The first evidence of dinosaur tracks in the Upper Cretaceous of Poland

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ABSTRACT – A new theropod and ornithischian dinosaur track (*Irenesauripus* sp. and cf. *Hadrosauropodus* sp.) are reported from the Polish Cretaceous carbonate facies. The reported finds came from the Maastrichtian limestones, informal unit called Gaizes, exposed in the vicinity of the Roztocze National Park and represents isolated theropod pedal print and manuspes set left by hadrosaurid dinosaur. These are the first dinosaur track record in the Cretaceous of Poland.

Key words: *dinosaur tracks, Cretaceous, Roztocze, Poland.*

INTRODUCTION

So far, dinosaur footprints in Poland were reported from the Lower and Upper Jurassic of the Holy Cross Mountains (e.g., Gierliński, 2004; Gierliński & Niedźwiedzki, 2002a, b, 2005; Gierliński & Pieńkowski, 1999; Gierliński et al., 2001, 2004), Upper Triassic of the Tatra Mountains, Holy Cross Mountains, and Silesia (Niedźwiedzki, 2005; Gierliński & Sabath, 2005; Niedźwiedzki & Sulej, 2007; Gierliński, 2007).

The specimens reported herein are the first dinosaur footprints discovered in the Roztocze region of southeastern Poland and the first from the Polish Cretaceous carbonate. The first track, of a large ornithischian (fig. 3), has been found in situ in June 2005 by GDG, on the eastern side of a country road from Stara Huta to Potok Sanderki, near the village of Potok (fig. 1). The second footprint, of a theropod (fig. 2), was found by GN, in the same exposure, just 18 m north from the previous find, in April 2006. Plaster casts of both specimens are housed in the Geological Museum of the Polish Geological Institute in Warsaw (coll. Muz. PIG), original specimens are housed in the Guciów Cottage, 5 km north from the tracksite. In May 2006, another, smaller theropod footprint, not described herein, has been found (by GDG) in the same horizon, 11 km south, near Majdan Nepryski.

According to the geological map of the area (Kurkowski, 1994), the sites are located within exposures of lower Maastrichtian limestones named gaizes. However, the tracks are imprinted in limestones, which contain a late Maastrichtian foraminiferan assemblage. The studied sample of trampled surface from Potok site, collected in June 2005 (stored in the microfossil collection of the Polish Geological Institute: Foraminifera cabinet L, bag 56 and cell 193) contains: *Bolivina incrassata* Reuss, 1851; *Bolivinoides sidestrandensis* Barr, 1966; *Cibicidoides bembix* Marsson, 1878; *Cibicidoides involutus* Reuss, 1851; *Gavelinella acuta* Plummer, 1926; *Gavelinella monterelenisss* Marie, 1941; *Osangularia peracuta* Lipnik, 1961; *Gavelinella pertusa* Marsson, 1878; *Gavelinella sahlstroemi* Brotzen, 1948; *Globotruncana rugosa* Marie, 1941; *Gyroidinoides* sp.; *Hedbergella* sp.; *Heterohelix striata* Ehrenberg, 1840; *Karreria fallax* Rzehak, 1891; *Lenticulina* sp.; *Osangularia navarroana* Cushman, 1938; *Praebulimina obtusa* d'Orbigny, 1840; *Rugoglobigerina rugosa* Plummer, 1926.

Foraminiferans from this site demonstrate that carbonate material of these limestone were deposited during the late Maastrichtian, but previous studies from this region based on belemnites, ammonites and bivalves indicate the lower Maastrichtian. Microfossils and macrofossils distinguish different time limits, the problem also discussed by Ciesielski and Rzechowski (1993).

The trampled bed is composed of calcareous material with numerous silicisponge spicules, glauconite grains and detritical quartz. This aranaceous limestone (wackestone) belongs to the informal litological unit called locally as Gaizes (Krassowska, 1997; Kurkowski, 1994; Błaszkiewicz & Cieśliński, 1979).

INSTITUTIONAL ABBREVIATIONS

AMNH, American Museum of Natural History in New York, New York; Muz. PIG, Geological Museum of the Polish Geological Institute in Warsaw, Poland; PMA, Provincial Museum of Alberta in Edmonton, Alberta; TMP, Royal Tyrrell Museum of Palaeontology in Drumheller, Alberta.

