FOOTPRINTS IN THE LOWER MIOCENE SANDSTONE OF IPOLYTARNÓC*

by

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HISTORY OF RESEARCH

Known since 1836 in scientific circles, the discovery of the fossil tree trunk of Ipolytarnóc was followed in 1900 by that of footprints in sandstones at the same locality by H. Böckh, then teacher at the Mining Academy of Selmeczbánya, and by botanist J. Tuzson. Commenting the discovery, J. Tuzson (1901) wrote as follows: "With Dr. H. Böckh, professor of Mining Academy, who was so kind to join the trip in order to scrutinize the geological setting of the trunk, this summer we discovered, on the aforesaid sandstone bench (a sandstone bench teeming with leaf and pine needle imprints lies closely to the trunk), the footprints of fossil mammals as well." J. Böckh, then director of the Geological Institute, gives, in his report on the year 1900 (published in 1902), already a more detailed description of what he termed the footprint sandstone, listing the first measures taken: "Dr. H. Böckh, Academy teacher at Selmeczbánya, called our attention, early that year, to the discovery he had made at a field trip of his at Ipoly-Tarnócz village (Nógrád County), a discovery which he explained quite correctly on the outset; stratigraphically, he placed it at the boundary between the Upper and Lower Mediterranean. The finds are represented by a sandstone plate (immediately under the andesite tuff) the surface of which is covered by a lot footprints deriving from various fossil mammals and also from birds. To save the unique finds, with the setting-in of drier summer weather, we took the necessary measures. On our request, T. Szontágh, senior mining engineer of the Geological Institute, came to the locality whom H. Böckh, the discoverer of the finds, was so kind as to accompany. Labour assistant I. Sedlyár was summoned to assist the two gentlemen. The products of the samplings are known deposited and exhibited at our museum now..."

Transported to the museum in 1900, the footprint sandstone slab was deposited in the corridor in front of what was then the museum. The catalogue of the museum alleged (L. Lóczy 1909) that the footprints had been discovered by foresters of the Ipolytarnóc region and then T. Szontágh and H. Böckh saved them from being lost to destruction. Footprints of "rhinoceroses, fossil deer and birds" have been identified on the sandstone slab. Fig. 7 of the catalogue is the first photograph ever published of the footprints, exhibiting rhinoceros prints.

As pointed out by A. Tasnádi Kubacska (1976), the excavations report of T. Szontágh contained no exact information on that part of the study area from which the sandstone slab in question derived. Measuring 270×250 cm, this specimen is deposited in the Great Conference Hall of the Institute.

Two additional large, probably contiguous, footprint sandstone slabs leaning against the wall of the mezzanine corridor of the Geological Institute were collected, on orders of director F. Nopcsa's, in the late 1920's, by preparator V. Haberl Sr. The original site of these slabs of 450×150 and 490×265 cm, respectively, could not be identified either (A. Tasnádi Kubacska 1976).

The next important step in studying the footprint sandstone was the organization in conjunction with the International Paleontological Meeting held in 1928 in Budapest of a special field trip to the locality. The renewed excavation and recovery operations were carried out, with preparator V. Haberl Jr's assistance, by A. Tasnádi Kubacska (1977) and the relevant geological description given in the excursion guide-book of that meeting was compiled by J. Noszky Sr (1928). The manifestations were attended by O. Abel who profited of the opportunity to gain information on the Ipolytarnóc footprints, data which he would quote in his book published a few years later (1935). In his opinion, at Ipolytarnóc there are footprints of two kinds of Rhinoceros (larger and smaller), Proboscidea (Deinotherium?, Mastodontidae?), smaller and larger deer (Palaeomeryx and Dicrocerus), *Anchitherium aurelianense* Cuvier, larger carnivores (Felidae, Machairodus?) and birds. To support his statements, he publishes six photographs (Fig. 139—144).

It was not with Abel's work, however, that the scientific evaluation of the footprints was initiated, for K. Lambrecht had dealt with larger bird footprints from Ipolytarnóc as early as 1912.

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As he put it very cautiously, these derive from a bird similar to or identical with *Gallinago gallinago*. He reiterates his conclusions in his palaeo-ornithological handbook (1933).

After the international meeting of 1928 no new originals were recovered from the footprint sandstone, as only plaster moulds were prepared some of which seem to have reached ABEL in Vienna. Eventually, the footprint-bearing sandstone portion then excavated, but left without conservation facilities, would be attacked by heavy erosion (A. TASNÁDI KUBACSKA, 1956).

After the excavations of 1901 and 1928, the third excavation of Ipolytarnóc was started in June 1937 by A. TASNÁDI KUBACSKA for the National Museum. During this work a rock slab, about 8 m^2 in size, containing for the most part rhinoceros footprints, was extracted. Transported to the National Museum, it is still available for studies, being a part of an exhibition. It was then that the availability of footprints in several layers of the sandstone laminae was discovered. The topmost prints of excellent preservation are contained in a rock slab underlain by a bed bearing "mastodon tracks" and plant remains. According to the excavation record published later by TASNÁDI KUBACSKA (1976), he identified footprints of rhinoceroses of calf's and adult's size, prints of both smaller and larger deer and mastodon as well coprolites of mastodons and bird footprints of varying size. O. ABEL's identification (1936) of a crocodile's external mould was considered by TASNÁDI KUBACSKA as mistaken.

The fourth excavation at Ipolytarnóc was launched by the Hungarian Geological Institute and it began, after a short field survey in 1956, in 1960 under A. TASNÁDI KUBACSKA's direction with the participation of Miss O. SZABÓ and Mr P. LAKATOS as permanent team members. The excavations lasted for 3 to 4 years. During this work the footprint-bearing surface was considerably widened and new footprints, first of all of carnivores and "mastodons", were discovered. On finishing their work, the excavators moulded the most valuable prints with paraffin and covered the surface with a plastic foil and then buried them with earth. To document the prints, they prepared a number of tracing copies on cellophane and plaster moulds of them. The pertaining records were summarized in popularizing works (1956, 1958, 1962, 1964, 1977) and professional papers (1976) by A. TASNÁDI KUBACSKA.

The fifth excavation project wast started in 1979, when investment in nature conservation was first made. In 1980 a Conservation Hall of 24×20.7 m ground area was built; in 1981 the protective layer was peeled off and then, in 1982, P. SOLT, preparator of the Hungarian Geological Institute, carried out fine-cleaning and preparation-conservation of the footprint sandstone surface. Next to follow was to start with a scientific re-examination of the locality.

Completed in 1980, the above-mentioned Conservation Hall has provided facilities for studying all but infinitesimal portions of the surfaces excavated by TASNÁDI KUBACSKA from 1937 to the late 1960's. Prior to that time, mainly sandstone surfaces rich in bird footprints had been known which, during the conservation developments, had been left untouched or reburied with earth.

79% (1,298 specimens) of a total of 1,644 individually distinguishable specimens is to be found under the roof of the Conservation Hall. The locations and symbols of the prints involved in the processing are given, with indication of the number of specimens in question, in Table 1.

The traces of a total of 11 animal species could be distinguished, a quantity to which the prints of the question-marked proboscideans and unidentifiable animal species are added. The number and frequency of the individual taxa and, respectively, their frequency recalculated on the basis of legs belonging to one specimen are listed, in decreasing order of succession, in Table 2.

Most frequent among the taxa are the rhinoceroses which are followed by the artiodactyls, birds and carnivores.

During the examination we have sought to study only original specimens and to resort to studying plaster moulds in case of emergency. To study the sandstone slab of a size of about 80×100 cm in the Hungarian Geological Institute and the large sandstone plate kept in the cellar of the Museum of Natural History has been impossible, owing to their being for the moment inaccessible. The wood-framed plaster mould retransported from the Hungarian Geological Institute to Ipolytarnóc and 25 to 30 plaster negatives of larger size made in the 1960's could not be studied either.

Ichnoordo: **Avipedia** VIALOV, 1966

Research into bird footprints began with the genus Ornithichnites which later proved to belong to a tetrapod and which was described by E. HITCHCOCK from the "New Red Sandstone" of Massachusetts (USA) in 1836. There is still some uncertainty about the attribution of prints of birdlike animals of the Cretaceous, too, since *Ignotornis macconelli* MEHL, 1931, a form described from the Dakota Sandstone, Kansas, USA, also does not seem to derive from birds. From the same Formation F. H. SNOW described a real bird print which derives from a big four-toed animal (1887).

Containing the first distinct bird prints ever found, the Eocene deposits are known to include already a host of bird print localities that are easy to overview owing to the summarizing works of K. LAMBRECHT (1933), O. ABEL (1935) and O. KUHN (1963). On evidence of these works and of subsequent information, the bird footprint remains known are as follows.

— From the Cretaceous of Algeria, PERON and LE MESLE (1880) and eventually E. AMBROGGI and A. F. LAPPARENT (1954) distinguished a larger type of bird prints (24 cm) and a smaller one.

— From the Upper Cretaceous locality Ybbsitz, Austria, O. ABEL published a three-toed bird footprint of 11-mm-length (1904, 1935).

— In France (Garrigues) an Upper Eocene footprint bed with finds of Artiodactyla, Perissodactyla, Carnivora and birds was discovered (P. ELLENBERGER, 1980).

— From the Eocene gypsum-bearing sequence of the Parisian Basin, M. J. DESNOYERS (1859) and eventually S. MEUNIER (1906), K. LAMBRECHT (1933) and O. ABEL (1935) reported 20-cm-long traces of *Gastornis* sp.

— Impressions of *Ornithichintes taurinus* and *O. argenterae* PORTIS (1879) from the Eocene of the locality Argentera, Italy, have already been known since the last century, too.

— From the Oligocene of Germany, G. BOEHM (1896, in O. ABEL, 1935) described, along with footprints of tapirus species, bird footprints referred to as *Ornithoidichnites badensis* as well.

The Avipedia finds from Spain are significant too. The locality Peralta de la Sal is mentioned by F. HERNANDET-PACHECO (1929, in O. ABEL, 1935). From the Lower Oligocene of northern Spain footprints of webbed birds are known (J. S. M. DE RAAD et al., 1965), while from Agramunt of Lérida, along with two Suiformes, three different kinds of bird footprints are reported (L. CASANOVAS-CLADELLAS—J. VTE. SANTAFE-LLOPIS, 1982).

Neogene bird footprints are known, in addition to the very significant Ipolytarnóc finds, from Switzerland, Rumania and the Carpathian Ukraine of the USSR (Table 3).

— From Switzerland, J. SPECK reported two different types of bird footprints of the Burdigalian "Luzernsandstein" by the Lake of Zurich (1945) which he connected with the families Cursoriinae and Charadriinae. From the footprint-bearing rock wall of Goldauer Bergsturz, another Swiss locality, two different types of bird footprints are known (H. BRÄM, 1954) — one of a larger, three-toed bird carrying a small skin gill between the toes (finger lengths 5.5, 7.5 and 4.4 cm respectively, their angle 50°) and a smaller three- toed one (6.8- and 6-mm-long, angle 30° to 40°).

