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Rovno amber insects: first results of analysis

Насекомые ровенского янтаря: первые результаты исследования

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KEY WORDS: Rovno amber, Saxonian amber, Eocene, Oligocene, palaeocurrents.
КЛЮЧЕВЫЕ СЛОВА: ровенский янтарь, саксонский янтарь, эоцен, олигоцен, палеотечения.

ABSTRACT: Some students believed that Rovno amber may have been transported to the Pripyat area during the Eocene from the north across the sea and thus it could have originated in the same region as the Baltic amber, but comparison between Baltic and Rovno amber faunas, especially myrmecofaunas indicates a geographically independent origin of Rovno and Baltic ambers.

In the Rovno amber assemblage, about 26% of ant specimens are represented by the new genera and new species (nine of them was described in the first year of the study). In contrast, new collections of Baltic amber of similar size yield much less proportion (normally 2–5%) of specimens belonging to new species.

Analysis of both palaeogeographic and palaeosedimentation evidence during the Late Eocene to Early Oligocene in the northwestern part of the Ukrainian Crystalline Shield, permits to consider the amber of the Ukrainian shield as autochthonous.

Klesov deposit is often misinterpreted as of Oligocene age [Grygyalis & Burlak, 1996; Tutskij & Stepanjuk, 1999; Weitschat & Wichard, 2002]. The source of the mistake was identification of the Klesov deposit by I.A. Maidanovich based on incorrect Early Oligocene dating of the coeval Prussian suite, in one chapter of the paper by Maidanovich & Makarenko [1988]. The analysis of the Rovno amber fauna confirms its Late Eocene age and autochthonous origin, with the latter being rather different from that of Baltic amber. It also provides no evidence of its close relationships with the Saxonian amber fauna.

РЕЗЮМЕ: Работа подводит итоги первых трех лет исследования энтомофауны ровенского янтаря.

В вопросе о происхождении янтарей Украинского Полесья долгое время доминировала гипотеза их привноса в места захоронения на Украинском щите морскими течениями из Прибалтики [Катинас, 1971 и др.]. В результате проведенного сравнительного исследования фаун (в первую очередь — мирмекофаун) ровенского (в основном с Клесовского и Дубровицкого месторождений) и балтийского янтарей подтвердилась противоположная гипотеза – украинского происхождения ровенского янтаря. Так, в первый год исследования из ровенского янтаря описаны девять новых видов муравьев [Длусский, 2002; Длусский, Перковский, 2002]; к новым таксонам принадлежит 26% определенных до вида экземпляров муравьев.

В ряде работ возраст янтареносных отложений Клесовского месторождения ошибочно указывался как олигоценовый. Источником этой ошибки, как указал сам И.А. Майданович [Майданович, Макаренко, 1988], было то, что, обоснованно указывая на одновозрастность янтареносных отложения Клесова и прусской свиты, И.А. Майданович полагал, что сама прусская свита имеет раннеолигоценовый возраст. Схемы палеотечений в морском бассейне [Григялис, Бурлак, 1996] основаны на предположениях о транспорте янтаря со Скандинавского полуострова в Клесов и олигоценовом возрасте Клесовского месторождения и нуждаются в пересмотре.

Introduction

Amber chemically identical to the dominating Baltic variety, succinite, is widespread in the Pripyat River basin in Byelorussia and the Ukraine, as pointed out by V.I. Katinas [1987] and B. Kosmowska-Ceranowicz [1999]. The amber area also covers the Southeast of Poland [Kosmowska-Ceranowicz *et al.*, 1990]. The amber is most common in lignite-bearing sands and in glauconitic sands resembling the amber-bearing Prussian Formation of the Baltic area. Rovno amber has been collected from the Klesov (the vast majority of inclusions) and Dubrovitsa deposits which are a constituent part of the vast region of amber distribution in the north of Rovno and Zhitomir regions within the

Ukrainian Polesye [Perkovsky *et al*., 2003, fig. 1]. The amber has long been known from the region. Archeologists have described decorations and amulets of amber found during excavations of Palaeolithic [Shovkoplyas, 1972; Rogachev & Anikovich, 1984 etc.] and Neolithic sites within the Ukrainian Polesye.