TRACK DESCRIPTION

The footprints are directed east and preserved as a natural molds on the top of a gray wackestone bed (fig. 1).

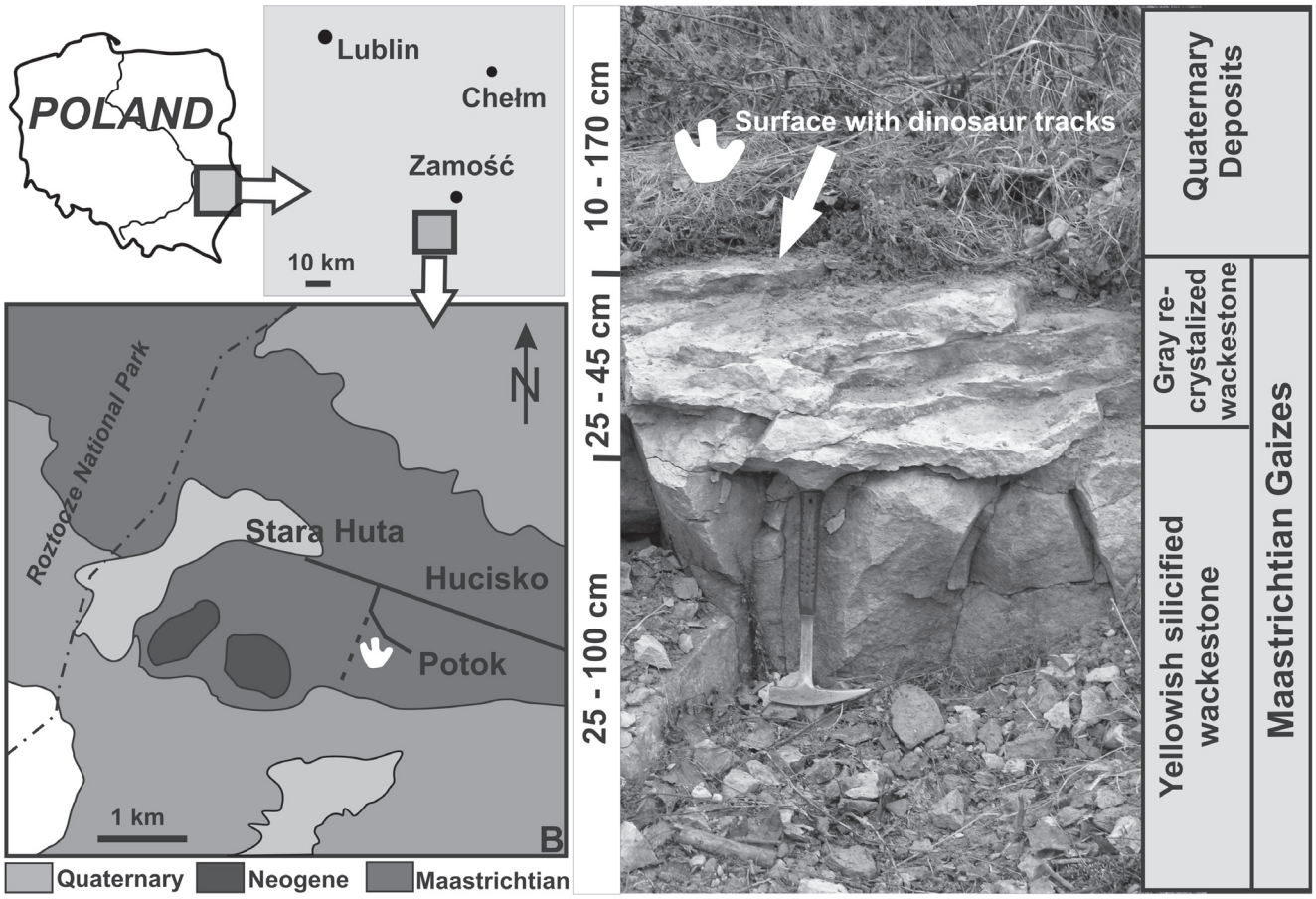

Figure 1 – Geographic and stratigraphic location of the dinosaur tracks in the vicinity of the Roztocze National Park, Poland. The geological map simplified from Kurkowski (1994).

