ANNALES HISTORICO-NATURALES MUSEI NATIONALIS HUNGARICI
Volume 94 Budapest, 2002 pp. 31–44.

Sarmatian (Late Miocene) arthropods from Tállya and neighbouring localities (Tokaj Mts, Hungary): preliminary report

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Abstract – Fossil remains of eight insect orders, a false scorpion (Arachnoidea) and a Decapoda (Crustacea) species have been found in Upper Miocene lacustrine deposits of Tállya and some other localities in the close vicinity. A baëtid larva is especially worth to mention, because fossil Ephemeroptera (apart from the trace fossils) were not found before in the Carpathian Basin, moreover this mayfly family hitherto was not reported from the Miocene at all. The insect-bearing laminated and sometimes tuffitic diatomaceous earth deposited in an eutrophic lake with anoxic bottom conditions. The depth of the lake was more than 10 m. Additionally, a survey is given on the fossil insects have been found earlier in the Carpathian Basin and the neighbouring territories. With 19 figures.

Key words – Insecta, Arachnoidea, Crustacea, Late Miocene, Sarmatian, Hungary, Central Paratethys.

INTRODUCTION

Tállya as a collecting site of a few fossil insects was already reported in the 19th, and in the first part of the 20th centuries (HEER 1872, PONGRÁCZ 1923). More recently – first of all as a result of the enduring collecting activity of GYÖRGY ENCSY – a really rich and interesting fossil arthropod material came to light from the Upper Miocene lacustrine deposits of Tállya and its surroundings (Tokaj Mts, Hungary; Central Paratethys). A part of this material was already examined by JENŐ PAPP (Department of Zoology, Hungarian Natural History Museum, Budapest), and photographed by ANDRÁS KEVE, but it was not yet published at all. Description of new taxa is not an aim of the present paper, but the authors would like to give a survey about the diversity of fossil arthropods found in this locality. Besides, in order to have a right judgement about the importance of the insect remains detailed below, it is worth to survey the insect fossils hitherto found in the Carpathian Basin and the neighbouring territories.

Abbreviations – CE = collection of GY. ENCSY, Tállya; PSZ = property of GY. SZIRÁKI; HNHM = Hungarian Natural History Museum.

A SURVEY OF THE INSECT FOSSILS HITHERTO KNOWN FROM THE CARPATHIAN BASIN AND THE NEIGHBOURING TERRITORIES

Studies on the fossil insects of the Carpathian Basin and the neighbouring territories have old traditions. The first two localities which already were investigated in the middle of the 19th century are Daia (earlier: Dolmány) in Transylvania (now in Romania) (Upper Miocene) (ANDRÄ 1855) and Radoboj in Croatia (Lower Miocene) (CHARPENTIER 1841, UNGER 1841). The extremely rich material of Radoboj was described in detail by HEER (1847, 1849, 1853) in the three volumes of his monograph on the fossil insects of Ohningen (Germany, at the lake Boden) and Radoboj. Later, among other researchers, SÁNDOR PONGRÁCZ described new fossil taxa from Radoboj (e.g. PONGRÁCZ 1917). In the present paper the localities with fossil insects (or insect traces) known from the Carpathian Basin and the nearby territories are listed below. The number in parentheses after the name of the locality agrees with the code number of the given locality on Figure 1, while the number after the name of the taxon means the number of species recognized there.

In the present list the unpublished fossil insect material of the Hungarian Geological Institute, and the large number of entomologically unstudied silicified wood remains with presumably many insect traces in different Hungarian collections are not considered.

Austria

Bad Tatzmannsdorf (A6) – Pleistocene: Coleoptera (34) (SCHWEIGER 1967).

Brunn – Vösendorf (A5) – Upper Miocene: Ephemeroptera (trace fossil, 1), Odonata (1), Heteroptera (1), Coleoptera (2), Hymenoptera (3), Diptera (1) (BERGER 1950, PAPP & MANDL 1951, BACHMAYER 1960, 1961, THENIUS 1979).

Graz-Andritz (A3) – Miocene: Odonata (1) (KNOLL 1902, BACHMAYER 1952).

Hennersdorf (A7) – Miocene: Ephemeroptera (trace fossil, 1) (THENIUS 1979).

Hollabrunn (A8) – Miocene: Ephemeroptera (trace fossil, 1) (THENIUS 1979).

