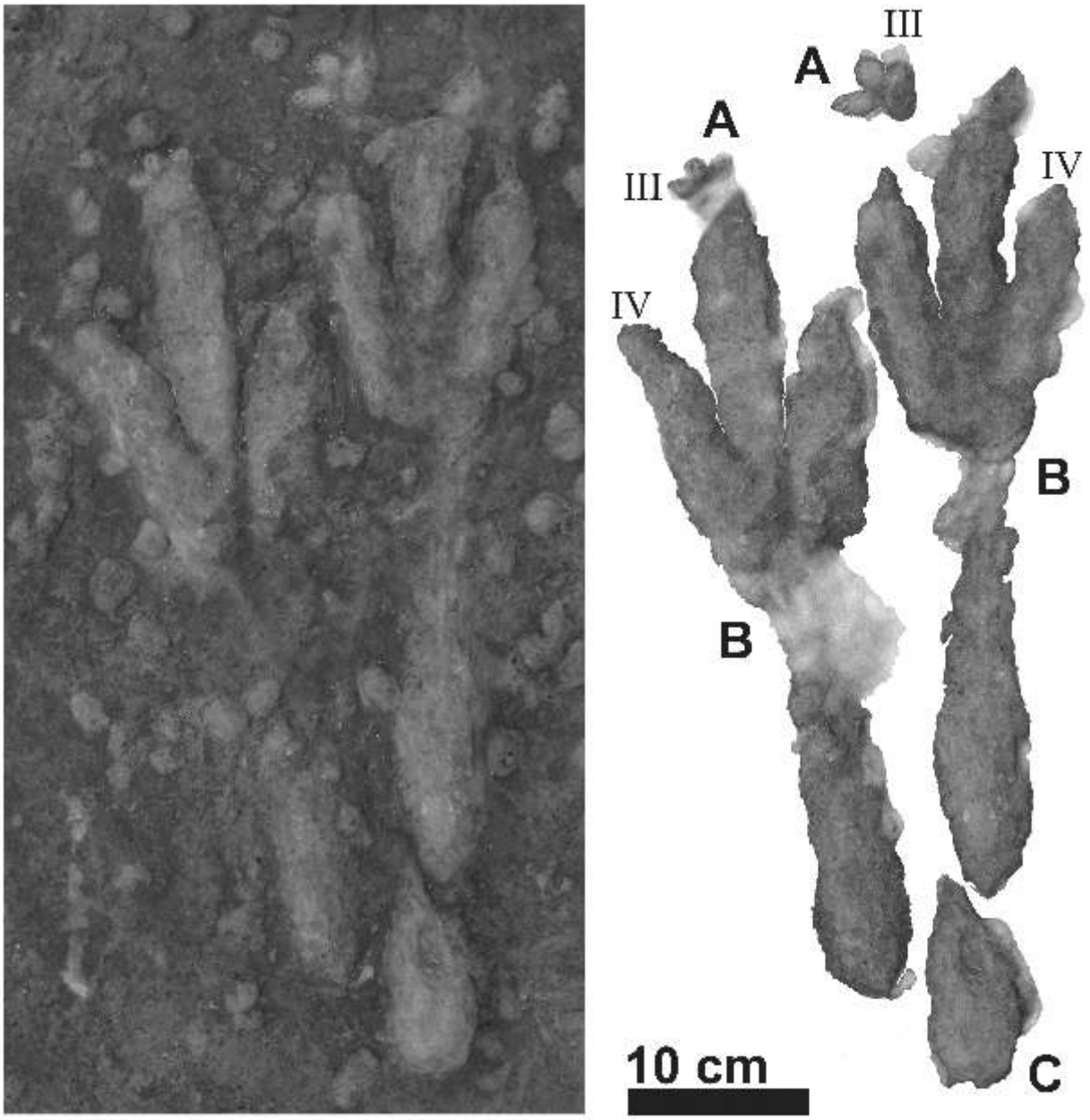

Fig. 3. Theropod crouching trace (specimen *JuraPark* J484) from the late Pliensbachian of Szydłówek, Poland

A — manus; **B** — pes; **C** — ischial callosity trace

a unique trace fossil of a crouching ceratosaurian theropod with well-defined manual digit prints left by the hands, and with its palms facing ventrally, not medially like in the St. George specimen SGDS.18.T1 (see, Milner *et al*., 2009) .