— From Rumania, H. G. GROZESCU (1914) was the first to figure the footprints of a Burdigalian wader from the Frumosa Beds in Bacău County. Later, in 1939, during geological mapping in the Porcului Valley near the village Andreiașul de Jos in Putna County, the footprints of a 22- to 30-m-long webbed birdlike animal were discovered. The bird footprints of the sandstone bed within Helvetian shaly marls were believed by M. PAUČA (1942) to be related to the genera Larus or Sterna. At the junction of the rivulets Putna and Zabola running accross Vrancea area there are beds rich in footprints. Overlying Aquitanian-Burdigalian breccias, the Lower Helvetian red- and dark grey beds contain footprints of proboscideans, carnivores, artiodactyls and birds (N. PANIN, 1961, 1964; N. PANIN—E. AVRAM, 1962). From among the birds the new genera and species *Ardeipeda egretta*, *A. gigantea*, *A. incerta*, *Gruipedia maxima*, *Charadriipeda recurvirostrioidea*, *Ch. minima*, *Ch. disjuncta*, *Ch. becassia* and *Antipeda anas* were described, in 1962, by N. PANIN and E. AVRAM.

The third Rumanian locality is near Pietra Neamț, in the Miocene molasse sequence of the eastern Carpathians (N. PANIN, 1964). The vertebrate footprints are contained in the so-called red beds constituted by green and red sandstones, flysch-type marls and the Upper Conglomerate of Almașu. The red beds are underlain by the Lower Conglomerate of Almașu containing common and potash salt deposits. Along with mammal footprints (Felidae, Artodactyla), the following bird footprints were recovered: *Charadriipeda minor*, *Gruipedia intermedia*, *Anatipeda* sp. (N. PANIN, 1964).

— In the Soviet Union, in the Lower Miocene (Burdigalian) molasse sequence of the Carpathian foreland between the towns of Delyatin and Dobrotov, on the bank of the river Prut, a footprint locality of a wealthy literary record lies (O. S. VIALOV—K. K. FLEROV, 1952, 1953, 1954; O. S. VIALOV, 1965, 1966). The footprint-bearing, so-

called Dobrotov Beds are split up into two parts: a lower, more sandy member and upper, more argillaceous one. On the surface of the lower, sandstone bed, along with traces of rain droplets and ripple-marks, the footprints of three bird species (*Avipeda phoenix, A. sirin* and *A. filiportatis*), three carnivores (*Bestiopeda bestia, B. sanguinolenta* and *B. gracilis*), one equuid (*Hippipeda aurelianis*) and eight Artiodactyla [*Pecoripeda (Gazellipeda) gazella, P. (G.) amalphea, P. (Ovipeda) satyri, P. (O.) diaboli, P. (O.) djali* and two *Pecoripeda* sp.] were discovered and/or described (O. S. VIALOV, 1965, 1966).

The bird footprint finds of Ipolytarnóc were registered already at the discovery of the footprints in the sandstone (J. BÖCKH, 1902) and eventually the first scientific evaluation was soon carried out too. K. LAMBRECHT (1912) could study three deep and intact bird footprints and an indistinct one on a sandstone slab which T. SZONTAGH had collected in 1900. Resembling to *Gallinago gallinago*, the footprints are presented, in Plate I of his paper, by K. LAMBRECHT, who eventually repeats his ideas and his photographic documentation, in his book of 1933. A. TASNÁDI KUBACSKA (1976) first quotes two bird footprints of varying size, then M. KRETZOI (1966) distinguishes three different types of bird footprints and, finally, again A. TASNÁDI KUBACSKA (1976) makes five ones distinct. These are characterized by him as follows.

1. "In the case of the swimming and wading birds, at the point where the three toes meet, i.e. with the round impression of the distal end of the pastern an additional characteristic feature is gained. At Ipolytarnóc we have found one trace of this kind (Fig. 3)."
2. "largest type of trace: 46 mm";
3. "most frequent type of trace: 25 mm";
4. "smallest type of trace" 20 mm;
5. "In addition, at one point we discovered a very small bird footprint of the size of a sparrow."

The independence of type 1 is refuted by the fact that an ample variety of footprints of type 3 has been observed and that, on evidence of this, such "distal round impression" forms must be regarded as transitional between footprints suggesting a foot with three completely separate toes and ones suggesting an undigited foot.

Type 2 is undoubtedly of extraordinary size, but on evidence of its morphology and of several finds coming close to it in size, it must be considered an extreme variant of type 3.

Undoubtedly most frequent at Ipolytarnóc, type 3 corresponds to Lambrecht's Gallinago (1912, 1933).

Type 4 ("the smallest type of footprints") differs both in size and morphology quite distinctly from type 3, suggesting the presence of an independent taxon.

Type 5 is represented by several specimens, thus being well separable from the other types.

Having revised Tasnádi's types, we are now able to distinguish three different types of footprints to which the newly discovered type with the impression of the hind, i.e. fourth, toe preserved is added.

The final conclusion drawn from the earlier international review was that the bird footprints of Ipolytarnóc could not be identified with any of their counterparts described elsewhere and that they differed very considerably from the taxonomically named footprints and that, for this reason, they must be described as new genera and species. Provisions for this are stipulated in the International Code of Zoological Nomenclature. We shall refrain from a consistent use of the too bureaucratic nomenclature proposed for the vertebrates, for those nomenclatural principles are, as formulated at present, to be regarded merely as recommendations (O. S. VIALOV, 1960, 1965, 1966; N. PANIN, 1964; N. PANIN—E. AVRAM, 1962). Respecting, naturally, the priority of footprint taxa described previously according to the rules of nomenclature, we hold it advisable to separate under new names the types that are distinguishable even at the generic level.

Ichnogenus: *Ornithotarnocia* n. ichnogenus.

Genoholotypus: Ornithotarnocia lambrechti n. g., n. sp.

Derivatio nominis: Ornitho = a reference to the presence of a bird; tarnocia = after the name of the type locality — Tarnóc.

Diagnosis: the same as for the species.

Ornithotarnocia lambrechti n. ichnospecies

Text-fig. 1—4, Pl. I—II

Holotypus: The prints of the right and left feet belonging to the one and the same animal and numbered 9 and 12 on the footprint sandstone slab deposited as No. V. 12721 in the Palaeovertebrate Collection of the Hungarian Geological Institute Text-fig. 1, Pl. I.

Derivatio nominis: Dedicated to the honour of palaeornithologist K. LAMBRECHT who studied this type of Ipolytarnóc footprints including the present holotype.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Bird print of medium size consisting of three toes. Biggest is the print of the middle toe, widening gradually towards the proximal third and having a pointed end. The following is the print of the outer toe, it's morphology is similar to the middle one. The inner toe is of variable, funnel-shaped. The three toe-prints are approximatelly symmetrical.

Material studied: see Table 4.

Description, dimensions: The most frequent form of the traces in question are three impressions, independent from one another, subsymmetrical and pointed toward a central apex. In such cases all three have a lanceolate ground-plan that is slightly impressed. In rare cases, the short triangular-plan prints of single claws are even discernible (Text-fig. 2—4, Pl. I—II). *Ornithotarnocia lambrechti*, the most common species of the genus, is characterized by the smallest size of all. The measuring points of the bird footprints are given in Fig. 5, the individual data are contained in Table 5.

In case of bird sole impressions deepened into a soft soil or more strongly impressed the linkage of the middle toe and one of the extreme toes results in a half-sole print, the other extreme toe being contorted or scarcely visible. In rare instances, this is the case when the form observed by A. TASNÁDI KUBACSKA with a dinstinct circular print at the distal end is formed. The footprints of this kind are least conspicuous, their size, especially the value of the angle between the toe joints, varying between extremely wide limits.

In case of a complete sole impression the three toes give a wide and deep print of rounded edge the elements coalescing into a uniform impression. A pair of such complete forms is represented by the holotype too. It is a comparatively rare type of greatest size dimensions, in which the morphology of the inner and outer toes is most distinct. The size values calculated from the holotype and all the measurable footprints of *Ornithotarnocia lambrechti* are listed in Table 6.

Remark: A. TASNÁDI KUBACSKA (1976) gives the drawing and dimensions of the one and the same bird in Text-fig. 4. The data represent projections, thus being unsuitable for comparison. In case of stride length two kinds of size can be determined:

1. half stride length when the straight line measured from the proximal end of one foot to the distal end of the other foot is calculated [in the present work, the designation "right/left" is used],

2. it is the straight distance between the proximal and distal ends of two prints of one and the same foot that is measured. This is the full stride length which, in case of bird footprints, is distinguished by designations "left—left" or "righ—right", respectively.

The holotype forms a half-footprint which is 100 mm across. The data of the measurable stride traces are contained in Table 7.

Although footprints and stride tracks may largely differ in size, the dimensions, when correlated with the morphological types, will provide clues to the taxonomic characterization of the footprints.

Ichnogenus: *Aviadactyla* n. ichnogenus.

Genoholotypus: Aviadactyla media n. g., n. sp.

Derivatio nominis: from the composition of the words Avis (bird) and dactylus (finger).

Diagnosis: the same as for the species.

Aviadactyla media n. ichnospecies

Text-fig. 6, Pl. III

Holotypus: Prints of the left and right feet of one and the same animal. Numbered as No. 18 and 20 respectively, the footprints are borne on a sandstone slab deposited under inventory number V. 12,729 in the Palaeovertebrate Collection of the Hungarian Geological Institute (Text-fig. 6).

Derivatio nominis: reference is made to the medium size (media) compared to the rest of the Ipolytarnóc bird footprints.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Bird footprint of small to medium size consisting of three toes. The prints of all three toes are thin, stick-like, shallowly imprinted. Longest is the middle toe, to be followed by the gradually shorter inner and outer toes. The distal end of the inner toe print is, in normal case, farther away from the basic line (the line normal to the middle toe) than the end of the middle toe print. Consequently, it is slightly asymmetric.

Paratypus: 1. Print No. 1 on plaster mould No. V. 12,730 in the Fossil Vertebrate Collection of the Hungarian Geological Institute (Text-fig. 6).

2. The only print on plaster mould No. V. 12,731 in the same collection (Text-fig. 6).

Material studied: see Table 8.

Description, dimensions: The middle toe print is completely straight, parallel-edged, its ends rounded. Proximal end more strongly imprinted into the rock than the distal one. The inner toe leaves a more pronounced, also parallel-edged, stick-like print which, unlike the case of the middle toe, is more deeply imprinted into the soil at its distal rather than proximal end. In case of a shallow print (paratype 2) some toe prints are tapering towards their proximal ends, becoming slightly arched. An imprint of normal development (paratype 1) is characterized by what is stipulated in the description. In a single case (print No. 24 on the rock slab containing the holotype-pair) an impression with toe prints ending in a narrowing sole and converging has even been observed, where the difference in size between the prints of the outer and inner toes and their asymmetry are particularly conspicuous (Text-fig. 6, Pl. III).

The individual and average dimensions of the holotype, the two paratypes and the other *Aviadactyla media* n. sp. specimens are given in Table 9. The individual data of all the measurable traces are to be found in Table 10.

It is evident from the holotype-pair that the stride is not rectilinear as in the case of Ornithotarnocia, but it deviates considerably from the direction of walk. The deviation of the right and left feet from the direction of walk is 50°, the half stride length is 45 mm. That this pair of footprints reflects a state of rest rather than stride is quite possible, but the data available are insufficient for settling the problem.