Klein-Hadensdorf (A10) – Miocene: Ephemeroptera (trace fossil, 1) (THENIUS 1979, 1988).

Münzenberg (A1) – Upper Miocene: Odonata (1), Heteroptera (1), Coleoptera (1) (BEIER 1952).

Nexing (A9) – Miocene: Ephemeroptera (trace fossil, 1) (THENIUS 1979).

Parschlung (A2) – Upper Miocene: Blattaria (1), Orthoptera (1), Coleoptera (5), Hymenoptera (6), Diptera (3) (HEER 1847, 1849, BEIER 1952).

Weingraben (A4) – Upper Miocene: Odonata (2), Hymenoptera (2) (BACHMAYER 1952, 1961).

Croatia

Radoboj (C1) – Lower Miocene: Odonata (7), Orthoptera (20), Isoptera (10), Homoptera (27), Heteroptera (33), Neuroptera (1), Coleoptera (17), Hymenoptera (93), Mecoptera (1), Diptera (7), Trichoptera (1), Lepidoptera (8) (CHARPENTIER 1841, 1843, UNGER 1841, HEER 1847, 1849, 1853, 1858, 1867, MAYR 1850, FUCHS 1880, ROSEN 1913, PONGRÁCZ 1917, 1923, 1926*a*, 1926*b*, ZEUNER 1929, KARNY 1932, HANDSCHIN 1937, FRASER 1951, KIAUTA 1969).

Czech Republic

Kelč (CZ2) – Oligocene: Heteroptera (1) (ŘIHA 1979).
Tučín (CZ1) – Pleistocene: Coleoptera (1) (ŘIHA 1979).

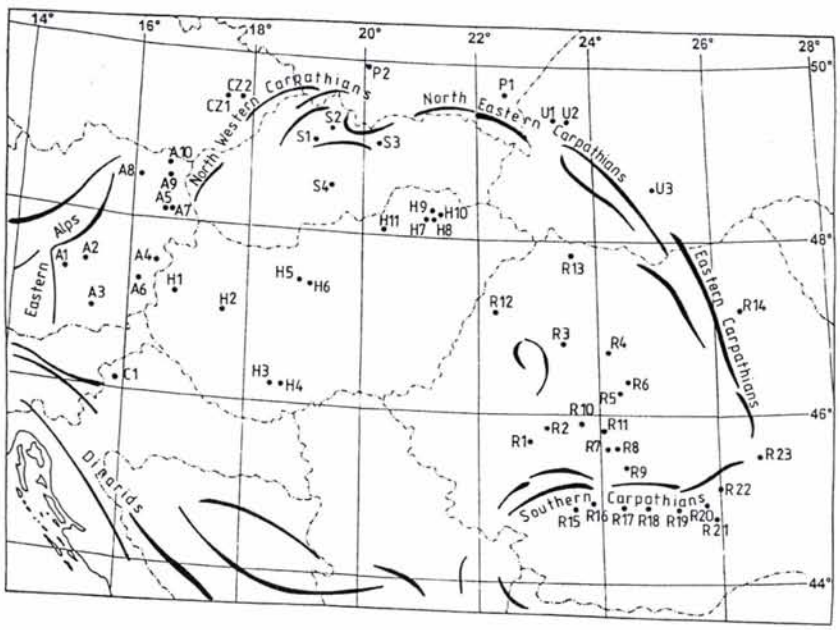


Fig. 1. Localities of fossil insects known from the Carpathian Basin and neighbouring territories. A1 = Münzenberg, A2 = Parschlung, A3 = Graz – Andritz, A4 = Weingraben, A5 = Brunn – Vösendorf, A6 = Bad Tatzmannsdorf, A7 = Hennersdorf, A8 = Hollabrunn, A9 = Nexing, A10 = Klein-Hadensdorf, C1 = Radoboj, CZ1 = Tučín, CZ2 = Kelč, H1 = Gérce, H2 = Pula, H3 = Magyaregregy, H4 = Hidas, H5 = Törökbálint, H6 = Budapest – Kiscell, H7 = Rátka, H8 = Tállya, H9 = Abaujszántó – Cekeháza, H10 = Erdőbénye, H11 = Mikófalva, P1 = Pawlokoma, P2 = Wieliczka, R1 = Tîmpa (Tompa), R2 = Simeria (Piski), R3= Feleacu (Erdőfelek), R4 = Mihesu de Cîmpie (Mezőméhes), R5 = Bazna (Bázna), R6 = Delenii (Magyarsáros), R7 = Sibiu (Nagyszeben), R8 = Daia (Dolmány), R9 = Avrig (Felek), R10 = Mihaş, R11 = Ocna Sibiului, R12 = Delureni, R13 = Chiuzabaia, R14 = Piatra Neamt, R15 = Săcel, R16 = Poenari, R17 = Rămnicu Vălcea, R18 = Suslanesti – Muscel, R19 = Deaul Mare, R20 = Sotrile, R21 = Matiţa, R22 = Scăioşi, R23 = Colţi, S1 = Biely Potok (Fehérpatak), S2 = Lucky (Lucski), S3 = Gánovce (Gánocz), S4 = Malá Lehota, U1 = Borislav (Boryslaw), U2 = Starunia, U3 = Myshin (Myszyn)