Historical account

The first mentions of amber of Ukrainian and Byelorussian Polesye in scientific literature go back to the middle of the 18th century. Among the first papers about Rovno amber perhaps the most significant belonged to P.A. Tutkovskij [1911]. Special research was carried out in order to understand the amber's origins, its chemical and physical composition and properties, features and regularities of deposit formation in the post-war years of the last century. Their results were published in the papers and monographs of S.S. Savkevich [1970], V.I. Katinas [1971], V.S. Trofimov [1974] and others. Although the main objective of those studies was Baltic amber, to a greater or lesser extent virtually all of them considered also ambers of the Ukrainian Polesye. Both these ambers were united into a Baltic-Dnieper Subprovince. The works of I.A. Maidanovich and D.E. Makarenko [1988] as well as of V.M. Matsuy and V.A. Nesterovsky [1995] were largely devoted to Rovno amber.

Recently, after the discovery of both above mentioned amber deposits [Perkovsky *et al*., 2003, fig. 1], amber extraction in the Rovno Region has become industrialized. Earlier, amber was taken in a primitive way from sandy-argillaceous sediments of granite quarries in the outskirts of Klesov, from drainage channels dumps, from natural outcrops of amber-bearing deposits along the river banks.

Geological background

Structurally, the region of the amber-bearing deposits is referred to the northwestern margin of the Ukrainian Crystalline Shield. Terrestrial and shallow water marine Palaeogene sediments, terrestrial (mainly bog-lacustrine) Neogene and predominantly glacial formations of Anthropogene overlie here the Pre-Cambrian formations and their weathering surface. The Palaeogene deposits in the most complete sections contain the Buchak (Lutetian), Kiev (Bartonian), Obukhov (Priabonian), Mezhigorje (Rupelian) and Berek (Chattian) suites; the Neogene deposits the Novopetrovtsy Suite and the strata of speckled and reddish-brown clays and the Anthropogene morainic fluvioglacial complex and alluvium of river valleys of the Anthropogene.

Amber occurs in almost all stratigraphic units of the sedimentary cover. It has not been found in the Buchak deposits only and is extremely rare in the Kiev ones. However, even in the part of the section where amber occurrences are abundant, its content in the rock is substantially different. The richest placers are associated with the Obukhov (Upper Eocene) and Mezhigorje (Lower Oligocene) suites.

The Obukhov and Mezhigorje suites seem to have been formed in shallow water zones of marine basins, with their deep water parts situated in the Pripyat and Dnieper-Donets depressions. The shorelines of these basins lay within the Ukrainian shield. The zone of littoral shallow waters in this shield was apparently the area where the formation of amber placers in the sea was simultaneous with the accumulation of primary sediment material of future suites. The Obukhov Suite consists of greenish gray and bluishgray sandy aleurites, clayey glauconite-quarts, non-carbonate, often with admixtures of carbonized plant detritus. The Mezhigorje Suite is represented by fine and medium-grained sands, light greenish gray, with yellowish or brown tint, with ferrugization nests and interlayers, slightly clayey. Interlayers of humidified sands of varied size with thin lenticular interlayers of coaly clays and brown coals, phosphoritic concretions, layers of gravel sands are confined to the base of the suite. The thickness of the strata usually varies from 2–3 to 5–7 m [Makarenko *et al*., 1987; Zosimovich, 1992].

A late Eocene age of the Obukhov Suite and an Early Oligocene age of the Mezhigorje Suite have been determined palaeontologically. According to A.B. Stotland (personal communication), dinocysts of the Obukhov Suite together with *Charlesdowniea clathrata angulosa-Deflandria phosphoritica* make up a complex characteristic of the Obukhov Regio-Stage in the stratotypical section, of the Alma Regio-Stage of the Black Sea depression and Crimea, of the Beloglinka Horizon in the North Caucasus and of the Priabonian Stage of Western Europe. The complex of palynomorphs with *Myrica pseudogranulata – Quercus gracilis – Q. graciliformis* is also characteristic of Upper Eocene deposits of various regions in the south of the East European Platform. The dinocyst complex of the Mezhigorje Suite (A.B. Stotland, personal communication) contains species characteristic of the zonal assemblages of the Early Oligocene, *Phthanoperidinium amoenum – Wetzeliella symmetrica – W.* gochtii. This corresponds to the dinoflora characteristic of the Mezhigorje Regio-Stage of the stratotype, of the Borysthen Suite of the Black Sea depression, the Planorbella Suite of the Crimea, the Pshekh Suite of the Northern Caucasus, the Rupelian Stage of Western Europe.