Ichnogenus: *Tetraornithopedia* n. ichnogenus.

Genoholotypus: Tetraornithopedia tasnadii n. g., n. sp.
Derivatio nominis: reference is made to the four-toed footprint.
Diagnosis: the same as for the species.

Tetraornithopedia tasnadii n. ichnospecies

Text-fig. 7

Holotypus: footprint No. 326 on the rock slab of original position kept in the Conservation Hall at Ipolytarnóc (quadrangle d7).
Derivatio nominis: in honour of A. Tasnádi Kubacska.
Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.
Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Contiguous bird sole print on which the three fore-toes are well developed, the hind toe print, though rudimentary, being quite distinct. The print of the anterior middle toe (III) is straight, widening gradually towards the proximal end and having a pointed end. The inner toe (II) is also straight, parellel-edged, of a character similar to that of the middle toe print. The print of the outer toe (IV) is heavily arched, widening towards the centre and then ending in a pointed apex. Its distal sole junction is the widest compared to the others. The hind toe (I) is a little bit displaced towards the inner side and after a little widening it shows a droplike narrowing and a rounded end.

Material: 5 specimens (numbered 191, 323, 326, 327 and 328, respectively) under the roof of the Conservation Hall at Ipolytarnóc.

Comparison: Tetraornithopedia tasnádii n. sp. can be separated from *Ornithotarnocia lambrechti* only in case of complete and distinct finds. Tetraornithopedia corresponds in dimensions to Ornithotarnocia maxima, so, in case of the presence of only toe prints, they may be confounded with each other. Represented by a greater number of deeply imprinted, full-sole specimens, the Ornithotarnocia footprints never had the imprint of the hind Ist toe, whilst in the case of the similar or just less intact Tetraornithopedia specimens the imprint in question could always be identified.

The *dimensions* are contained in Table 11 (under No. 6a the straight distance between the proximal and distal ends of the footprint is to be understood).

Ichnogenus: *Passeripedia* n. ichnogenus.

Genoholotypus: Passeripedia ipolyensis n. g., n. sp.

Derivatio nominis: reference is made to the presence of a footprint characteristic of the size of that of song-birds (Passeriformes).

Diagnosis: the same as for the species.

Passeripedia ipolyensis n. ichnospecies

Text-fig. 8

Holotypus: footprint No. 12 on the large original sandstone slab (No. II) exhibited in the mezzanin corridor of the Hungarian Geological Institute.

Derivatio nominis: after the river Ipoly flowing close to the locality and figuring in the name Ipolytarnóc.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Impression of small size consisting of three independent toe prints. The outline of the middle toe resembles to an oat grain, that of the extreme toes rather to a stick. A little asymmetric, the outer and the middle toe prints standing closer to each other than the middle toe to the inner one.

Material: 3 specimens, (Nos. 12, 34, 96) corridor II, of the Hungarian Geological Institute. The *dimensions* are given in Table 12.

In the case of footprint No. 34, even the outline of the distally elongated sole imprint is observable.

Ichnoordo: **Carnivoripedida** Vialov, 1966

Footprints of carnivores are not unfrequent among European Oligocene, Miocene and Pliocene traces of animal activity.

— In Spain a complete "Paleo-Felido" sole imprint is known from Site No. I of the locality Vilanova de la Aguda (L. Casanovas-Cladellas—J. Vte. Santafe-Llopis, 1974).

— In Austria, O. Abel (1935) was the first to report the footprints of a carnivore from the Pliocene Rohrbach Conglomerate, and then E. Thenius (1967) succeeded in distinguishing four types of it: footprints of an animal of a cat's size (*Bestiopeda* sp.), that of a leopard-like animal (*Bestiopeda* sp.), that of an Amphicyonid-like one (*Bestiopeda amphicyonides* Thenius) and that of an animal resembling the mustelids (*B. guloides* Thenius). The genus Bestiopeda was established in 1965 by Vialov who based it on *B. bestia* Vialov he had found at Dobrotov locality. From the same locality he described two more carnivores, *B. sanguinolenta* and *B. gracilis*.

— On dealing with fossils from a Rumanian Miocene footprints locality, N. Panin—E. Avram (1962) improved the systematics of carnivore footprints and eventually they established new subfamilies, genera and species. Within the Carnivoripedae family established by Vialov (1961), they distinguished between two subfamilies (Canipedinae, Felipedinae) and two genera *(Canipeda longigriffa, Felipeda lynxi)*.

The first carnivore footprint from Ipolytarnóc was described and figured by O. Abel (1935, Abb. 144). On his opinion, it derived either from an Amphycion or a felid carnivore. Eventually, E. Thenius published a drawing of what he believed to belong to the genus *Hyaenaelurus* sp. (1948, Fig. 1a). The original of this first—controversial—carnivore find is missing from the Hungarian museums and even duplicates are not known to us. A. Tasnádi Kubacska (1976) alleged that this footprint had included even the imprints of the claws at the intact toe tips. He doubted the alleged felid origin of this footprint. New carnivore footprints were discovered by him during the excavations of 1963. In his opinion, the three juxtaposed prints deriving from one and the same animal belonged to Amphicyonida (1976, 1977).

In addition to Abel's carnivore finds and to Tasnádi's discoveries of 1963, the Palaeovertebrate Collection of the Hungarian Geological Institute includes the plaster mould of another carnivore footprint (its location under the roof of the Conservation Hall is well-known). In the course of the elaboration carried out parallel with the local excavation and nature conservation investment projects launched in 1981 new carnivore traces have come into the fore. As far as our present-day knowledge goes, four types of carnivore footprints from the locality Ipolytarnóc could be distinguished: *1.* Abel's find, *2.* blurred footsprints of medium to great size, *3.* an assemblage consisting of the three footprints, recorded by Tasnádi Kubacska and *4.* small-sized traces of soles and nail-rows of carnivores.

The distinction in the literature of Neogene carnivore traces between felids and canids is rather controversial (conf. N. Panin—E. Avram, 1962 and E. Thenius, 1967), at the same time, their nomenclature is homogeneous (O. S. Vialov, 1965, E. Thenius, 1967) or, on the contrary, differentiation-minded (N. Panin—E. Avram, 1962). For this very reason, being aware of the heterogeneity of the carnivores in Neogene times and their remote kinship ties, we think it to be prematureto take a stand now in this controversy.

Ichnogenus: *Bestiopeda* VIALOV, 1965.

Bestiopeda maxima n. ichnospecies

Holotypus: O. ABEL (1935), Fig. 144; E. THENIUS (1948) Abb. 1a. Its original was recovered, in 1900, from Ipolytarnóc, by T. SZONTAGH; neither the original, nor a reproduction of it is known to be available in a Hungarian public collection.

Derivatio nominis: maxima = greatest, a reference to the presence of the largest known Neogene footprint of a carnivore.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Carnivore footprint of great size. Sole impression proximodistally flattened with five separate toe prints of oval plan-view. In the median of the footprint is the largest (IIIrd) toe. The Vth toe is displaced into an extreme position, its proximal end falling in one line with the distal apex of the Vth toe. No trace of claw apex visible.

The *dimensions* are given in Table 13. Those of *Bestiopeda maxima* n. sp. can be measured from the figures published by Abel and Thenius, where the fossil is figured on photograph and drawing with a size reduction of 1/5 and 1/6 respectively. The points of measurement are shown in Text-fig. 9.

Comparison: Added to the large size, the oval shape of the sole print and the toe prints shows great resemblance to the *Bestiopeda amphicyonides* THENIUS find. In the case of this latter the toe prints are closely juxtaposed, the Vth toe is not displaced into an extreme position and no claw apex is present.

In spite of the similarities between the two large carnivore footprints, no close relation can be supposed, owing, for that matter, to the marked chronological difference between them (Lower Miocene and Pliocene, respectively).

Bestiopeda sp.

Text-fig. 10—11, Pl. VI, figs. 1—2

From among the footprints of *Bestiopeda* sp. a total of 11 specimens are known. Recovered by chisel from quadrangle l14 of the surface under the roof of the Conservation Hall of Ipolytarnóc, one footprint was reproduced in form of plaster mould which is now deposited under inventory No. V. 12732 in the Palaeovertebrate Collection of the Hungarian Geological Institute, while the original is unknown. Since 1981 10 more finds, including fragments of footprints, have been recovered at the original site under the roof of the Conservation Hall, of which Nos. 273, 276 and 840 are most intact and complete, the rest being limited, for the most part, to toe prints only (Nos. 211, 245, 252, 253, 259, 261 and 275).

The sole part of the *Bestiopeda* sp. footprints is proximo-distally elongated. Their rounded IVth or Vth toe prints are separate and, in several cases, only single toe prints are available. The most complete footprint (plaster mould of inv. No. 12732, Pl. VI, fig. 1) has a bifid sole part. Its proximal part is in the shape of a bean, the distal half of it adding an oval rounded edge to the outline of the footprint. It is the contact between the IVth and IIIrd toes rather than the largest, IIIrd toe, that lies in the median of the footprint. Consequently, the Ist toe is blocked between the IInd toe and the sole print margin. This latter is often impossible to separate, so that the carnivore footprint usually consists of only four toes.

Footprints Nos. 273, 276 and 840, blurred as they are, exhibit only the dimensions and the shape of the sole of *Bestiopeda* sp. As far as the other fragmentary footprints are concerned, only in the light of the foregoing has it been possible to reveal that they too are most probably assignable to the type of carnivore in question (Pl. VI, fig. 2). The conspicuous, circular to oval-shaped impressions aligned in one row do not resemble any other footprint of Ipolytarnóc.

The *dimensions* are contained in Table 14 (in mm). The complete footprints show a good agreement in size, the individual toe prints being largely scattered. On the basis of the morphology of the footprints, these finds stand closest to the holotype of *B. bestia* VIALOV (1966), but the remains available are not sufficient for specific identification.

Ichnogenus: *Carnivoripeda* n. ichnogenus

Genoholotypus: Carnivoripeda nogradensis n. g., n. sp.

Derivatio nominis: after the order Carnivora (carnivore).

Diagnosis: the same as for the species.

Carnivoripeda nogradensis n. ichnospecies

Pl. IV, figs. 1—2, Pl. V, figs. 1—2

Holotypus: Three footprints (Nos. 97, 98, 99) belonging to one animal, under the roof of the Conservation Hall of Ipolytarnóc (quadrangle d5). Figured in A. Tasnádi Kubacska 1974, Fig. 15 and respectively 1977, pp. 118, 119, 121 and 122.

Derivatio nominis: after the name of the county Nógrád, to which Ipolytarnóc belongs.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Five-toed carnivore footprint. The sole print is laterally wider than longitudinally, being distally impressed. Toe prints elongated, droplet-shaped, ending in an apex. The imprint of the tip of each claw is quite distinct.

Description: Imprint of the left fore-foot (97): The distal end of the sole is indistinct, rounded, impressed in its proximal half. It is in the median of the sole that the middle (IIIrd) toe lies, the axes of the IVth and Vth toes are parallel to it. All three are in the shape of an elongated droplet, being symmetrical. At the base of the toes the margins of the claw sheaths are quite distinct. The prints of the IInd and Ist toes are arcuate, falciform. The Ist toe is displaced to the edge of the inner sole margin, its apex ending in one line with the distal end of the Vth toe. All toes but the Ist one are sharply disintegrated from the sole print.