Hungary

Budapest – Kiscell (H6) – Oligocene: Heteroptera (1) (PONGRÁCZ 1928*b*).

Gérce (H1) – Pliocene: Coleoptera (7), Hymenoptera (1) (KRZEMINSKI *et al.* 1997).

Hidas (H4) – Miocene: Diptera (1) (HÁMOR 1970).

Magyaregregy (H3) – Miocene: unidentified insects (HÁMOR *et al.* 1974); Diptera (1) (in Natural History Collection of Komló, unpublished fossil).

Mikófalva (H11) – Miocene: Diptera (trace fossil, 1) (SÜSS & MÜLLER-STOLL 1975).

Pula (H2) – Pliocene: Odonata ("a number of larvae"), Heteroptera (1), Coleoptera (3), Psocoptera (1), Trichoptera (1), Diptera (2) (KRZEMINSKI *et al.* 1997).

Tállya (H8) – Upper Miocene: Odonata (4), Hymenoptera (1), Diptera (1) (HEER 1872, PONGRÁCZ 1923).

Törökbálint (H5) – Oligocene: Coleoptera (borings and insect fragments in silicified wood) (PSZ, unpublished data).

Poland

Pawlokoma (P1) – Oligocene: Coleoptera (borings in silicified wood), Hymenoptera (borings in silicified wood) (RAJCHEL & UCHMAN 1998).

Wieliczka (P2) – Miocene: Coleoptera (1) (HANDLIRSCH 1908).

Romania

Avrig (Felek) (R9) – Pleistocene: Hymenoptera (1), Coleoptera (1) (PAX 1908).

Bazna (Bázna) (R5) – Upper Miocene: Heteroptera (1) (HANDSCHIN 1937).

Chiuzabaia (R13) – Upper Miocene: (partly trace fossils), Homoptera (1), Hymenoptera (8), Coleoptera (4), Lepidoptera (1), Diptera (5) (SCHLÜTER 1978, GIVULESCU 1984, KOHRING 1989).

Colți (R23) – Qurternary: Homoptera (1), Coleoptera (1) (PAUCA & COIBANU 1978).

Daia (Dolmány) (R8) – Upper Miocene: Neuroptera (1), Hymenoptera (1) (ANDRÄ 1855, PONGRÁCZ 1928*b*, HANDSCHN 1937).

Deaul Mare (R19) – Oligocene: Coleoptera (1) (PAUCA & COIBANU 1978).

Delenii (Magyarsáros) (R6) – Upper Miocene: Neuroptera (1) (HANDSCHIN 1937).

Delureni (R 12) – Pliocene: Hymenoptera (1) (SCHLÜTER 1978).

Feleacu (Erdőfelek) (R3) – Upper Miocene: Diptera (1) (STAUB 1883); Pleistocene: Hymenoptera (1) (PONGRÁCZ 1928*b*).

Matița (R21) – Pliocene: Coleoptera (1) (PAUCA & COIBANU 1978).

Mihaş (R10) – Miocene: Hymenoptera (1) (PAUCA & COIBANU 1978).

Mihesu de Cîmpie (Mezőméhes) (R4) – Upper Miocene: "well preserved insect fossils" (HANDSCHIN 1937).

Ocna Sibiului (R 11) – Miocene: Hymenoptera (1) (PAUCA & COIBANU 1978).

Piatra Neamt (R14) – Oligocene: Odonata (1), Coleoptera (1) (PAUCA & COIBANU 1978).