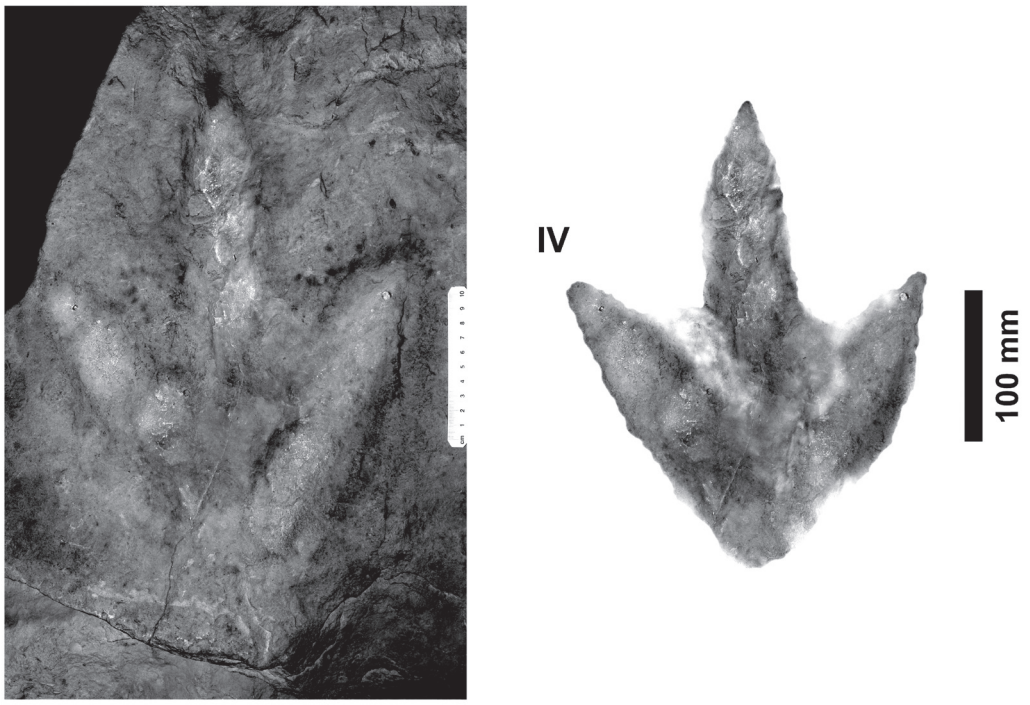

Figure 2 – Theropod footprint, *Irenesauripus* sp., Muz. PIG 1704.II.2, from Maastrichtian Gaizes of Potok, Roztocze, Poland.