Print of the right fore-foot (No. 98): The distal part of the sole is invisible, its proximal edge being readily traceable. All five toes are discernible, Nos. IInd, IIIrd and IVth are most distinct, followed by No. I next, No. V being rather blurred. The claw apices of the IIIrd and IVth toes are the strongest.

Print of the right hind foot (No. 99): This is the most complete and intact sole print of all, exhibiting quite distinctly a proximo-distally shortened, arcuate and rounded outline. The IInd, IIIrd and IVth toes are separate, the Ist and Vth ones being attached to the sole.

Dimensions are listed in Table 15.

Comparison: On evidence of the dimensions, *Carnivoripeda nogradensis* n. sp. belongs to the category of large to medium-size carnivore footprints. The "Paleo-Felido" of Spain is 90×100 mm in size, so it is similar in length and width to its Ipolytarnóc counterpart, but it differs from this completely as far as its morphology is concerned (L. Casanovas-Cladellas—J. Vte. Santafé-Llopis, 1974). *Felipeda lynxi*, a Lower Miocene fossil from Romania, attains a maximum of 52 mm in size, *Canipeda longigriffa*, in turn, measures 61×32 mm (N. Panin—E. Avram 1962). From among the fossil footprints of Dobrotov, *Bestiopeda bestia* measures 53×62 mm, *B. sanguinolenta* 65×78 to 85 mm, *B. gracilis* 29×35 mm (O. S. Vialov 1966). The dimensions of the Pliocene carnivore footprints from the Rohrbach Conglomerate are, as given by E. Thenius (1967) as follows: the small-size felid measures 40 to 48×45 to 50 mm, the medium-size felid 60 to 90×65 to 85 mm, *B. amphicyonides* 128 to 135×165 to 170 mm, *B. guloides* 93×92 mm. As follows from the size comparisons, *B. amphicyonides* is a very big fossil, the Spanish find, *B. guloides* and, from Ipolytarnóc, *Carnivoripeda nogradensis* are big to moderate, *B. bestia*, *B. sanguinolenta* and the medium-size felid of Austria being of small to medium size, while the two carnivore footprints from Rumania, *B. gracilis* from Dobrotov and the felid from Rohrbach are small.

Because of the breadth of the sole impression and the elongate toe prints *B. amphicyonides* Thenius and *B. sanguinolenta* are referable to the closest morphological relation of *Carnivoripedia nogradensis*.

Ichnogenus: *Mustelipeda* n. ichnogenus.

Genoholotypus: Mustelipeda punctata n. g., n. sp.
Derivatio nominis: Small carnivore footprint referable to some mustelids.
Diagnosis: the same as for the species.

Mustelipeda punctata n. ichnospecies

Text-figs. 12—13

Holotypus: One footprint, No. 354, in quadrangle g7 under the roof of the Conservation Hall of Ipolytarnóc.
Derivatio nominis: punctata = punctate. Reference is made to the fact that the footprints are most frequently found in arched rows of successive dots.
Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.
Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Small circular sole print with the imprints of the five toes closely attached to it.

Material: 2 or maybe 3 soled footprints are known from the original footprint-bearing surface under the roof of the Conservation Hall at Ipolytarnóc, the remaining 12 finds being restricted to toe (or claw) imprints.

Description, dimensions: The sole print is a circle that is slightly compressed proximo-distally, to which the imprints of claws are attached, directly in the case of the holotype and discontinuously in that of specimen No. 626. This latter circumstance suggests that the animal did not walk with its sole adhering to the ground, but it had to set its sole on the ground surface only when it was climbing up a tree or something else, the weight of its body resting on its hind feet. Footprints Nos. 354 and 626 have registered such a situation. In the case of specimen No. 626, along the proximal arc of the sole, the faint outlines of the closely adherent toes and, occasionally, the places of the pointed claws are visible.

The claw imprints are of resting oval or rhombic plan view and equal spacing. Two or three claw rows are repeatedly found to lie close to one another and thus interconnected.

The results of measurement are listed in Table 16.

Mustelipeda punctata n. sp. occupies, with its dimensions, an intermediate position between the small felid of Rohrbach and the felid of medium size. The claw prints of the Ipolytarnóc finds are not longitudinally elongated, like the preceding forms, but they are flattened which means a substantial difference as compared to them.

Ichnoordo: **Perissodactipedida** Vialov, 1966

From among the footprints of perissodactyls the representatives of rhinoceroses are most frequent at Ipolytarnóc. O. Abel's (1935) earlier identification of an Anchitherium footprint has proved to be completely erroneous, and the presence of proboscideans is to be questioned (M. Kretzoi, 1950). As far as the "Mastodon" problem is concerned, we shall return to it hereinafter in detail.

— Footprints of Rhinoceratidae are known from North America, the Oligocene of White River, where along with Brontotheriidae, Artiodactyla and two different kinds of Camelidae, 4 smaller representatives of Rhinocertidae did also occur (R. G. Chaffe, 1943).
— At Vilanova de la Agua in Spain, another Oligocene locality, one very poorly preserved rhinoceros footprint is found.
— In Switzerland, on the rock wall of the Goldauer Bergsturz, several rhinoceros footprints indicate the presence of the species in Early Miocene time (H. Bräm, 1954).
In the Carpathian regions (Rumania, USSR) no rhinoceros footprint is known to occur.

Among the rhinoceros finds from Ipolytarnóc, O. Abel (1935) distinguished between two forms based on differences in size. As shown by A. Tasnádi Kubacska (1976), the divergencies are due to differences in age and sex of the animals rather than resulting from the presence of different species. He ascribed the few extremely large footprints to bulls (230×225 mm) and the bulk of the smaller ones (170×150 mm) to cows, while the very small ones (120×130 mm) he identified with juvenile animals.

According to the results of latest research, this division into three different types of footprints has changed in such a way that the presence of enormous footprints (on the rock slabs of 1900 and on those exhibited by Nopcsa at the Hungarian Geological Institute) is acknowledged and that the bulk of the footprints is a little bit smaller (200×210 mm) and that the footprints of juvenile rhinoceroses are not unfrequent either (130×150 mm). Consequently, the distinction of three size categories is relevant, only the size limits have shifted as a result of processing of a statistical set of data.

Ichnogenus: *Rhinoceripeda* VIALOV, 1965.

Rhinoceripeda tasnadyi VIALOV, 1965

Text-figs. 14—16, Pl. VII, figs. 1—2; Pl. VIII, figs. 1—2; Pl. IX—XI; Pl. XII, figs. 1—2; Pl. XIII, figs. 1—2

In connection with the finds from Dobrotov, VIALOV systematically elaborated, in 1965, a considerable part of the footprints of mammals. After studying the finds from Ipolytarnóc and referring to Figs. 140 and 141 of O. ABEL (1935), he then named the rhinoceros footprints *Rhinoceripedia tasnadyi*, but failed to give a description and a diagnosis. Because of the incompleteness of his publication of data and the impossibility of identification of Abel's figures with the originals, it is desirable to establish a neotype on the taxon *Rhinoceripeda tasnadyi* VIALOV—a measure justified by the availability now of finds of an excellent state of preservation.

Neotypus: Trail of footprints consisting of 7 paces and 6 pairs of footprints on the sandstone slab exhibited in the mezzanin of the Hungarian Geological Institute.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Footprints of a big rhinoceros deriving from a male, a female and a juvenile individual. On the proximal side of the footprints there are three oval hoof prints, of which the two extreme ones are approximately equal, the middle one being larger. The hoof impressions are close to one another, their margins being often in contact.

Material: see Table 17.

Dimensions: The points of measurement of the rhinoceros footprints are shown in Text-fig. 17, their extreme and average values being given in Table 18, the detailed data in Table 19 and 20.

As evident from the dimensions, the neotype footprints are quite representative of adult rhinoceros footprints from Ipolytarnóc characterized by a length to width ratio of 1:1. The Oligocene fossils are of yet smaller size and more elongate (R. S. CHAFEE, 1943). Evolution trends from the long type of footprints towards the circular one and, in now-living species, this process has led to a marked strengthening of the middle hoof (Text-fig. 14—16 and Pl. X—XIII).

The rhinoceros of Ipolytarnóc has, as shown by A. TASNÁDI KUBACSKA (1976), a stride length of 138 to 140 cm, the length of pace in footprint trails being 34 to 44 cm.

In the course of our studies we carried out a renewed measurement of the footprint trails of rhinoceroses. Before proceeding to give quantitative details, let us note that with a change in the gait of the animal at least two types of arrangement of the footprints are distinguishable. The anterior and posterior prints of the left and right feet of the animal follow one another with a regular spacing (Text-fig. 18a) or the pairs of footprints coming close to one another tend to overlap (Text-fig. 18b). Accordingly, during the measurements we have distinguished between "length of stride" and "length of pace". The additional points of measurement are given in Text-fig. 18, where the following distances figure: left fore—left hind, right fore—right hind, left—right half-stride length, left—right full stride length (values in cm). In Table 21, the stride length values of Rh. tasnadyi are listed.

There is a marked difference between the data calculated by A. TASNÁDI KUBACSKA (1976) and the lately measured ones which may be due to our having measured different footprint trails. Another source of deviation may have derived from the fact that on determining the full length of stride, TASNÁDI KUBACSKA, as shown by his Fig. 9, was giving the distance between the hind distal margin of the footprints left over by the four feet and the proximal margin of the foremost footprint. In the international practice, so in the present work too, the distance between the distal (or, for that matter, proximal) margins of the hind- and foremost footprints rather than the afore-mentioned maximal full length of stride is determined. Using the data of TASNÁDI KUBACSKA's figure, we found the distance in question, as determined by this method, to be 118 cm.

Ichnoordo: **Artiodactipedida** VIALOV, 1966

To differentiate and systematize artiodactyl footprints is even more problematic than it is the case with evaluating their bone remains. The uniformized development of hoofs is characterized by a wide range of micromorphological variations which depends first of all on the lithology of the soil, the relief conditions and the stage of evolution reached by the animal. Within one locality, when a sufficient amount of traces is known, the morphotypes can be distinguished with safety, but to compare fossils preserved under different circumstances and taken from different localities may be fraught with dangers.

On the basis of the footprints from Dobrotov, VIALOV (1965) attempted to make finer systematic distinctions. He assigned the footprints of all artiodactyls to Pecora representing, in the system of nowliving forms, the most varied group of ruminants. This group include the cervids, the giraffids, the antilocaprids and the bovids. These latter, include, in turn, such extreme subgroups as the antelopes (Antilopinae), the gazelles (Gazellinae), the goat-like animals (Caprinae) and the various types of cattle (Bovinae), etc. Made within the genus Pecoripeda the Gazellipeda, Ovipeda, Cervipeda and Giraffipeda subgenera and six species distinct. Such a general identification of the footprints testifies to great caution and realism, but the subgenera are certainly worthy of independence, as they exhibit fundamental morphological divergencies from one another. Such an approach is handicapped by the fundamental principles adopted as starting point in developing this classification, for VIALOV based his ichno-subgenera on systematic units of now-living forms and on their names. Inasmuch as the names proposed by him are used, it is to be expected with high probability that the systematic assignation of the footprints will be incorrect.