Poenari (R16) – Miocene: Diptera (1) (PAUCA & COIBANU 1978).

Rămnicu Vălcea (R17) – Miocene: Coleoptera (1) (MARINESCU & PROCHES 1999).

Săcel (R15) – Miocene: Odonata (2), Homoptera (1), Neuroptera (1), Hymenoptera (2), Diptera (1) (PAUCA & COIBANU 1978).

Scăioşi (R22) – Pliocene: Homoptera (1) (PAUCA & COIBANU 1978).

Sibiu (Nagyszeben) (R7) – Pleistocene: Coleoptera (1) (ASSMANN 1870).

Simeria (Piski) (R2) – Upper Miocene: Hymenoptera (4) (PONGRÁCZ 1928*b*).
Sotrile (R20) – Tertiary: Coleoptera (1) (PAUCA & COIBANU 1978).
Suslanesti – Muscel (R18) – Oligocene: Heteroptera (1), Coleoptera (1) (PAUCA & COIBANU 1978, PAUCA & PAINA 1981).
Tîmpa (Tompa) (R1) – Miocene: Isoptera (2), Diptera (3) (PONGRÁCZ 1928*a*).

Slovakia

Biely Potok (Fehérpatak) (S1) – Pleistocene: Odonata (1) (PAX 1908).
Gánovce (Gánocz) (S3) – Pleistocene: Diptera (2) (PAX 1908).
Lucky (Lucski) (S2) – Pleistocene: Diptera (1) (PAX 1908).
Malá Lehota (S4) – Age is not given: Diptera (1) (ŘIHA 1979).

Ukraine

Borislav (Boryslaw) (U1) – Pleistocene: Orthoptera (1), Heteroptera (4), Coleoptera (70), Lepidoptera (1), Diptera (2) (HANDLIRSCH 1908, ANGUS 1973).
Myshin (Myszyn) (U3) – Miocene: Coleoptera (1) (HANDLIRSCH 1908).
Starunia (U2) – Pleistocene: Orthoptera (1), Hemiptera (1), Coleoptera ("a lot of species"), Diptera ("several species") (HANDLIRSCH 1908, ANGUS 1973, NOWAK *et al.* 1930).

GEOLOGICAL BACKGROUND

The Tokaj Mts are the easternmost part of the Northern Hungarian Range and mainly consist of Miocene volcanic formations. These hills belong to the so-called Inner Carpathian Volcanic Chain and a very variegated volcanic activity took place in this area about 15–9 million years ago. The volcanic rocks are very diverse from the rhyolite to the basalt and the total thickness of the lavas and tuffs is more than 3000 m at some places. The volcanism started in the Badenian (Middle Miocene), mainly in marine environment. The most powerful eruptions were in the Sarmatian and the volcanic activity finished in the Pannonian. The Central Paratethys (including the Carpathian Basin) occluded from the world oceans during the Sarmatian, therefore the sedimentary formations intercalating within the Lower Sarmatian volcanics, contain very typical brackish water mollusc fauna (*Pirenella*, *Cerithium*, *Cardium*, *Ervilia*, *Modiola*). The Upper Sarmatian sequences show more or less fresh water and terrestrial environments. Several smaller or larger limnobrack and fresh water basins appeared on the uneven surface of the so-called Upper Rhyolite Tuff. A great amount of dissolved SiO_2 arrived into the lakes by thermal springs connecting to the post-volcanic activity. Another important source of dissolved SiO_2 is the intensive weathering of silicium-rich volcanic rocks (e. g. rhyolite) on the warm subtropical climate of the Late Miocene. The extreme high

SiO_2 content of the lakes was very favourable to the bloom of fresh water diatoms. Most of the dissolved SiO_2 was used to shell-building by diatoms. The microscopic shells of diatoms were deposited on the bottom of lakes in rock-forming quantity. Several diatomaceous formations, even some diatomaceous earth (diatomite) are known in the marginal areas of the Tokaj Mts. The most important occurrence is at Erdőbénye, but some smaller localities are found around Tállya as well. A part of the SiO_2 may form thin chert layers within the diatomaceous earth sequence. The diatomaceous layers are always white, mainly laminated and sometimes highly silicified. This formation contains more or less volcanic tuff at some places, because of the simultaneous volcanic activity.