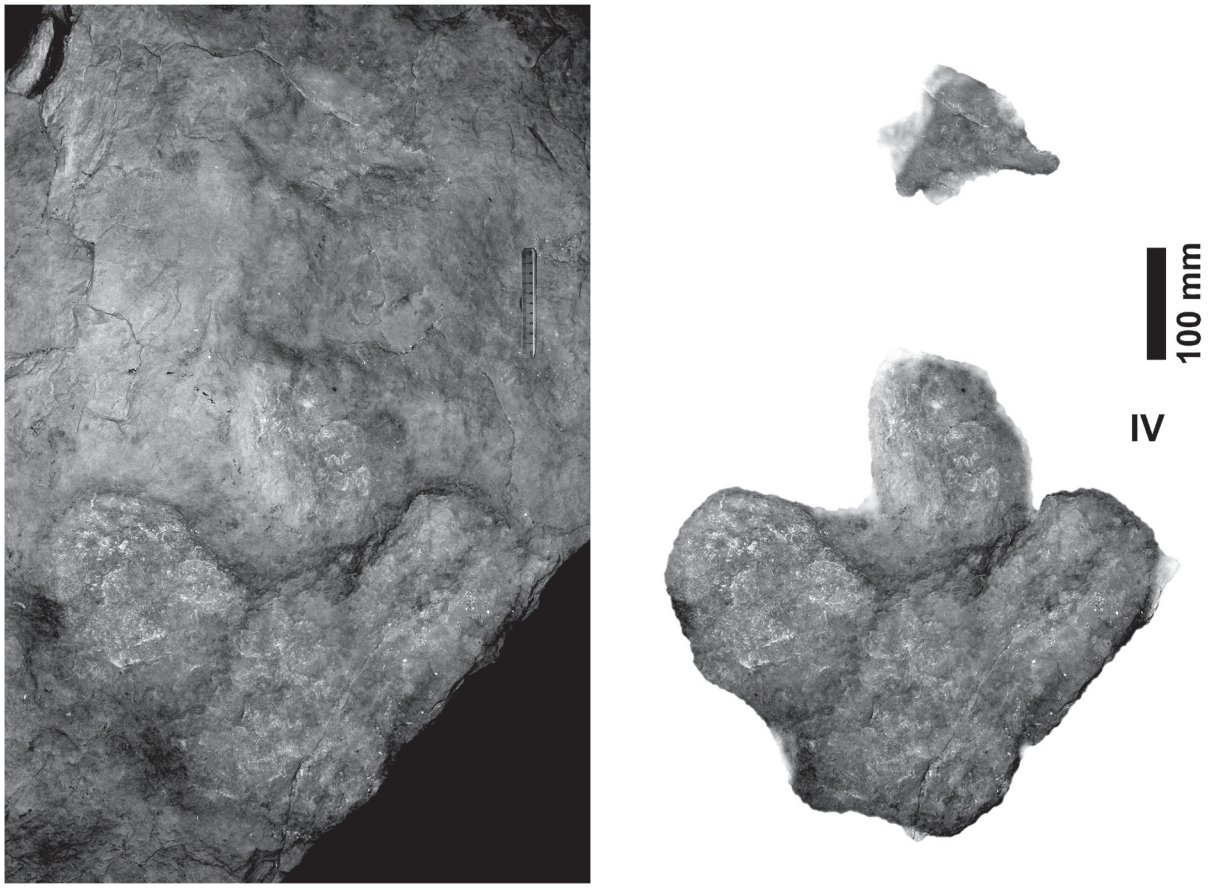

Figure 3 – Ornithopod manus-pes set, cf. *Hadrosauropodus* sp., Muz. PIG 1704.II.1 from Maastrichtian Gaizes of Potok, Roztocze, Poland.

The specimen Muz. PIG 1704.II.2 (fig. 2) is a sharp toed tridactyl footprint with the longest middle digit, which indicates its theropod affinity. The footprint is slightly longer than wide, 33 cm long and 26 cm wide. The middle toe of this footprint is highly projected beyond the hypex and its digits are narrow and widely divaricated. The angle between the axes of digit II and III is 30º, while that one between digit III and IV is 36º. The fourth digit metatarsophalangeal node (proximal pad) is located below the third toe, thus the footprint is V-shaped posteriorly. Digits are distinct, well seperated, with no phalangeal pads clearly developed.

The morphology of other pedal print Muz. PIG 1704.II.1 (fig. 3) is in contrast quite typical for large ornithopod tracks. The pes is large, wider than long, 47 cm wide and 42 cm long, with broad, blunt toes and large triangular metatarsophalangeal area (bilobed heel). Total digit divarication, the angle between the axes of lateral digit, is 55º. The middle toe axis shows an inward rotation. The pedal print is associated by the manus impression. Manus is smaller than the pes and rhombic (20 x 20 cm), located anterior to the apex of pedal digit III.

DISCUSSION

The medium to large V-shaped theropod tracks, similar to that one from Roztocze, with distinct and widely divaricated digits, with no discrete phalangeal pads, seem common in several Cretaceous track assemblages. Orginally this morphotype has been labeled as *Irenesauripus* Stenberg, 1932, and previously described from the Early Cretaceous Gething Formation of British Columbia. Later, Langston (1974) reffered to *Irenesauripus* Comanchean theropod tracks (fig. 4A) from the Lower Cretaceous of Texas. The Cameros large theropod tracks from the Lower Cretaceous of Spain also resemble this ichnogenus (fig. 4B). In the Upper Cretaceous, *Irenesauripus*-like forms occur evidently in the Neungju Group of South Korea (Huh et al., 2006) and Blackhawk Formation of Utah (Parker & Rowley, 1989). *Xiangxipus*, Zeng 1982 and *Chapus* Li et al., 2006 from the Cretaceous of China, seem also to be the junior synonyms of *Irenesauripus*.