At present no thorough-going monograph or study analyzing, for that matter, the types of modern artiodactyl footprints, is available, not to speak of a similar evaluation of fossil forms. In lack of this—and in the light of older Neogene bone fossil finds from Hungary—the taxonomic identification, even at the family level, of any of the footprints available is impossible.

From among the footprints of Ipolytarnóc, footprints of deer (Hirsch) were figured by O. ABEL (1935). The term "deer" was widely used by the subsequent authors too and, as observed by TASNÁDI KUBACSKA (1976), this is necessary least anybody think of having to do with an antelope footprint, the hoof prints of this animal being completely different. What is striking to the eye both when examining the sandstone slab exhibited at the Hungarian Geological Institute and the sandstone in situ is that there are two kinds of "deer footprints". In terms of the distinctions made by TASNÁDI KUBACSKA (1976) the footprints of the more frequent smaller deer are 4 to 5 cm long and 3 to 3.5 cm wide. The length of stride of the animal varies between 104 and 121 cm. The footprints of the larger deer are, on the average, 7 cm long, 6 cm wide and have a length of stride of 157 cm. The distinction of the two artiodactlys is relevant even in the light of latest investigations.

Ichnogenus: *Megapecoripeda* n. ichnogenus.

Genoholotypus: Megapecoripeda miocaenica n. g., n. sp.

Derivatio nominis: reference to the presence of footprints that are larger than all the representatives of Pecoripeda hitherto described.

Diagnosis: the same as for the species.

Megapecoripeda miocaenica n. ichnospecies

Text-figs. 19—22, Pl. XIV, figs. 1—3

Holotypus: Three footprints deriving from one animal on the original sandstone slab (No. II) exhibited in the mezzanine corridor of the Hungarian Geological Institute (7—6, No. 85) (Text-fig. 19, Pl. XIV).

Derivatio nominis: miocaenica = reference to the Miocene age of the enclosing bed and the footprints.

Locus typicus: Ipolytarnóc (Nógrád County, N Hungary), tributary valley of Botos-árok.

Stratum typicum: Ipolytarnóc Beds, Eggenburgian—Ottnangian boundary, Lower Miocene.

Diagnosis: Footprints of a large artiodactyl of composite stature. The print of the inner hoof is usually smaller than it is the case with the outer hoof, being shifted distally. In case of quiet gait and a horizontal, even surface this asymmetry will disappear. The hoof prints grow proximally wider, deviating by 10 to 20 degrees from the axial line.

Material: a total of 181 specimens, of which 164 at Ipolytarnóc, under the roof of the Conservation Hall, 10 specimens (including the holotype) in the mezzanine corridor of the Hungarian Geological Institute, 2 specimens (V. 12 727 and V. 12 728) in the Palaeovertebrate Collection and 5 specimens in the exhibition of the Hungarian Natural History Museum.

Description, dimensions: The two hoof prints are of rounded edge and apex, being elliptical in shape. It is in the proximal one-third that their medial part is the least apart. This is the area, where the hoof prints grow wider. Becoming distally narrower, the hoof prints are impressed on the medial surface. Within the large pair of footprints three sub-surfaces are distinguishable. Joining the apex proximally, an elongate depression is observable, which is followed, in the median region, by a ridge and, distally, again a minor depression. A very gentle ridge runs between the inner and outer hoof prints, the difference in depth between the two imprints being practically naught. They grow a little bit deeper in the direction of movement. In some cases the anterior narrow and the posterior more elongate continuation of the hoofs is traceable (Text-figs. 20—22).

The points of measurements taken from the footprint are given in Text-fig. 23, the individual data are listed in Table 22. The extreme and average values of all the measured footprints and the holotype are given in Table 23.

The length and width values of the footprints (points of measurement 7 and 9) accord well with the figures given by TASNÁDI KUBACSKA (1976). As measured by him, the total length of stride of the animal is 157 cm, the spacing between the individual footprints is 48 to 52 cm.

The method of determining the stride length already applied in the case of rhinoceros footprints was used for Megapecoripeda as well, the results in cm being listed in Table 24.

The total length of stride in the material studied cannot be measured, 140 to 160 cm being inferred from the results available.

Ichnogenus: *Pecoripeda* VIALOV, 1965.

Pecoripeda cf. *amalphaea* VIALOV, 1965

Text-figs. 24—30. Pl. XV, figs. 1—3; Pl. XVI, figs. 1—3

From the footprint locality of Dobrotov, VIALOV (1965) described a peculiar, medium-size type of footprint, *Pecoripeda (Gazellipeda) amalphaea*. This footprint type is wider and more symmetric than the others described from that locality. Its length—width dimensions are 40×17 cm. In Romania, N. PANIN and E. AVRAM (1962) pointed out the presence, in addition to *P. gazella*, of *P. amalphaea* too (in their communication the specific name amalphae is used, and the date of description is given erroneously as 1961). From the Rohrbach Conglomerate, E. THENIUS (1967) quotes several artiodactyl footprints which he refers to as *Pecoripeda* div. sp.

Next to the rhinoceros footprints, the footprints of "smaller deer" are most frequent at Ipolytarnóc, being represented by diversified types and an ample variety of morphological patterns. Most common among them are symmetrical droplet-like hoof prints growing wider of 8—15° in the shape of an elongate ellipse with rounded edges and subequal size. Not unfrequently are the hoof prints displaced from one another at a rather great angle, thus becoming different in size, distorted. The distal parts of two footprints may overlap, coincide, producing a uniform depression. An impression of this kind may have induced ABEL to suggest the presence of Anchitherium (1935). In addition to hoof imprints, full impressions containing additional proximal parts of the foot are frequent too.

Behind either of the two main hoof imprints there is in this case another, more shallow, oval depression; then, in the distal half of the print, in the continuation of the former, there are single patch-like traces of smaller size, too. In case of a complete imprint the circular outline of the foot is observable. A distinct ridge, 2 to 5 mm tall, runs between the two hoof imprints. The inner hoof is always more shallow than the outer one. The longitudinal section of the footprints shows that the hoof imprints grow in the walking direction (forwards) deeper, their arc being just slightly convex (Text-figs. 24—30, Pl. XV—XVI).

Excelling with their more elongated hoof imprints among the footprints of "smaller deer", some extreme varieties may suggest the presence of another taxon. Not until the discovery of homogeneous trails of such footprints is added to their exceptional and sporadical occurrences is it possible to separate them taxonomically.

Material: see Table 25.

The individual *dimensions* of the footprints, are contained in Table 26, their extreme and average values being given in Table 27.

The length—width dimensions of the average footprints are 33×17 mm, the size of prints in which the complete foot is reflected in outline being 45×32 mm. For the length of stride of "smaller deer", TASNÁDI KUBACSKA (1976) gave 104 to 121 cm; for the spacing of the individual footprints, he obtained 22 to 63 cm; for the average, 36 cm. According to the latest measurements, the dimensions of the individual types of pace (Text-fig. 18) are listed in Table 28.

The data published herewith deviate considerably from those given by TASNÁDI KUBACSKA; in fact, the value of the complete length of stride, as given here, is scarcely the half of that quoted by him. In every case the length of one footprint (3—5 cm) is to be discounted from the earlier data and it is quite probable that what TASNÁDI KUBACSKA measured was the largest footprint trail.

To judge whether the footprint sandstone of Ipolytarnóc contains proboscidean footprints or not is crucial from the stratigraphical viewpoint. To settle the problem would be quite easy if distinct and convincing footprint trails testifying the onetime presence of proboscideans were available to us even now. As far as the identification to such an extent of all the other traces and footprints is concerned, there is no doubt at all.

The "Mastodon problem" was launched by O. ABEL (1935) when describing the footprints seen there, following his trip to Ipolytarnóc in 1928. In his Fig. 139 he published the photograph of a four-toed Proboscidea (Dinotherium?, Mastodonidae?) which had been made from a plaster mould. Corresponding to 1/4 of the natural size, the photograph of the footprint has a largest diameter of 70 mm, which, recalculated to natural size, corresponds to 28 cm.

First in a manuscript field-report (1950a), then in the periodical Földtani Közlöny (1950b) M. KRETZOI set forth quite firmly that ABEL had been wrong when regarding the footprint in question as a Proboscidea, for as KRETZOI put it, "when reviewing the footprint-illustrating plates of the Hungarian Geolgoical Institute and the Hungarian Natural History Museum and NOPCSA's plaster moulds, I could not discover the footprint of any animal that would prove the setting in of the Miocene transgression: the only quadruped footprint (on account of its shape, size and four-toed feet) does not belong to a Proboscidea either".

As far as the footprints figured by O. ABEL are concerned, I fully agree with M. KRETZOI, considering them as traces of two rhinoceroses that had trampled upon each other's footsteps. In fact, a lot of other footprints of this kind are found among the original traces. The largest size—comprising the four hoof prints—is 28 cm. Consequently, it is almost the same as the size of the biggest rhinoceros. Inasmuch as the distance between the outer and inner hoof prints is measured (as we did when determining the width of the imprint in the case of rhinoceroses), 24 cm is obtained as a result which corresponds to the corresponding dimension of a grown-up rhinoceros footprint.

In his vulgarizing papers (1956, 1958, 1962, 1977) and scientific communications (1976) TASNÁDI KUBACSKA takes a stand in favour of the one-time existence of mastodons. He points out that the proboscidean footprints are found under the upper, typically rhinoceros-footprint-bearing sandstone slab rather than on it and that the bedding surface containing them is densely covered with needles and leaves of deciduous trees. He locates the footprints even topographically both on his layout (Fig. 1) and his description of the locality. Accordingly, "the first footprints of a mastodon are found on the southern margin of the 'wallowing-place'. This first footprint is quite distinct, but the remaining footprints are not impressed very deeply into the dry and harder ground surface" (p. 82). He further writes that "as I could observe, it was one animal that strode from beside the wallow to the rhinoceros 'wateringplace', whence it turned to the opposite direction... the footprints of the fossil proboscidean have come down to us in a rather poor state of preservation, not having been impressed deep enough into the sandy ground" (p. 86). In Fig. 10, he has reproduced the Mastodon trail including 6 footprints. The individual footprints vary between 25 and 30 cm in size, the full stride length being 370 cm*. In TASNÁDI KUBACSKA's opinion, the proboscidean from Ipolytarnóc does not correspond to Prodinotherium, a taxon identified upon bone fossils from the lignitiferous sequences of the Nógrád and Borsod basins, but it seems to have been a primitive Mastodon smaller than an Indian elephant.

When checking TASNÁDI KUBACSKA's description and figures with the original surface exposed under the roof of the Ipolytarnóc Conservation Hall which comprises the Mastodon footprint area as a whole, we observed three patches which contained unusually large footprints or footprint frag-

* TASNÁDI KUBACSKA further writes about the Mastodon coprolite, which is not a coprolite in my opinion, but an eroded surface covered by pine-needles seems to be there. Similar eroded layers of the same origin are found on that area.

ments that cannot be unambiguously identified. In quadrangle c3, amid the rhinoceros footprints (No. 55) there is such an elongate footprint with three pointed toes which, with its 31×21 cm size, could possibly represent the footprint of a Proboscidea (Text-fig. 31). On the surface, heavily trampled down and rounded off, of an area abounding with vegetal fibre, to the south of the wallowing-place quoted by TASNÁDI KUBACSKA several large depressions can be observed, including what might be identified with proboscidean footprints (No. 283, 284, 286, 294, 296, 297, 298, 309). The most complete footprint of this kind includes four huge toe prints resembling droplets or circles in plan view (about 13×10 cm) and one complete sole print (32×30 cm) (Text-fig. 32). In our opinion, it is the roughness of the trampled-down and rolled-down ground surface that may occasionally produce such footprint patterns and the observed patterns have nothing to do with proboscideans.

