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## Dinosaur ichnotaxa from the Lower Jurassic of Hungary

The Early Jurassic strata of the Mecsek Coal Formation of southern Hungary revealed new dinosaur tracks. Two ichnospecies of *Grallator tuberosus* (Hitchcock 1836) Weems 1992 and *Kayentapus soltykovensis* (Gierliński 1991) comb. nov. have been recognized. The ichnotaxonomy of *Kayentapus* is emended and supplemented by a ichnotaxon previously designated as "*Grallator (Eubrontes) soltykovensis*".

### INTRODUCTION

Occurrence of dinosaur tracks in Hungary is restricted to the Early Liassic deposits of the Mecsek Coal Formation, in the Pécs area. The first discoveries were reported from the Vasas mine and Komlo (A. Tasnádi Kubacska, 1967, 1968, 1970; L. Kordos, 1983). Later, dinosaur tracks were also found in the Pécsbánya mine (K. Hips *et al.*, 1989).

New material described herein was collected in September, 1995, in the Vasas and Pécsbánya opencast coal mines.

Contrary to L. Kordos (1983), the features of hitherto discovered ichnites from Hungary indicate their theropod affinity (not ornithischian, as L. Kordos postulated). The tracks resemble well known cosmopolitan theropod ichnotaxa of *Grallator* and *Kayentapus*.

**Abbreviation used in the text:** te — third digit projection beyond the lateral toes; fl — pes length; fw — pes width; Muz. PIG — Geological Museum of the Polish Geological Institute, Warsaw, Poland; LO — Geological Institute of the Lund University, Lund, Sweden; UCMP — University of California Museum of Paleontology, Berkeley, California, USA; MNA — Paleontological Locality Files of the Museum of Northern Arizona, Flagstaff, Arizona, USA.

## SYSTEMATIC DESCRIPTIONS

Suborder Theropoda Marsh 1881  
 Ichnofamily Grallatoridae Lull 1904  
 Ichnogenus *Grallator* Hitchcock 1858  
*Grallator tuberosus* (Hitchcock 1836) Weems 1992  
 (Pl. I, Figs. 2, 3)

**Material:** Muz. PIG 1624.II.1 (plaster cast) and uncatalogued track left in the field. The specimens found in the Pécsbánya mine, Hungary: coal seam 22 (Lower Sinemurian), Mecsek Coal Formation.

**Description.** — Both tracks are 24 cm long and preserved as natural molds. Tridactyl pes with third digit as the longest one. The lateral digits equal in length, which accounts for 74% of the third digit length. The angle between the digits II and III varies from 15 to 16°, while the angle between the digits III and IV varies from 18 to 19°. The pes proportion ratios are:  $te/fw = 0.65$  and  $0.72$ ,  $(fl-te)/fw = 1.13$  and  $1.15$ .

**Discussion.** — The pes measurement ratios of mentioned tracks (according to the method of R. E. Weems, 1992) correspond to the ratios of *Grallator tuberosus* (Hitchcock 1836) Weems 1992. However, the Hungarian examples are slightly larger (24 cm long) than those from the Newark Supergroup. The ichnotaxa referred by R. E. Weems (1992) to the ichnogenus *Grallator* comprised small tracks — less than 23 cm long.

Ichnogenus *Kayentapus* Welles 1971

- 1858 *Gigantitherium* Hitchcock; E. Hitchcock: p. 93 (in part).  
 1953 *Stenonyx* Lull; R. S. Lull: p. 159.  
 1953 *Apatichnus* Lull; R. S. Lull: p. 201 (in part).  
 1971 *Apatichnus* Lull; H. Haubold: p. 85 (in part).  
 1971 *Kayentapus* Welles; S. P. Welles: p. 32.  
 ?1983 *Komlosaurus* Kordos; L. Kordos: p. 504.  
 ?1986 *Schizograllator* Zhen, Li et Rao; S. Zhen *et al.*: p. 6.  
 ?1989 *Schizograllator* Zhen, Li et Rao; S. Zhen *et al.*: p. 191.  
 1991 *Grallator (Eubrontes)* Olsen et Galton; G. Gierliński: p. 138 (in part).  
 1991 *Grallator (Eubrontes)* Olsen et Galton; A. Ahlberg, M. Siverson: p. 339–340.  
 1992 *Kayentapus* Welles; R. E. Weems: p. 124.  
 1994 *Grallator (Eubrontes)* Olsen et Galton; G. Gierliński, A. Ahlberg: p. 101 (in part).  
 1994 *Grallator (Eubrontes)* Olsen et Galton; G. Gierliński: p. 283–284 (in part).  
 1995 *Grallator (Eubrontes)* Olsen et Galton; G. Gierliński: p. 33–39 (in part).  
 1995 *Kayentapus* Welles; M. Lockley, A. P. Hunt: p. 119.