The presence of a well-preserved manual imprint in the previously described squatting theropod impression, AC 1/1 from the Lower Jurassic of Massachusetts (see, Gierliński, 1994), was later questioned by Lockley *et al*. (2003). According to the original interpretation, the Massachusetts specimen shows manual toe traces, which increase in length in the sequence: I, II, III. The same feature is observed in the present specimen from Poland. As noted by Gierliński (1994), this feature seems important in understanding the origin of the *Atreipus* trackmaker (Olsen and Baird, 1986).

Atreipodids are distinctive Late Triassic ichnites, which combine a small theropod-like (grallatorid) pes with the primitive archosaurian (chirotheriid) reduced, tridactyl or tetradactyl manus. Furthermore, their manual digits increase in length in the clearly different sequence: I, IV, II, III. Olsen and Baird (1986) have argued that such a combination might have been made by a basal ornithischian trackmaker, However, later authors, such as Thulborn (1990, 1993) and Weems (1992), suggested a theropod origin for those ichnites.

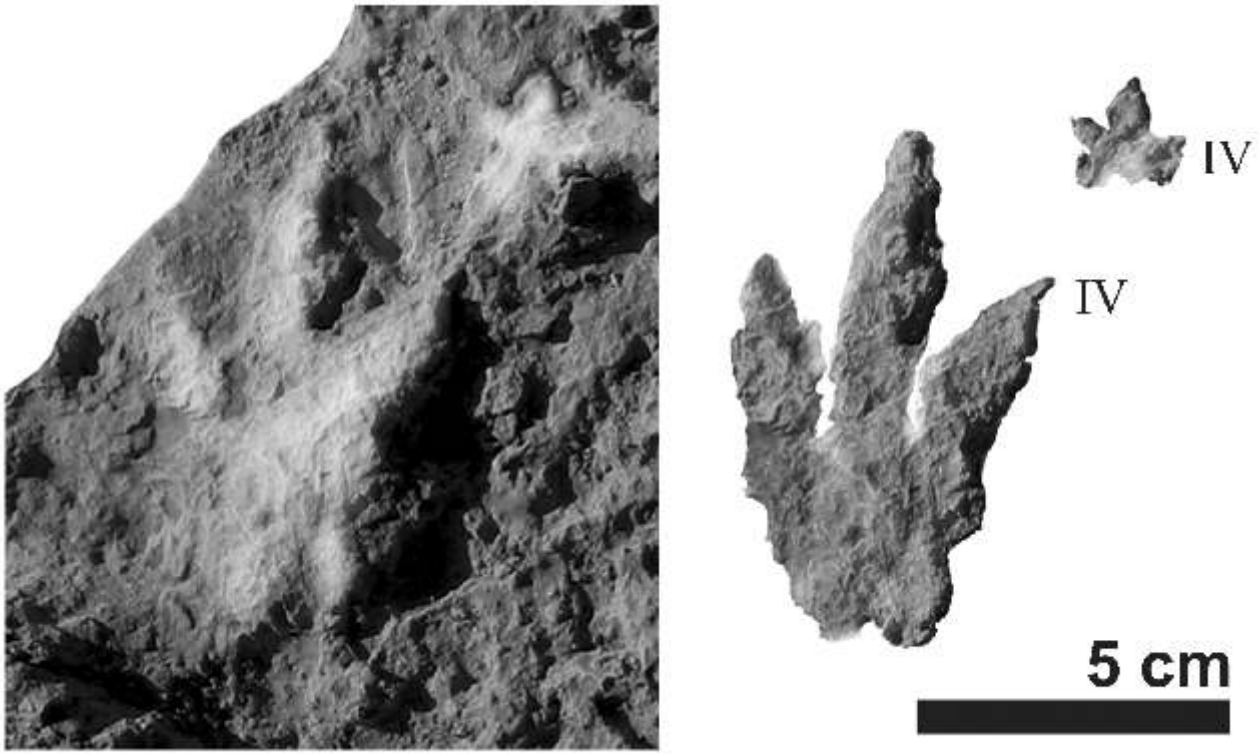

Fig. 4. ***Atreipus*** **sp. from the Upper Triassic of Woźniki near Częstochowa, Poland, the specimen found and owned by G. N.**