What TASNÁDI KUBACSKA (1976) reproduced in his Fig. 10 as a Mastodon trail was at the original site, at the time of examination, in a very poor, fractured and weathered condition, so that a total of only two such traces could be found (No. 496 in quadrangle c11 and No. 625 in quadrangle c13) in the case of which the suspicion of representing traces other than rhinoceros footprints may arise. The remaining 4 proboscidean footprints given in the figure just quoted could not be found. In our opinion, as suggested by the shape of the imprints, three traces from that figure derive certainly from a rhinoceros rather than from a proboscidean.

For the sake of further solution to the "Mastodon problem" we have studied TASNÁDI KUBACSKA's alleged "Mastodon" plaster moulds, deposited at the Hungarian Geological Institute, the Geological and Palaeontological Collection of the Hungarian Natural History Museum and the Kubinyi Ferenc Museum of Szécsény, which had been taken from a total of two footprints. More widely known from among these are the footprints of two animals that had stepped into each other's trackway (Text-fig. 33) — a phenomenon photographically illustrated by TASNÁDI KUBACSKA in his vulgarizing book (1976, p. 85, Pl. XVII). Attaining a full size of 32×23 cm, this doubled trackway includes 8 arched, oval hoof prints about 9×4 cm each. Two "small deer" tracks are even contained in the "Mastodon" footprints. The question of how the two sole prints were situated is difficult to solve on the basis of the shallow footprints in question. Whichever of the possible variants is chosen, the resulting shape of the footprints is of a pattern in which the hoofs are longitudinally juxtaposed. Such a type, however, reminds us of a tapir (H. BRÄM, 1955, H. TOBIEN, 1949) rather than a proboscidean. We are of the opinion that this "double trackway" was produced by the translation, slip, of several rhinoceros footprints (or of one and the same foot). Such a hypothesis is most of all supported by the fact the hoof prints completely agree in shape and size with the hoof prints of hundreds of rhinoceros footprints from Ipolytarnóc.

The other plaster mould has been taken from a very characteristic footprint that is really incomparable to any of the footprints hitherto discussed (Text-fig. 34). Measuring 27×26 cm in size, the sole print includes three oval hoof prints arranged asymmetrically and having a size range of 8 to 10×6 to 7 cm. The sole grows distally narrow which may be due to the fact that the footprint of the larger deer is closely attached to it. This impression may be interpreted by other authors as the fourth hoof print.

Since Abel's photograph provides convincing evidence proving that the footprint to the south of the wallowingplace quoted by TASNÁDI KUBACSKA does not belong to a Proboscidea; that the alleged coprolite is not a coprolite; and that no proboscidean footprint can be identified now on the "Mastodon" trackway, the opinion suggesting a proboscidean origin for the plaster moulds may be discredited. Accordingly, in the present state of our knowledge, the proboscidean footprints have to be discarded from the ichnofauna of Ipolytarnóc.

GEOLOGICAL CIRCUMSTANCES OF THE FOOTPRINTS

The geological circumstances and stratigraphic relations of the footprint sandstone being analyzed in detail, in this volume, by L. BARTKÓ, so we shall refrain from the discussion here of the glauconitic sandstone, the terrestrial conglomerate, the footprint sandstone and the Lower Rhyolite Tuff sequence.

Those characteristics of the footprint sandstone that are important from the viewpoint of traces of animal life can be well studied under the roof of the newly built Conservation Hall. The footprint sandstone bed is underlain by coarse conglomerates that can be studied in a pit near the northern wall, under a sandstone layer of about 1.2 m thickness. With the thinning of the sandstone bed toward the northeastern corner of the Hall and because of the higher topographic position of the conglomerate, a gradual and complete transition between the two types of sediment can be observed at the surface. This does not mean, however, that we have to do with one and the same bed. The fact is that the sandstone had been removed by erosion from the conglomerate making up the hillock and that, by the time when the footprints were formed, the ground surface was constituted by both. The

silicified log fragments intersect the sandstone, being often enclosed in the conglomerate. The presence of a common, eroded surface is indicated by the fact that hosts of rhinoceros footprints can be found on the surface of both the sandstone and the conglomerate. A clay ridge of E—W direction, 5 to 6 m long, 15 to 30 cm wide and 5 to 6 cm high, extends on the gravelly surface, having been brought about probably by the rhinoceroses trampling on it and by the sheetwash action of rainwater. Rhinoceros footprints are recognizable both on its margin and at its top.

As observable in the pit by the northern wall, 9 to 10 parallelly disintegrated, 9 to 10-cm-thick beds can be identified in the footprint sandstone. These beds are thinning out toward the more flat surface farther south and three of the footprint-bearing surfaces now available to study are found here.

The sandstone surface in contact with the conglomerate is actually the second footprint sandstone bed as counted from atop, being underlain—whence the sandstone slabs were extracted—by the third footprint-bearing bed and overlain, almost exclusively on the "rhinoceros-bearing hillock" of a northwestern position, by the topmost, or first, bed.

Hence, as far as our present-day knowledge goes, at least three footprint sandstone horizons are distinguishable in a vertical succession. The lowermost or third horizon of these is characterized by the fact that its surface is covered by a maze of pine needle remains and that on its surface, trampled-down and rammed as it is, only faint traces of rhinoceroses are recognizable.

The middle or second bed was referred to as "Mastodon-bearing" bed by Tasnádi Kubacska (1976), for it was on the surface of this bed that he believed to have recognized the traces of proboscideans. This varied horizon embraces the greatest part of the area under the roof of the Conservation Hall. At its western edge, it has developed into a hardtrampled, rough surface, where just a few traces are recognizable only upon scrutinized examination. At the centre of the Hall, the surface is not so rough anymore. Certainly less deformed, less affected by trampling, the sandstone here carries perfectly preserved traces of animals, especially the footprints of artiodactyls and, along with rhinoceroses, the birds are also clearly represented. It is into this surface that the trace of a "Mastodon coprolite" is impressed, representing with highest probability such an elliptical wearing away of the bed as has exposed the material of the conifer-bearing, or third, bed underneath. The second footprint-bearing horizon is that which formed one surface with the conglomerate.

The uppermost or first horizon in the Conservation Hall area is preserved only in the northwestern corner, over a total of a few square metres. Covering the second footprint-bearing horizon in a total of 5 to 7 cm, it has reproduced its microforms, being otherwise well separated from it. Hence it can be peeled off and removed quite easily. It is on this surface that the most perfect rhinoceros and artiodactyl footprints can be studied. Although reduced to minor isolated patches, it still occurs somewhere around the centre of the Hall. All the footprint sandstone slabs recovered and deposited at the Geological Institute and the Museum of Natural Sciences derive from this bed. That this topmost surface was covered by a very thin and hard "varnish" of reddish-brown colour is well-known. This film-like coating is now for the most part lost to erosion which has resulted in damages to the footprints.

The various footprint-bearing horizons show but insignificant differences between the types of imprints. This may imply, for that matter, even centuries of accumulation of sediment, but by no means does it mean a change in lithology on a geological scale.

The locations and types of the studied footprints are shown in Text-figs. 35 to 64.

RECONSTRUCTION OF THE EARLY MIOCENE HABITAT

As evident from the geological constitution and stratigraphic position of the footprint sandstone, the footprints were impressed into terrestrial sands or gravels. Underlying the coarse-grained conglomerate, the marine glauconitic sandstone may possibly have been deposited on an abraded shore or in a delta. The material of the sandstone seems, with high probability, to have been redeposited from the glauconitic sediment.

The occurrence of footprints in several horizons indicates that the contemporaneous depositional environment provided already at the time of deposition a proper habitat for the life of terrestrial mammals and birds. The widely shared opinion that a paleo-"beach", i.e. a sandy seashore used to occur in what is now Ipolytarnóc can by no means be confirmed. No features or markings suggestive of deposition in a seashore environment could be found in the structure of the sandstone, the marine fossils being totally absent too. The "beach" theory appears to have stemmed merely from journalistic fancy.

Much more realistic seems to be the idea that the habitat that was to accomodate the footprints had developed in the neighbourhood of a spring that was welling up through a gravel bed in outcrop. From the relatively higher-situated conglomerate area a distinct, ravine-like depression extends accross the study area, the "wallowing-place" lying at its deepest point. It is on the bank

of this that well-preserved trace of slip of a rhinoceros is found, excellently reflecting the existence here of a more argillaceous and wet surface. Issuing from the spring welling up from the conglomerate, several minor shallow puddles may have extended southwards on the rough surface in question —a probability suggested by the presence of a ripple-marked surface there. From time to time, these would run dry or more or less desiccated, for perfectly preserved "deer footprints" are traceable over the ripple-marked surface. When impressed into deeper mud, these footprints changed to shapeless holes as the mud flowed back to whence the feet were retracted, but it could not fill the footprints completely (A. TASNÁDI KUBACSKA, 1976).

Whether a watering-place or a ford used to be in what is now Ipolytarnóc has been another point of controversy. In our opinion, the locality may have had either of the two functions, since springs, pure-water ponds and a narrow watercourse are equally documented in the fossil record.

Very rich in fossil plant remains, the third bed indicates that a forest or tree vegetation must have been here when the bed was being formed. The higher-situated (younger) beds contain already quite sporadical phyto-fossils suggesting that, at the time of their deposition, the contiguous foliage did not exist anymore. Each silicified tree trunk has its origin in the conglomerate or the lower-situated sandstone beds, but none lies on the surface of the topmost sandstone slab.

None of the observed types of vertebrate footprints is suggestive of an aquatic or palustrial habitat. At other localities of similar age or character (Carpathian fore-deep, Alpine molasse) the birds represent explicitely webbed or wading types. Extremely adapted to the hard ground they had to walk on, the artiodactyls left over footprints that are not so widened as those produced by walking on a soft ground. Most of the footprints were impressed into a fairly hardened and dry ground. Markings suggestive of a wet, muddy environment can be observed only on the slopes of some relatively higher-situated surfaces or at local puddles.

As obvious from the above analysis, the footprint sandstone horizons of Ipolytarnóc must have been formed on a land surface with some vegetation around a spring which, from time to time, at the downpour of torrential rains or at minor floods, was buried with a mud layer. The last covering, which has preserved the footprints, was formed as late as the accumulation of the Lower Rhyolite Tuff began.

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TÁBLÁK — PLATES

Photo: Mrs. L. Pellérdy

Ornithotarnocia lambrechti n. sp.