**Type ichnospecies:** *Kayentapus hopii* Welles 1971, p. 32, figs. 2, 4A, from MNA 197, northern Arizona, USA: Kayenta Formation (Hettangian-Sinemurian).

**Included ichnospecies:** *Kayentapus hopii* Welles 1971, *K. minor* (Lull 1953) Weems 1992 and *K. soltykovensis* (Gierliński 1991) comb. nov.

**Diagnosis:** Bipedal, usually digitigrade. In the trackway, the pes directed forward. The functionally tridactyl pes with hallux and metapodium rarely imprinted. The digits are slender and highly divaricated. The third digit is the longest one.

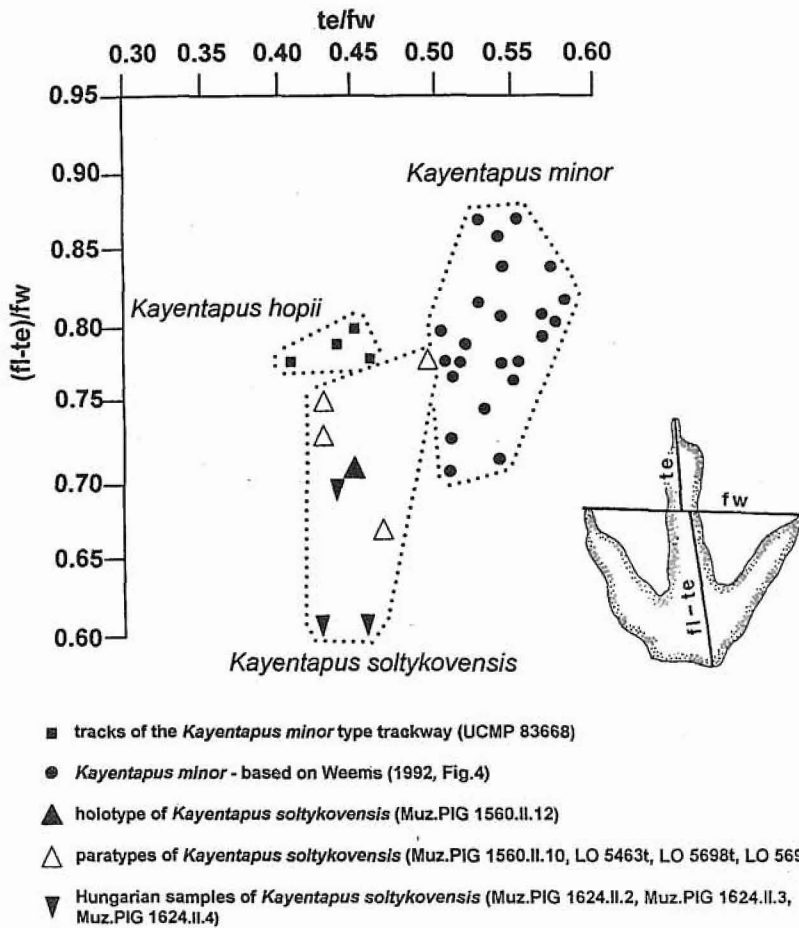


Fig. 1. Graphic separation of *Kayentapus* ichnospecies on the basis of pes proportion ratios, modified from R. E. Weems (1992)

Rozróżnienie tropów *Kayentapus* na poziomie ichnogatunkowym na podstawie wzajemnych proporcji geometrii tropów, zmodyfikowane z R. E. Weemsa (1992)

**Discussion.** — R. E. Weems (1992) has recognized two ichnospecies of *Kayentapus*: *K. hopii* Welles 1971 and *K. minor* (= *Apatichnus minor* and *Stenonyx lateralis* Lull 1953). Later both ichnospecies have been synonymized with *Grallator* (*Eubrontes*) *soltykovensis* Gierliński 1991 (G. Gierliński, 1994). Recently, M. Lockley and A. P. Hunt (1995) argue against the idea that grallatorids can not be distinguished on an ichnogenetic level. Such idea was presented by P. E. Olsen (1980), P. E. Olsen and P. M. Galton (1984), while in the opinion of R. E. Weems (1992), M. Lockley and A. P. Hunt (1995), *Grallator*, *Eubrontes* and *Kayentapus* are distinct ichnogenera.