Most of the studied arthropod fossils came from the bedding surface of the diatomaceous sediments (Tállya: Dorgó-oldal; Tállya: Gomboska; Erdőbénye; Abaújszántó: Cekeháza). A few fossils were found in limnoquartzite (Rátka, Koldu). The accompanying fauna and flora consists of fish remains and leaf imprints at most localities. The macroscopic paleobotanical material was studied by ANDREÁNSZKY (1959) and recently by ERDEI (1995). The diatoms were sudied in several papers and a monograph by HAJÓS (e.g. 1959, 1978, 1986).

MATERIALS AND METHODS

The overwhelming majority of the examined material is housed in the collection of GYÖRGY ENCSY. A few rock samples with insect fossils are in the Hungarian Natural History Museum, while one of the studied fossils is property of the first author.

The rocks, according to need, were moistened by water to improve microscopic examination.

LOCALITIES AND FOSSILS

Rátka: Koldu (H7)

Insecta: Coleoptera: Dytiscidae – One specimen (Fig. 2) (CE). Dorsal surface of the insect is visible. Length of the body 35 mm.

Insecta: Lepidoptera – One rather poorly preserved ventral imprint (Fig. 3) (CE). Both fore and hindwings are wide, but the left ones (on the photo at right) are folded. Abdomen short and stout, legs moderately long. Length of the body 15 mm.

Tállya: Dorgó (H8/a)

Insecta: Coleoptera: Staphylinidae – Ventral and dorsal imprint of the same specimen (Figs 4–5), collected by GY. ENCSY and the authors in spring of 2000 (HNHM). Length of the head and the

thorax in ventral imprint 7 mm; length of the body fragment (head, thorax and some traces of abdomen) in dorsal imprint 10 mm.

Insecta: Hymenoptera: Symphyta – Ventral (Fig. 6) and dorsal imprint of the same specimen (CE). Length of the body 16 mm.

Insecta: Hymenoptera: Aculeata: Chrysididae – One specimen (Fig. 7) (CE). Length of the body 16 mm.

Insecta: Hymenoptera: Aculeata: Formicidae – One wingless and four winged specimens (CE). Length of the body 3 mm in the case of the wingless, and 7–10 mm in the winged specimens. The photographed specimen is 7 mm long (Fig. 8).

Insecta: Hymenoptera: Aculeata: Vespoidea – One specimen (Fig. 9) (CE). Length of the body 16 mm.

Insecta: Diptera: Nematocera – Six specimens (CE). Length of the body 4–7 mm; the photographed specimen is 4 mm long (Fig. 10).

Arachnoidea: Pseudoscorpiones – One specimen (Fig. 11) (CE). Length of the body 4 mm.

Tállya-Gomboska: Palota-tető (H8/b)

Insecta: Heteroptera: Notonectidae – Ventral imprint of one specimen (Fig. 13) (CE). Length of the body 20 mm.

Abaújszántó: Cekeháza (H9)

Insecta: Odonata – 15 diatomite samples with imprints of larvae (13 CE, 2 HNHM, donated by GY. ENCSY). The specimens identifiable at least to family level belong to Libellulidae (Figs 14–15). Length of the body 12–31 mm; length of the illustrated specimens 30–31 mm.

Insecta: Ephemeroptera – One poorly preserved wing fragment (HNHM, donated by GY. ENCSY).

Insecta: Odonata: Libellulidae – Three larvae (CE). Length of the body 20–27 mm. The illustrated specimen is 7 mm long (Fig. 12).

Insecta: Orthoptera: Acridoidea – One specimen (Fig. 16) (HNHM, donated by GY. ENCSY).

Insecta: Hymenoptera: Formicidae – One poorly preserved specimen (HNHM, donated by GY. ENCSY). Length of the body 4.5 mm.

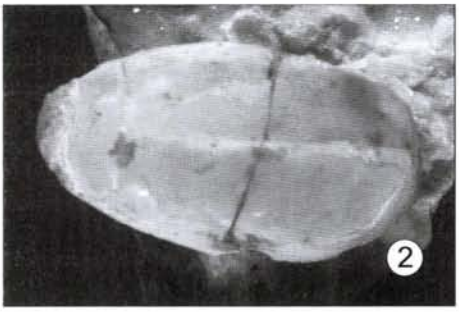
Erdőbénye: diatomite quarry (H10)

Crustacea: Decapoda: Brachiura – Five specimens (decapodite larvae?) (Figs 17–18) (CE). Length of the body 12–22 mm; in the case of illustrated specimens 22 mm (Fig. 17) and 20 mm (Fig. 18).