Among the quadrupedal trackways of large Cretaceous ornithopods, rhombic manual print, like that one in our Roztocze ornithopod track (fig. 3) appears in *Caririchnium*

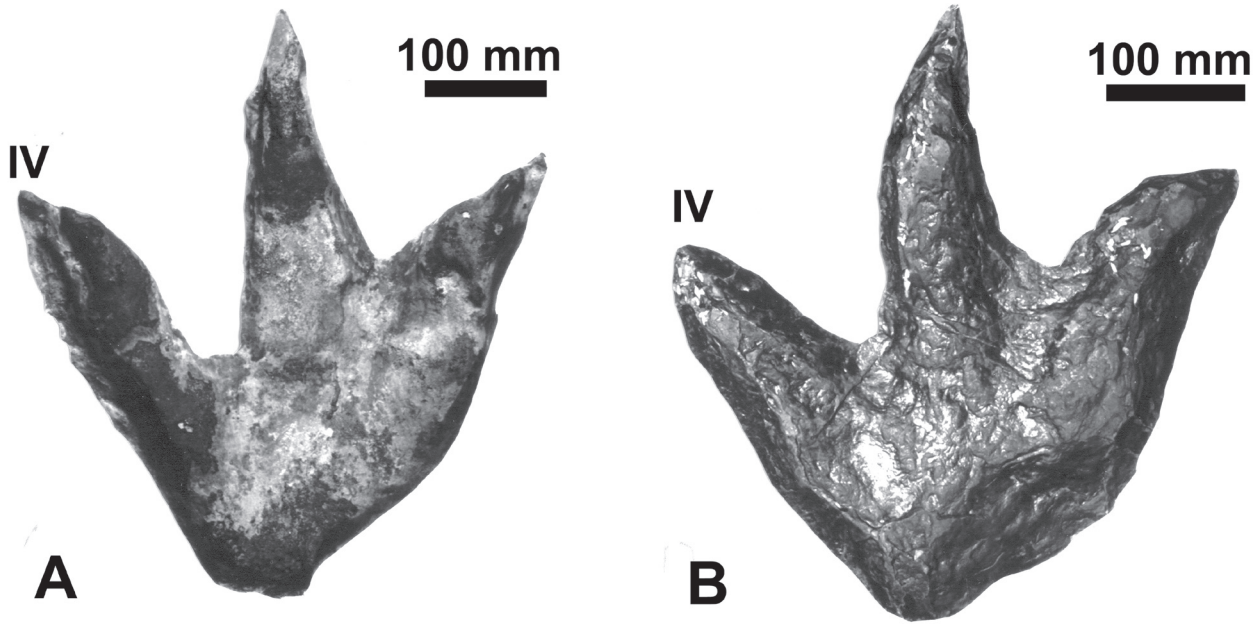

Figure 4 – The *Irenesauripus* footprint, AMNH 3065, from Comanche series (Aptian-Albian) of Dinosaur Valley State Park, Texas (A) and the similar ichnite from Cameros Basin, Enciso Group (Aptian) of Los Cayos site, Spain (B).