Considering *Kayentapus* as a separate ichnogenus from *Grallator* and *Eubrontes*, three different morphological types could be recognized among *Kayentapus* tracks (Fig. 1). *Kayentapus hopii* Welles 1971 lies closer to *Eubrontes*, having third digit less projected in comparison to the pes width than *K. minor* (Lull 1953) Weems 1992 and *K. soltykovensis* (Gierliński 1991) comb. nov. In contrast, *K. minor* (Lull 1953) Weems 1992 is more *Grallator*-like shaped, showing relatively high projection of digit III in comparison to the pes width. *K. soltykovensis* (Gierliński 1991) comb. nov. is distinguished from *K. hopii* Welles 1971 and *K. minor* (Lull 1953) Weems 1992 by very wide angles of digit divarications.

Basically, the previously described Hungarian ichnotaxon of *Komlosaurus carbonis* Kordos 1983 is similar to *Kayentapus*. However, tracks on which this ichnotaxon was established differ from the Hungarian specimens described herein by one important feature. Their  $te/fw$  ratio is lower than 0.40, which is even lower than in any other Liassic *grallatorids*. On the other hand, *Komlosaurus carbonis* holotype comprised two small, very poorly preserved tracks and thus their measurements seem to be uncertain.

A Chinese *Kayentapus*-like form named *Schizograllator xiaohebaensis* Zhen, Li et Rao 1986 poses a similar problem. On the basis of figures published by S. Zhen *et al.* (1986, 1989), *Schizograllator* differs from the other *Kayentapus* ichnotaxa by a very low  $te/fw$  value of 0.35.

**O c c u r r e n c e .** — Upper Triassic and Lower Jurassic of North America: Newark Supergroup and Glen Canyon Group. Lower Jurassic of Europe: Helsingborg Member of the Höganäs Formation, Mecsek Coal Formation and Zagaje Formation. ?Lower Jurassic of southeastern Asia: Lower Fenjiahe Formation.

*Kayentapus soltykovensis* (Gierliński 1991) comb. nov.  
(Pl. II, Figs. 4–6)

1975 Theropodian footprints; C. Pleijel: p. 120.

1991 *Grallator* (*Eubrontes*) *soltykovensis* Gierliński; G. Gierliński: p. 138.

1994 *Grallator* (*Eubrontes*) *soltykovensis* Gierliński; G. Gierliński, A. Ahlberg: p. 101.

1994 *Grallator* (*Eubrontes*) *soltykovensis* Gierliński; G. Gierliński: p. 284 (in part).

1995 *Grallator* (*Eubrontes*) *soltykovensis* Gierliński; G. Gierliński: p. 35–39.

**M a t e r i a l :** Muz. PIG 1624.II.2–4 (plaster casts) found in the Vasas mine, Hungary: Mecsek Coal Formation (Lower Sinemurian).

**D e s c r i p t i o n .** — Tracks' length varies from 11.5 to 27.5 cm. All mentioned tracks are preserved as the natural casts. The pes is functionally tridactyl with third digit as the longest one. The length of digit II varies from 66 to 72% of length of digit III, while the length of digit IV varies from 82 to 91% of that of digit III. In the case of Muz. PIG 1624.II.3, the hallux impression appeared and the metapodium is partially imprinted.

The angle between the digit axes are: I–II = 66°, II–III = 33–34°, III–IV = 38–46°. The pes proportion ratios are:  $te/fw = 0.43–0.46$ ,  $(fl-te)/fw = 0.61–0.70$ .