Insecta: Ephemeroptera: Baëtidae – One specimen (larva) (Fig. 19) (PSZ). Length of the body (without cerci): 10 mm.

DEPOSITIONAL ENVIRONMENT

The rock-forming frequency of diatoms prove unambiguously the eutrophic character of a lake. The deeper parts of the eutrophic lakes are anoxic, because after the death of the diatoms the oxidation consumes lots of oxygen at the bottom of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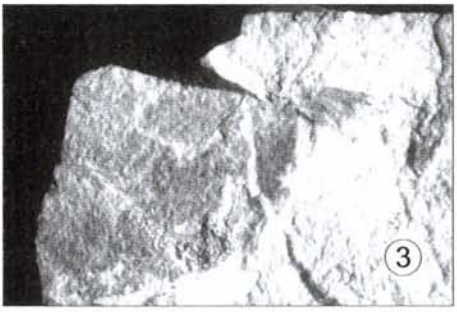
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the basin. The eutrophic lakes are oxygen-poor already at relatively small depths. The sedimentary formations are generally laminated in this environment because of the lack of the benthic animals, and consequently the lack of bioturbation. So, the laminated or thinly-bedded diatomaceous earth refer to eutrophic lake environment with anoxic bottom conditions. However, the formation of laminated layers requires at least some 10 m of depth. In the shallower part of the lakes the waves and the surface currents prevent the formation of anoxia and laminated layers. Therefore the insect-bearing laminated diatomite layers must have been deposited in an eutrophic lake which was deeper than 10 m.

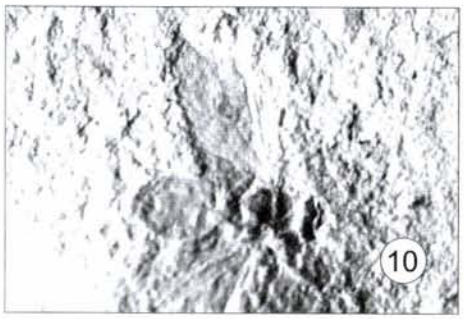
Similar eutrophic lakes formed in the Badenian (Middle Miocene) at the SW part of the Mátra Mts (Szurdokpüspöki) and at the SE part of the Börzsöny Mts (Szokolya). The diatomaceous earth layers with thin chert intercalations are deposited on andesite at these localities. The water of the Pliocene crater lake at Pula was also rich in dissolved SiO_2, and diatoms were deposited in rock-forming quantity. Some insect fossils were published from this locality (KRZEMIŃSKI *et al.* 1997).

A significant part of the examined arthropod specimens are aquatic animals (e.g. Brachiura, Notonectidae, Dytiscidae), or insects with aquatic larvae (Odonata and Ephemeroptera). At the same time there are some terrestrial arthropods in the studied material (e.g. Orthoptera, Coleoptera: Staphylinidae, Hymenoptera, Lepidoptera) originated from the most likely arboreal habitats near to the lakes where the fossilization took place.

DISCUSSION

Representatives of eight insect orders (Ephemeroptera, Odonata, Orthoptera, Heteroptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera) were found in the Sarmatian (Upper Miocene) lacustrine deposits of Tállya and the nearby localities, within a circle of 12 km in diameter. Moreover, one false scorpion (Arachnoidea) and five specimens of probably one Brachiura (Crustacea) species were also collected. It means that – apart from Radoboj – this group of localities yielded the most diverse fossil arthropod assemblage in the Carpathian Basin and the neighbouring territories (Fig. 1).