Recent discoveries support the hypothesis of Olsen and Baird (1986), Gierlinski (1994), and Milner *et al*. (2009) on the non-theropod affinity of the *Atreipus* trackmaker. It is also noteworthy that a potential atreipodid trackmaker candidate has already been found: an ornithischian-like dinosauromorph, such as the recently-discovered *Silesaurus* from the Upper Triassic of Poland (Dzik, 2003). *Silesaurus* is a small, non-theropod, quadruped with a theropod-like pes. Moreover, *Atreipus* footprins were recently found in the Upper Triassic strata of Poland (Fig. 4).

REFERENCES

DZIK J. (2003) — A beaked herbivorous archosaur with dinosaur affinities from the early late Triassic of Poland. J. Vertebr. Paleont., **23** (3): 556–574.

GIERLIŃSKI G. (1994) — Early Jurassic theropod tracks with the metatarsal impressions. Prz. Geol., **42** (4): 280–284.

LOCKLEY M., MATSUKAWA M. and LI J. (2003) — Crouching theropods in taxonomic jungles: ichnological and ichnotaxonomic investigations of footprints with metatarsal and ischial impressions. Ichnos, **10** (1): 169–177.

MILÀN J., LOOPE D. B. and BROMLEY R. G. (2008) — Crouching theropod and *Navahopus* sauropodomorph tracks from the Early Jurassic Navajo Sandstone of USA. Acta Palaeont. Pol., **53** (2): 197–205.

MILNER A. R. C., HARRIS J. D., LOCKLEY M. G., KIRKLAND J. I. and MATTHEWS N. A. (2009) — Bird-like anatomy, posture, and behavior revealed by an Early Jurassic theropod dinosaur resting trace. PLoS ONE, **4** (3): e4591.

NIEDŹWIEDZKI G. and REMIN Z. (2008) — Gigantic theropod dinosaur footprints from the upper Pliensbachian of the Holy Cross Mountains, Poland (in Polish with English summary). Prz. Geol., **56** (9): 823–825.

NIEDŹWIEDZKI G., REMIN Z., ROSZKOWSKA J. and MEISSNER U. (2009) — New finds of dinosaur tracks in the Liassic strata of the Holy Cross Mountains, Poland (in Polish with English summary). Prz. Geol., **57** (3): 252–262.

OLSEN P. E. and BAIRD D. (1986) — The ichnogenus *Atreipus* and its significance for Triassic biostratigraphy. In: The Beginning of the Age of Dinosaurs: Faunal Change Across the Triassic-Jurassic Boundary (ed. K. Padian): 61–87. Cambridge University Press. Cambridge.

OLSEN P. E ., SMITH J. B. and McDONALD N. G. (1998) —The material of the species of the classic theropod footprint genera *Eubrontes*, *Anchisauripus* and *Grallator* (Early Jurassic, Hartford and Deerfield basins, Connecticut and Massachusetts, U.S.A.). J. Vertebr. Paleont., **18** (3): 586–601.

PIEŃKOWSKI G. (2004) — The epicontinental Lower Jurassic of Poland. Pol. Geol. Inst. Spec. Pap., **12**.

THULBORN R. A. (1990) — Dinosaur tracks. Chapman and Hall, London.

THULBORN R.A. (1993) — A tale of three fingers: ichnological evidence revealing the homologies of manual digits in theropod dinosaurs. In: The Nonmarine Triassic (eds. S. G. Lucas and M. Morales). New Mexico Mus. Nat. Hist. Sc. Bull., **3**: 461–263.

WEEMS R. E. (1992) — A re-evaluation of the taxonomy of Newark Supergroup saurischian dinosaur tracks, using extensive statistical data from a recently exposed tracksite near Culpeper, Virginia. In: Proc. 26th Forum on the Geology of Industrial Minerals (ed. P. C. Sweet). Virginia Division of Miner. Res. Publ., **119**: 113–127. Charlottesville.