1. Az ipolytarnóci védőcsarnokban fekvő, egy állathoz tartozó lépésnyomsorról készült gipszmásolat (M. Áll. Földtani Intézet, ősgerinces gyűjtemény)

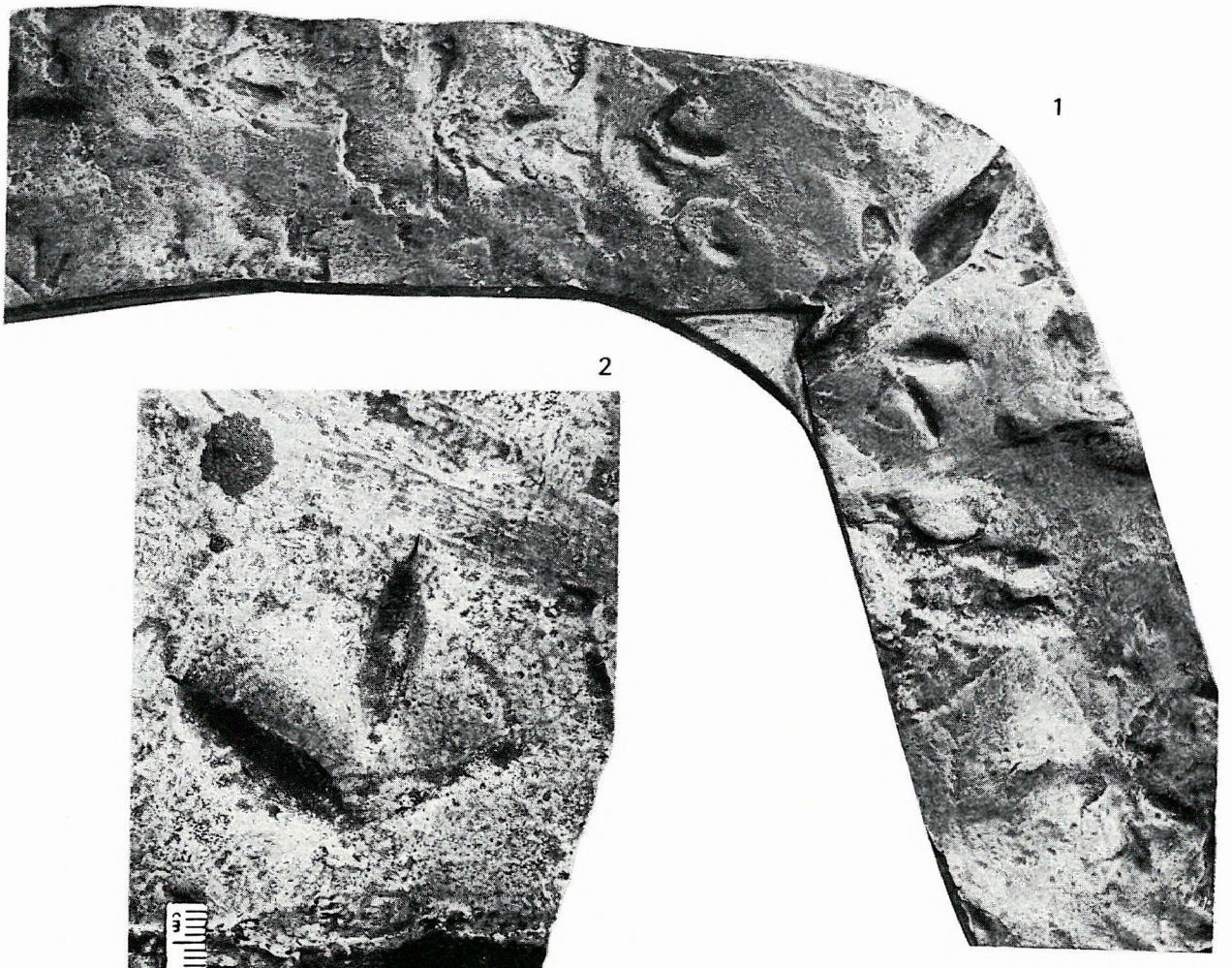
2—3—4. Az egyes lábnyomok képe, 1:1

* * *

Ornithotarnocia lambrechti n. sp.

1. Plaster mould taken from the trail of one animal left over on the surface under the roof of the Conservation Hall at Ipolytarnóc (Hungarian Geological Institute, Palaeovertebrate Collection)

2—3—4. Photographs of single footprints, 1:1



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Ornithotarnocia lambrechti n. sp.

1. A M. Áll. Földtani Intézet magasföldszinti folyosó II. jelű homokkőlapján látható nyomok

2—3. A homokkőlapon látható nyomok, 1:1

4. A M. Áll. Földtani Intézet ősgerinces gyűjteményében levő gipszmásolaton látható különlegesen nagy méretű nyomok

* * *

Ornithotarnocia lambrechti n. sp.

1. Footprints visible on sandstone slab II in the mezzanine corridor of the Hungarian Geological Institute

2—3. Footprints visible on the sandstone slab, 1:1

4. Footprints of unusually great size observable on plaster moulds in the Palaeovertebrate Collection of the Hungarian Geological Institute

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Aviadactyla media n. sp.

1—5. Madárnyomok a M. Áll. Földtani Intézet ősgerinces gyűjteményében őrzött gipszmásolatokról, 1:1

* * *

Aviadactyla media n. sp.

1—5. Bird footprints as photographed from plaster moulds kept in the Palaeovertebrate Collection of the Hungarian Geological Institute, 1:1

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Carnivoripeda nogradensis n. sp.

1. Az egy állathoz tartozó három talplenyomat (holotypus) az ipolytarnóci védőcsarnok alatti homokkőfelszínen
2. A bal hátsó láb nyoma, 1:1

* * *

Carnivoripeda nogradensis n. sp.

1. Three sole prints belonging to one animal (Holotype) on the sandstone surface under the roof of the Conservation Hall at Ipolytarnóc
2. Print of left hind foot, 1:1

1

2

Carnivoripeda nogradensis n. sp.
1. A holotypus bal elülső lábnyoma, 1:1
2. A holotypus jobb elülső lábnyoma, 1:1

* * *

Carnivoripeda nogradensis n. sp.
1. Left fore-footprint of the Holotype, 1:1
2. Right fore-footprint of the Holotype, 1:1

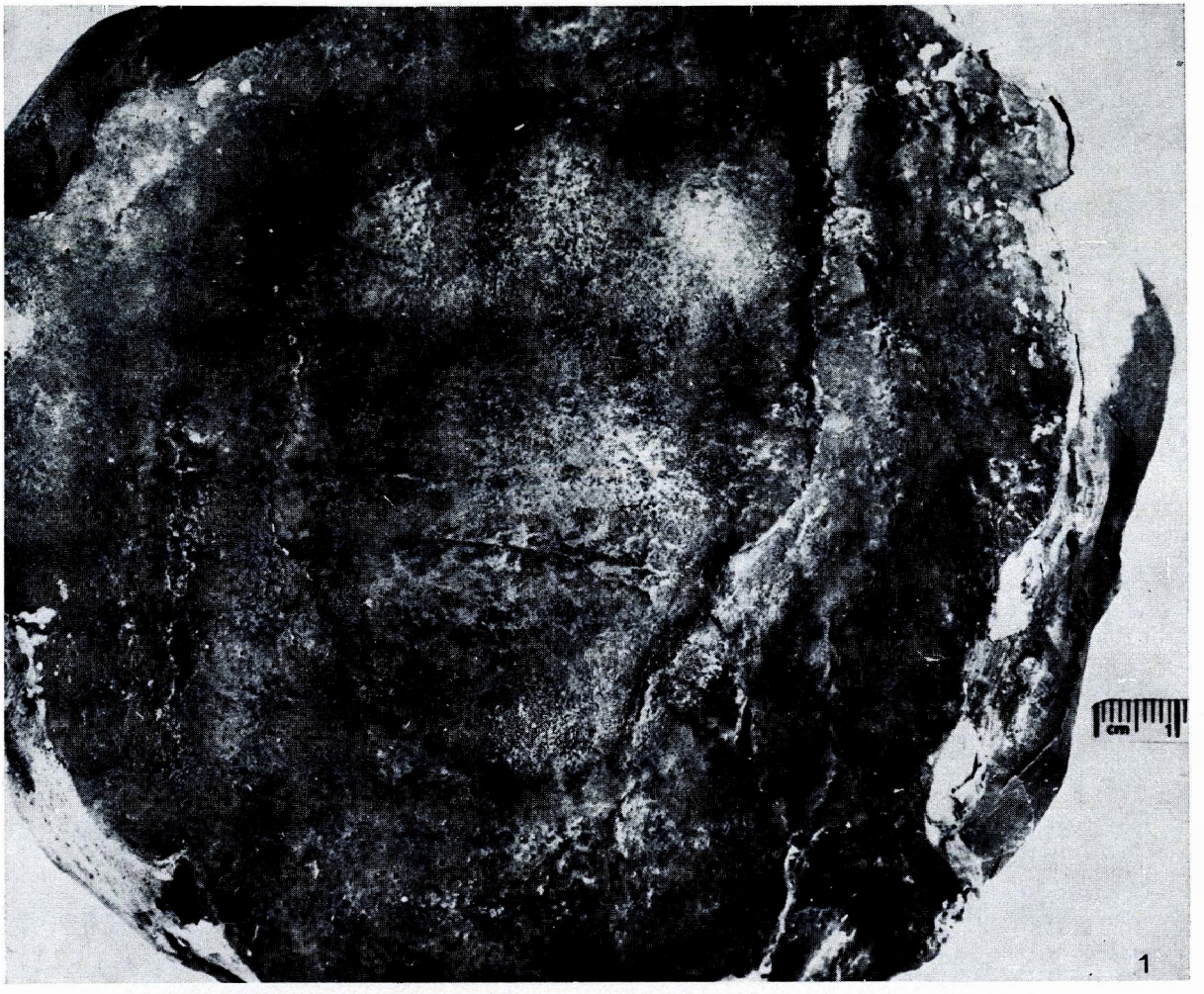
1

2

Bestiopeda sp.
1. Talplenyomat gipszmásolata a M. Áll. Földtani Intézet ősgerinces gyűjteményében
2. Talplenyomatok az ipolytarnóci védőcsarnok alatt, 1:3

* * *

Bestiopeda sp.
1. Plaster mould of a sole print in the Palaeovertebrate Collection of the Hungarian Geological Institute
2. Sole prints under the roof of the Conservation Hall at Ipolytarnóc, 1:3



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Rhinoceripeda tasnadyi VIALOV

1. Neotypus lábnyomsor részlete a M. Áll. Földtani Intézet magasföldszinti folyosó I. jelű homokkőlapján
2. A neotypus lábnyomok egyike, 1:2

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Rhinoceripeda tasnadyi VIALOV

1. Detail of a Neotype footprint trail on sandstone slab I in the mezzanine corridor of the Hungarian Geological Institute
2. One of the Neotype footprints, 1:2

1

2

Rhinoceripeda tasnadyi VIALOV

1. Neotypus lábnyomsor részlete a M. Áll. Földtani Intézet magasföldszinti folyosó I. jelű homokkőlapján
2. A neotypus lábnyomok egyike, 1:2

* * *

Rhinoceripeda tasnadyi VIALOV

1. Detail of a Neotype footprint trail on sandstone slab 1 in the mezzanine corridor of the Hungarian Geological Institute
2. One of the Neotype footprints, 1:2