**D i s c u s s i o n .** — According to the method of R. E. Weems (1992), the Hungarian *Kayentapus soltykovensis* tracks show the typical pes proportion ratios of this ichnospecies (Fig. 1). Their ratios are located far away from those of *K. hopii* Welles 1971 and *K. minor*

(Lull 1953) Weems 1992, in having the lowest values of (fl-te)/fw over the *Kayentapus* group.

Among the Hungarian tracks of this kind, three specimens were chosen to be presented herein. They show a wide range of morphological variations of the *Vasas* footprints. The specimen Muz. FIG 1624.II.2 (Pl. II, Fig. 4) reflected a classic example of *Kayentapus soltykovensis* (Gierliński 1991) comb. nov. The second one: Muz. FIG 1624.II.3 (Pl. II, Fig. 5), is the relatively rare form, which has been left during the semi-digitigrade locomotion. The third one: Muz. FIG 1624.II.4 (Pl. II, Fig. 6), represents the footprint of juvenile trackmaker.

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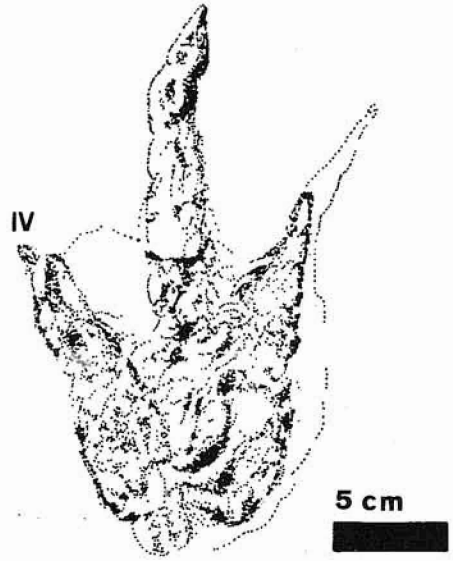
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## ICHNOTAKSONY DINOZAUROW Z DOLNEJ JURY WĘGIER

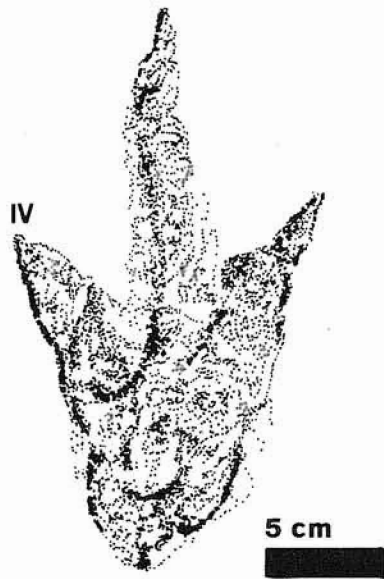
### Streszczenie

Węgierski materiał ichnologiczny dinozaurów pochodzi z wczesnoliasowej formacji węglowej Mecsek. Pierwszych znalezisk dokonano w kopalni Vasas i w Komlo (A. Tasnádi Kubacska, 1967, 1968, 1970). Na podstawie tego materiału L. Kordos (1983) ustanowił ichnotakson „*Komlosaurus carbonis*”, który interpretował jako ślady dinozaurów ptasiomiedniczych. Oznaczenie to jednak zdaje się podważać ich podobieństwo do dobrze znanego ichnorodzaju *Kayentapus* Welles 1971, identyfikowanego z teropodami (S. P. Welles, 1971; R. E. Weems, 1992; M. Lockley, A. P. Hunt, 1995). Aczkolwiek pewniejsze wyznaczenie przynależności ichnosystematycznej omawianych tropów ogranicza niezadowolający stan zachowania.

W 1995 r. w kopalniach Vasas i Pécsbánya zostały zebrane nowe okazy, których stan zachowania umożliwił precyzyjną identyfikację. Z Pécsbánya został rozpoznany *Grallator tuberosus* (Hitchcock 1836) Weems 1992 (tabl. I). W Vasas zostały znalezione tropy (tabl. II) poprzednio znane z dolnego liasu świętokrzyskiego i Skanii pod nazwą „*Grallator (Eubrontes) soltykovensis*” (G. Gierliński, 1991; G. Gierliński, A. Ahlberg, 1994). Przynależność ichnopodrodzajowa tej ostatniej, wymienionej formy opierała się na ichnotaksonomii grallatorów reprezentowanej przez P. E. Olsena i P. M. Galtona (1984). Autorzy ci rozróżniali grallatory na poziomie ichnopodrodzajowym, nie uwzględniając *Kayentapus* ani jako ichnopodrodzaju, ani też odrębnego ichnorodzaju. Taki typ klasyfikacji kwestionowany jest obecnie przez M. Lockleya i A. P. Hunta (1995), w wyniku czego „*G. (E.) soltykovensis*” Gierliński 1991 odpowiada definicji *Kayentapus*. Lokalizacja tych śladów w obrębie *Kayentapus* za pomocą metody R. E. Weemsa (1992) — fig. 1 — podtrzymuje ich niezależność ichnotaksonową jako *Kayentapus soltykovensis* (Gierliński 1991) comb. nov.