Figs 2–9. 2 = Dytiscidae (Coleoptera) sp. from Rátka: Koldu (code number in CE: 12/1). 3 = Lepidoptera sp. from Rátka: Koldu (code number in CE: 11/1). 4–5 = Staphylinidae (Coleoptera) sp. from Tállya: Dorgó. (Inventory number in HNHM: M.2002.37). 4 = ventral imprint, 5 = dorsal imprint. 6 = Symphita (Hymenoptera) sp. from Tállya: Dorgó (code number in CE: 15/1). 7 = Chrysididae (Hymenoptera) sp. from Tállya: Dorgó (code number in CE: 15/16). 8 = Formicidae (Hymenoptera) sp. from Tállya: Dorgó (code number in CE: 15/13). 9 = Vespoidea (Hymenoptera) sp. from Tállya: Dorgó (code number in CE: 15/17)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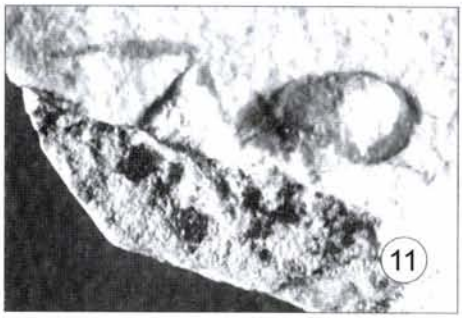
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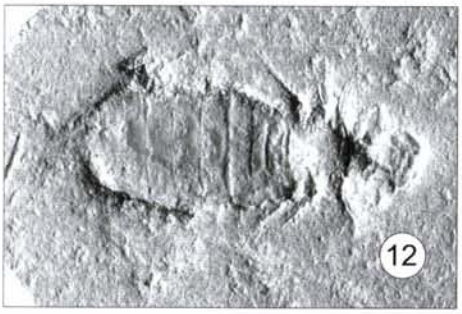
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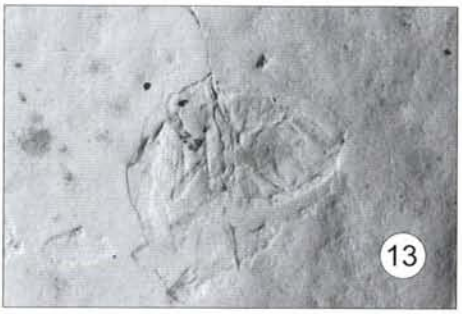
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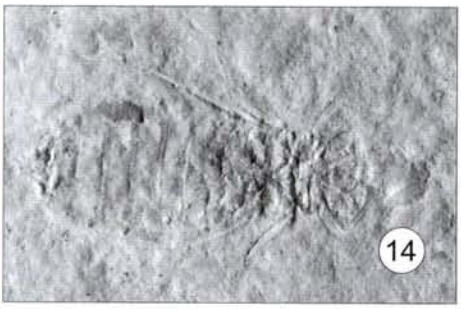
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Figs 18–19. 18 = Brachiura (Crustacea: Decapoda) sp. from Erdőbénye: diatomite quarry (code number in CE: 23/6). 19 = Baëtidae (Ephemeroptera) sp. from Erdőbénye: diatomite quarry (PSZ)

The mayfly larva from Erdőbénye is especially interesting, because (apart from the trace fossils) it is the first known fossil Ephemeroptera from the Carpathian Basin and its surroundings. This larva most probably represents a species belonging to the family Baëtidae, because of relatively narrow head, long legs with slender femur, large thorax, minute and leaf-like tracheal gills and moderately long caudal filaments (Fig. 18). Furthermore, this is the first finding of the Baëtidae from the Miocene, as their fossils were hitherto found in Pliocene and Holocene only (CARPENTER 1992).

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Acknowledgements – The authors are grateful to GYÖRGY ENCSY who made possible the study of his collection and showed us the localities at Tállya and Abaújszántó, as well as to LÁSZLÓ FORRÓ and GYŐZŐ SZÉL (Crustaca Collection and Coleoptera Collection respectively in the Department of Zoology of HNHM) for consultations. A. DULAI was supported by the Hungarian Scientific Research Fund (OTKA F25556).

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Figs 10–17. 10 = Nematocera (Diptera) sp. from Tállya: Dorgó (code number in CE: 15/9). 11 = Pseudoscorpiones (Arachnoidea) sp. from Tállya: Dorgó (code number in CE: 15/5). 12 = Libellulidae (Odonata) sp. from Tállya: Gomboska (code number in CE: 17/3). 13 = Notonectidae (Heteroptera) sp. from Tállya: Gomboska (code number in CE: 14/4). 14–15 = Libellulidae (Odonata) from Abaújszántó: Cekeháza (code numbers in CE: 4/1 and 4/13). 16 = Acridoidea (Orthoptera) sp. from Abaújszántó: Cekeháza (inventory number in HNHM: M.2002.38). 17 = Brachiura (Crustacea: Decapoda) sp. from Erdőbénye: diatomite quarry (code number in CE: 23/5)

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