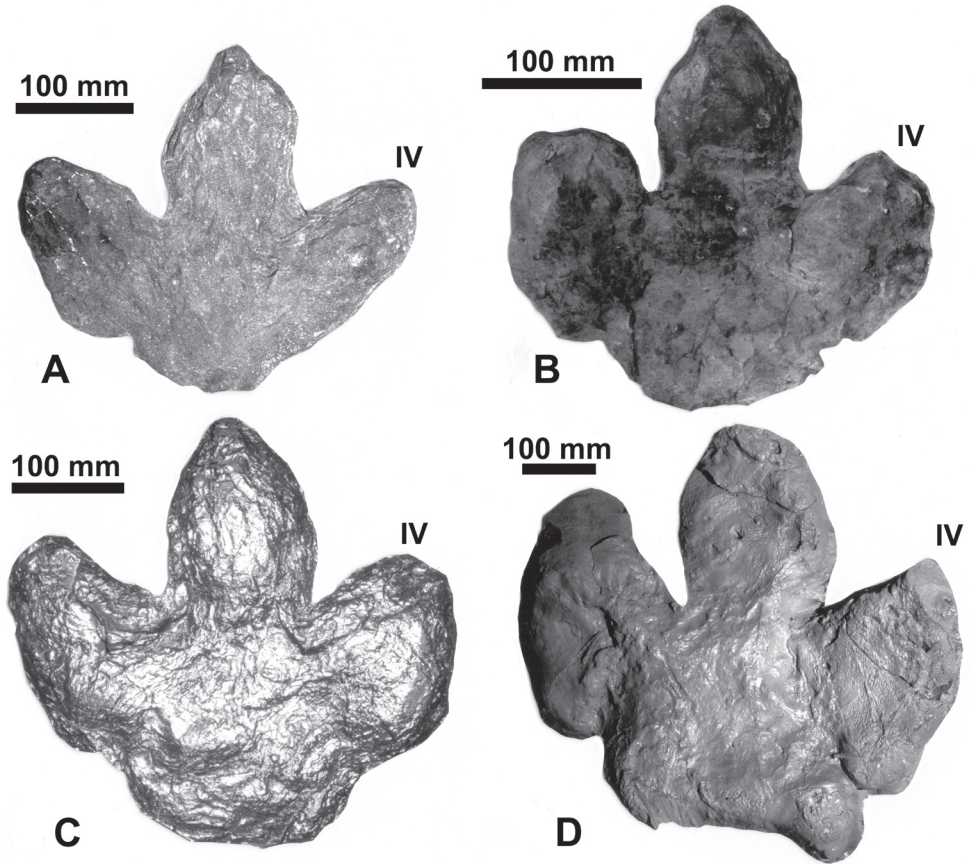

Figure 5 – Footprints of large Cretaceous ornithopods: *Iguanodontipus* sp. from Bückeburg Formation (Berriasian-Valanginian) of the Münchehagen Dinopark, Germany (A); *Caririchnium leonardii* Lockley, 1987 from Dakota Group (Albian-Cenomanian) of Dinosaur Ridge, Colorado (B); *Amblydactylus kortmeyeri* Currie & Sarjeant, 1979, PMA P76.11.11, from Gething Formation (Aptian) of Peace River Canyon, Canada (C); *Hadrosauropodus longstoni*, TMP 87.76.6, from St. Mary River Formation (Maastrichtian) of St. Mary River Valley, Canada (D).