**Fig. 2**



**Fig. 3**

PLATE I

*Grallator tuberosus* (Hitchcock 1836) Weems 1992, from the Pécsbánya mine, Hungary; Mecsek Coal Formation (Lower Sinemurian)

*Grallator tuberosus* (Hitchcock 1836) Weems 1992 z kopalni Pécsbánya, Węgry; formacja węglowa Mecsek (dolny synemur)

Fig. 2. Muz. PIG 1624.II.1

Fig. 3. Uncatalogued specimen

Okaz niezinventaryzowany



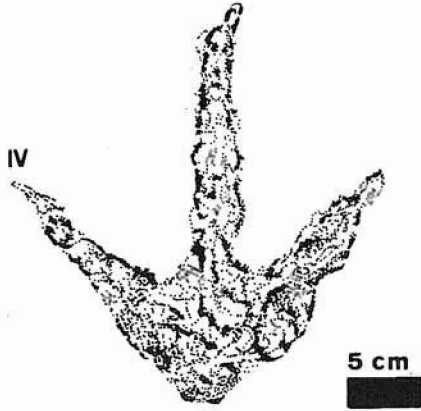


Fig. 4

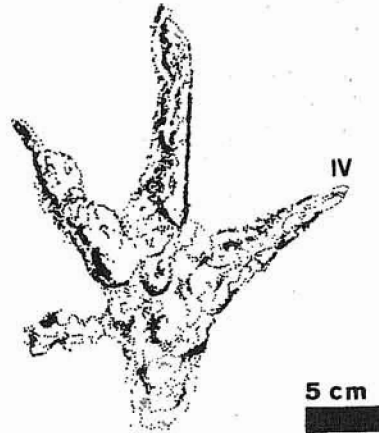
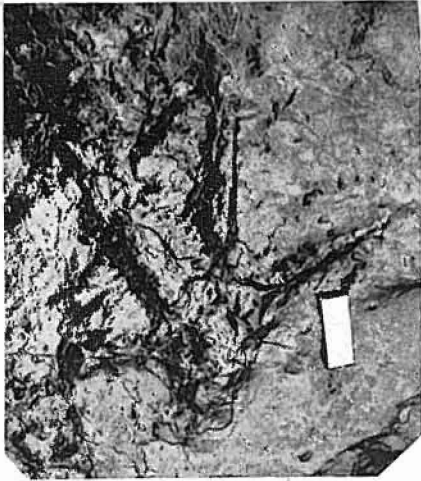


Fig. 5

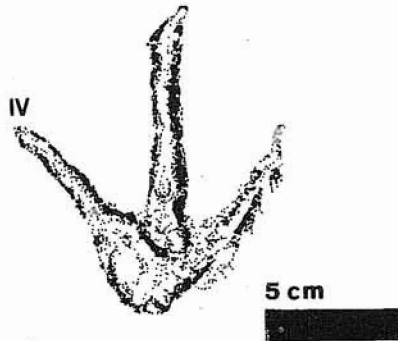


Fig. 6

PLATE II

*Kayentapus soltykovensis* (Gierliński 1991) comb. nov. from the Vasas mine, Hungary; Mecsek Coal Formation (Lower Sinemurian)

*Kayentapus soltykovensis* (Gierliński 1991) comb. nov. z kopalni Vasas, Węgry; formacja węglowa Mecsek (dolny synemur)

Fig. 4. Muz PIG 1624.II.2

Fig. 5. Muz PIG 1624.II.3

Fig. 6. Muz PIG 1624.II.4