1

2

Rhinoceripeda tasnadyi VIALOV
Részlet a neotypus lábnyomsorról, amely mellett Pecoripeda cf. amalphaea nyomsor húzódik (M. Áll. Földtani Intézet, magasföldszinti folyosó, II. jelzésű homokkőlap), kb. 1:6

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Rhinoceripeda tasnadyi VIALOV
Detail of the Neotype footprint trail along which the trail of Pecoripeda cf. amalphaea extends on sandstone slab II. in the mezzanine corridor of the Hungarian Geological Institute, cca 1:6

Rhinoceripeda tasnadyi VIALOV
Nagyméretű lábnyom a M. Áll. Földtani Intézet dísztermében felállított eredeti homokkőlapon, 1:2

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Rhinoceripeda tasnadyi VIALOV
Large footprint on original sandstone slab exhibited in the Conference Hall of the Hungarian Geological Institute, 1:2

Rhinoceripeda tasnadyi VIALOV
Nagyméretű lábnyom a M. Áll. Földtani Intézet dísztermében felállított homokkőlapon, 1:2

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Rhinoceripeda tasnadyi VIALOV
Large footprint on the sandstone slab exhibited in the Conference Hall of the Hungarian Geological Institute, 1:2

Rhinoceripeda tasnadyi VIALOV
1. Nyomsor az ipolytarnóci védőcsarnok alatti felületen, kb. 1:4
2. Egyedi nyom az ipolytarnóci védőcsarnok alatti felületen, 1:3

* * *

Rhinoceripeda tasnadyi VIALOV
1. Footprint trail under the roof of the Conservation Hall, Ipolytarnóc, kb. 1:4
2. Individual footprint under the roof of the Conservation Hall, Ipolytarnóc, 1:3

1

2

Rhinoceripeda tasnadyi VIALOV

1. Részlet a neotypus lépéssorából
(M. Áll. Földtani Intézet, magasföldszinti folyosó, II. jelű homokkőlap), 1:3
2. Orrszarvú csúszásnyoma ipolytarnócról (TASNÁDI KUBACSKA A. 1976 után), kb. 1:6

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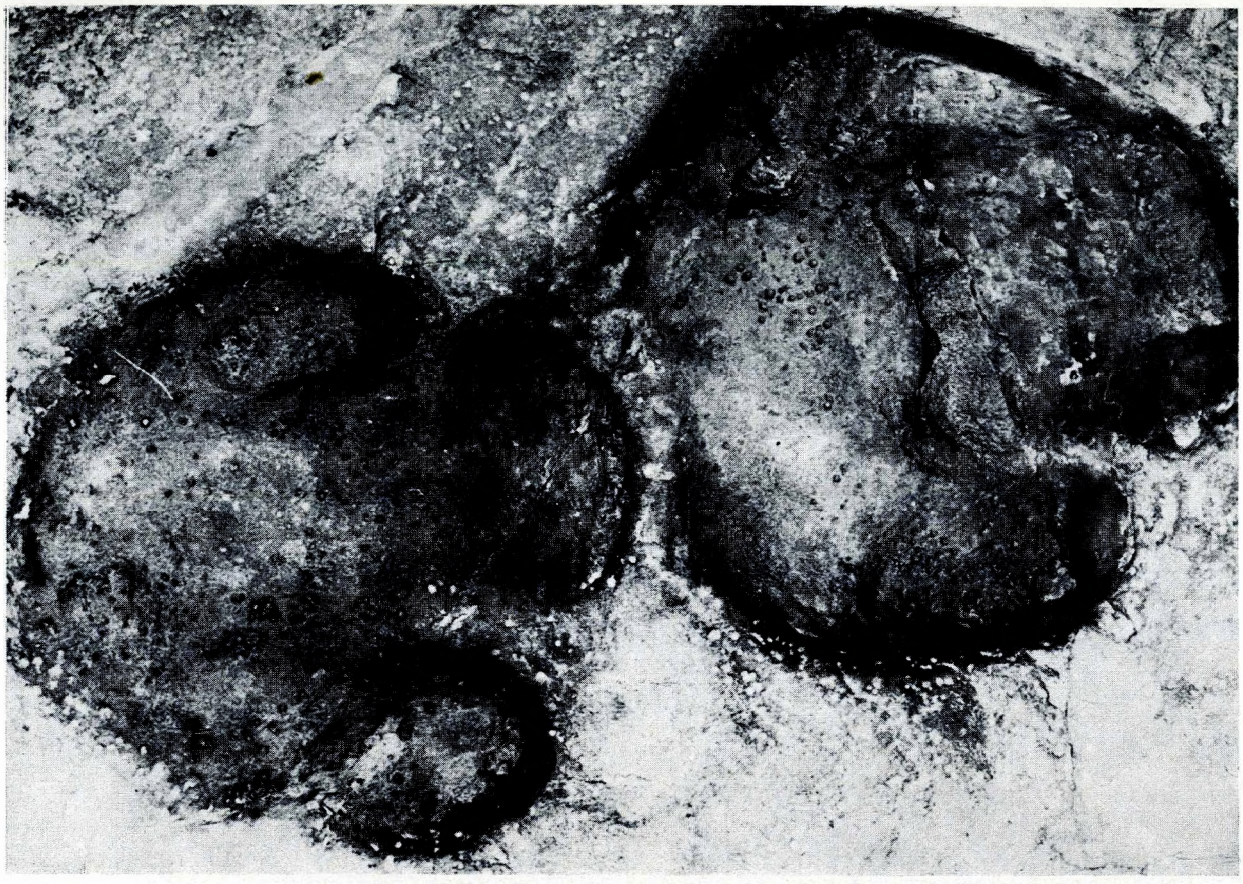
Rhinoceripeda tasnadyi VIALOV

1. Detail of Neotype footprint trail of the Hungarian Geological Institute, on sandstone slab II in the mezzanine corridor, 1:3
2. Trace of sliding of rhinoceros from Ipolytarnóc (after A. TASNÁDI KUBACSKA, 1976), cca 1:6



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Megapecoripeda miocaenica n. sp.

1. Holotypus lépésnyom a M. Áll. Földtani Intézet magasföldszinti folyosó, I. jelű homokkőlapon
2—3. A két patanyom, 1:2

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Megapecoripeda miocaenica n. sp.

1. Holotype stride track, sandstone slab I in the mezzanine corridor of the Hungarian Geological Institute
2—3. Two hoof prints, 1:2

1

2

3

Pecoripeda cf. *amalphaea* VIALOV
1—3. Lépésnyomok a M. Áll. Földtani Intézet magasföldszinti folyosó, I. jelű homokkőlapon, kb. 1:3

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Pecoripeda cf. *amalphaea* VIALOV
1—3. Stride tracks on sandstone slab I in the mezzanine corridor of the Hungarian Geological Institute, cca 1:3

1

2

3

Pecoripeda cf. *amalphaea* VIALOV

1—2. Lépésnyomok a M. Áll. Földtani Intézet magasföldszinti folyosó, I. jelű eredeti homokkőlapján

3. Lépésnyomok a M. Áll. Földtani Intézet magasföldszinti folyosó, II. jelű eredeti homokkőlapján

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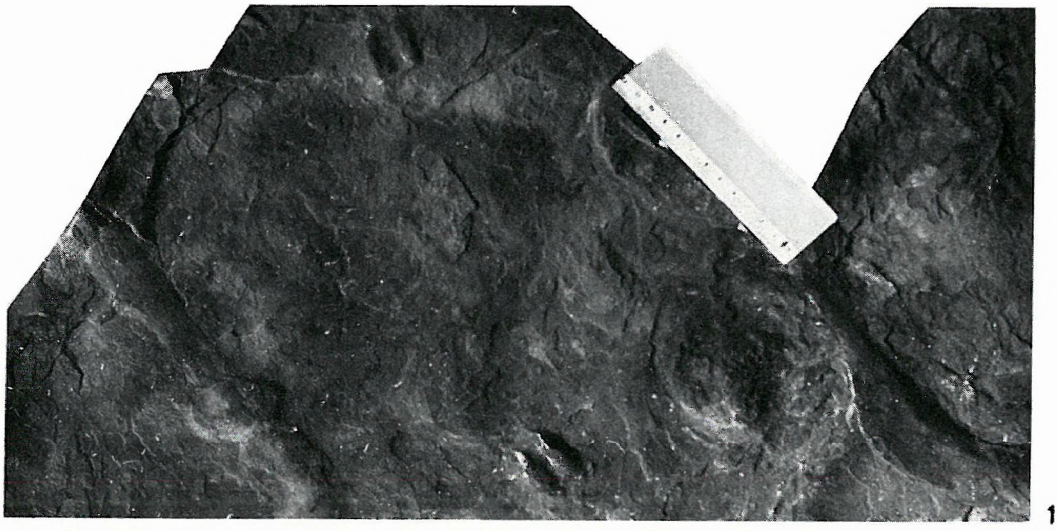
Pecoripeda cf. *amalphaea* VIALOV

1—2. Stride tracks on original sandstone slab I in the mezzanine corridor of the Hungarian Geological Institute

3. Stride tracks on original sandstone slab II in the mezzanine corridor of the Hungarian Geological Institute



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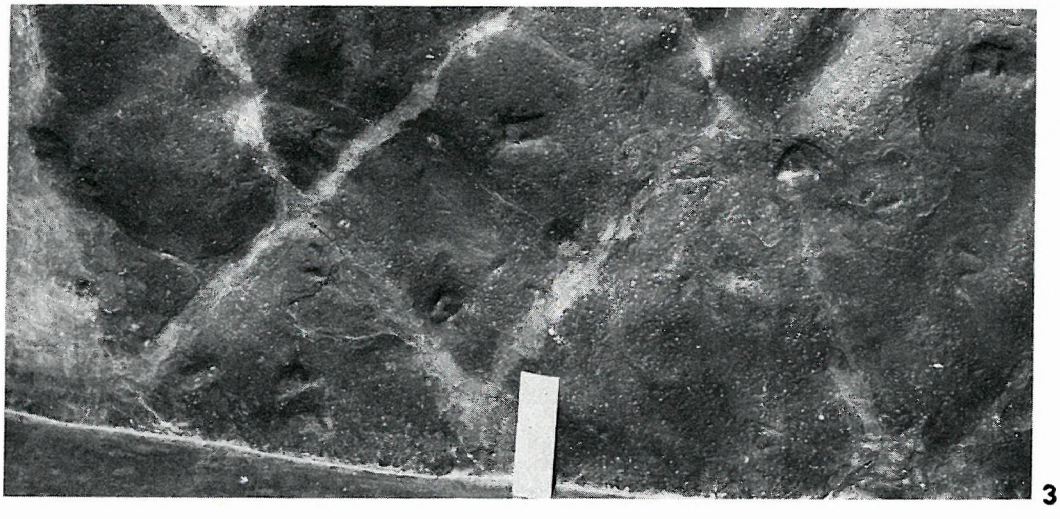

3

Két egymásba lépett „Mastodon"(?)-nyom képe (Tasnádi Kubacska A. 1976 után), 1:1

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Photograph taken of the footprints of two "mastodons"(?) that have stepped into each other's trackway (after A. Tasnádi Kubacska, 1976), 1:1