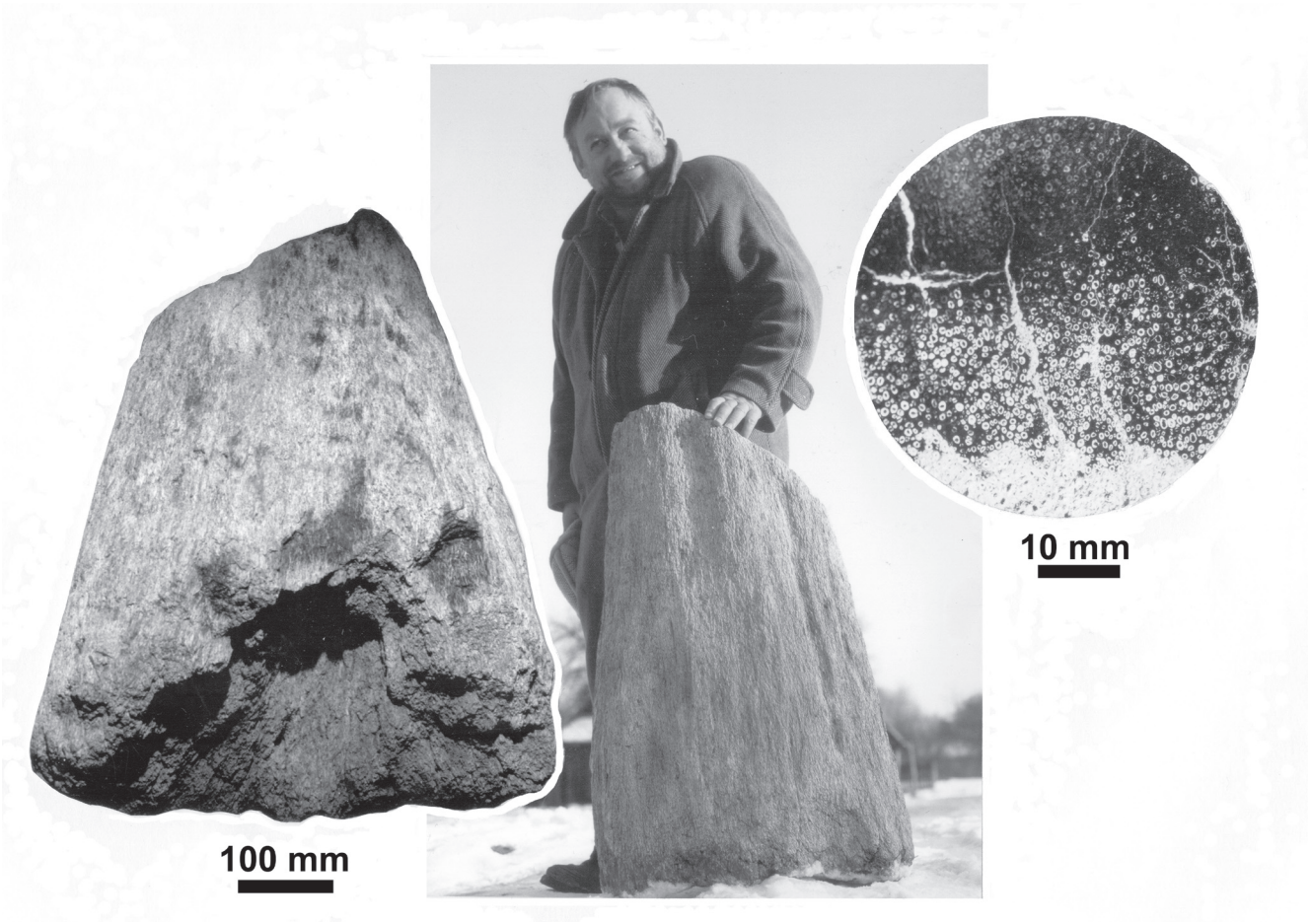

Figure 6 – *Tempskyaceae* indet. from the Maastrichtian Gaizes of Czarnystok, Roztocze, Poland. Oblique basal view of the petrified stem (A), the fossil trunk, with scale provided by Stanisław Jachymek, the specimen owner (B), and the close up of the polished cross section of the stem (C).

leonardii Lockley, 1987, from the Dakota Group (Albian-Cenomanian) of the Western United States. However, the Roztocze ornithopod pedal print, with its very short third digit, better fits footprints of seemingly more derived ornithopods than *Caririchnium* Leonardi, 1984 (fig. 5B), *Amblydactylus* Sternberg, 1932 (fig. 5C) and *Iguanodontipus*, Sarjeant et al., 1998 (fig. 5A). The morphology of our specimen seems close to such robust form as *Hadrosauropodus* Lockley et al., 2004 (fig. 5D) from the St. Mary River Formation (Maastrichtian) of Canada.

The Early Cretaceous *Iguanodontipus* is considered as an iguanodontid track (Sarjeant et al., 1998; Diedrich, 2004). The Early–Mid-Cretaceous ichnotaxa *Caririchnium* and *Amblydactylus* differ from *Iguanodontipus* by having large proximal metatarsophalangeal area, in other words, by having a better developed heel area. Both forms are indeed very similar, and Currie (1995) even suggested that *Caririchnium* is a junior synonym of *Amblydactylus*. Both are also interpreted as have been made by early hadrosaurids (e.g., Currie & Sarjeant, 1979; Lockley et al., 2004). However, the metatarsophalangeal area of *Hadrosauropodus* is even larger than in *Caririchnium* and *Amblydactylus*. Such huge bilobed heel, which is observed in *Hadrosauropodus* and the Roztocze specimen, appears just in the Late Cretaceous forms and indicates more derived hadrosaurids (Lockley & Wright, 2001).

In the Maastrichtian of adjoining region, hadrosaurid remains were reported from the Maastrichtian of Ukraine (Riabinin, 1945). Dalla Vecchia (2007) suggested that European Late Cretaceous hadrosauroids represent rather less derived forms than those from the Asia and North America. However, the most recent finds from Roztocze, at Młynarka Mt. site, revealed track assemblage similar to the Cretaceous dinosaur ichnofauna of Asia (Gierlinski, 2007).

The reported dinosaur tracks from Roztocze, as well as a huge stem (88 cm high) of the tempskyaceaean tree-fern (fig. 6) previously found in the Roztocze Maastrichtian Gaizes near Czarnystok (Wcisło-Luraniec, 2001), speak in favor of emergence of that area, during the Late Cretaceous. In contrast to the durable conifer and angiosperm wood, a little consolidated tree-fern trunk, which is composed of numerous siphonostelic stems, could not have been transported far over the sea in one large piece.

The studied region probably was a temporary

emerged part of a carbonate platform, near the western margin of the East European Land, in the Late Maastrichtian times.

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