Klesov deposit are often misinterpreted as of Oligocene age [Grigyalis & Burlak, 1996; Tutskij & Stepanjuk, 1999; Weitschat & Wichard, 2002]. The source of the mistake was identification of the Klesov deposit age by I.A. Maidanovich, based on incorrect Early Oligocene dating of the coeval Prussian suite, in one chapter of the paper by Maidanovich & Makarenko [1988]. All other chapters of this paper refer to the age of Klesov deposit as Late Eocene.

Some students believe that Rovno amber may have been transported to the Pripyat area during the Eocene from the north across the sea and thus it could have originated in the same region as the Baltic amber

[Katinas, 1971, 1987], while others suggest local origins of the amber in the Ukrainian Crystalline Shield [Komarov, 1935; Kosmowska-Ceranowicz *et al*., 1990; Zherikhin, 1998; Kosmowska-Ceranowicz, 1999; Perkovsky, 2000; Azhgirevich *et al*., 2000] .

During the Late Eocene and Early Oligocene, the territory between northwestern Europe and the southern Urals (the so-called Subparatethys Sedimentation Province) is known to have been covered by marine basins. Scheme of palaeocurrents within this marine basin is restored by Grigyalis & Burlak [1996] based on two assumptions that we consider incorrect, i.e., on the hypothesis of Scandinavian origin of the amber of Ukraine, and on that of the Oligocene age of Klesov deposit. The palaeontological data appear to confirm the same age of basic amber-bearing strata of the Ukrainian Polesye and the Baltic, i.e. the Obukhov and Prussian suites, respectively [Grigyalis *et al*., 1988]. However, analysis of both palaeogeographic and palaeosedimentation evidence during the Late Eocene to Early Oligocene in the northwestern part of the Ukrainian Crystalline Shield, as presented below, permits to consider the amber of the Ukrainian shield as autochthonous. An indirect confirmation of that is an apparently Eocene age of the autochthonous ambers of Parczew in the south of Poland [Kasinski & Tolkanowicz, 1999].

According to the vegetation composition, the climate in the region seems to have been subtropical. The sea covering the northwestern part of the Ukrainian Crystalline Shield was apparently shallow, the shoreline was cut by numerous lagoonas, skerries, bays etc, i.e., of a character considered optimum for amber accumulation [Maidanovich & Makarenko, 1988].

As it has been predicted by V.V. Zherikhin and K.Yu. Eskov [1999], a comparison of the inclusions of the Rovno and other ambers offers a clue to solving problem of the origins of Rovno amber [Dlussky & Perkovsky, 2002].

Results

Before our study, only 11 insect inclusions in Rovno amber, deposited in the Rovno Museum of Regional Studies (Dolichopodidae, Cecydomyiidae, Psychodidae, Limoniidae, Mycetophilidae, Helodidae, Megalyridae), all identified by A.P. Rasnitsyn and V.G. Kovalev (PIN), plus some Rhagionidae, deposited in the Zhitomir Museum of Regional Studies, have been reliably identified to the family level. Unfortunately, all other identifications cited by W. Tutskij and L. Stepanjuk [1999] and later repeated by B. Kosmowska-Ceranowicz [1999], appear incorrect even at the family or, in the case of one ant and one pompilid, genus level [Perkovsky, 2001; Perkovsky *et al*., 2003].

An analysis of the determinations of 1500 Rovno amber inclusions from the Klesov and Dubrovitsy deposits, Rovno Region, Ukraine acquired by the Institute of Zoology of the National Academy of Sciences of Ukraine in Kiev (IZK) from the "Ukramber" Company allows for the first time to compare the Rovno amber fauna to the other European Late Eocene amber faunas. Specialists of the PIN and IZK have largely studied the Kiev collection. The list of families has been supplemented with Anthocoridae, being found in Polish collections of Rovno amber [Putchkov, Popov, 2003] and Piesmatidae [Yu.A. Popov, pers. comm.]. First Rovno amber representatives of Leiodidae and Mutillidae have been identified in the private collection of S.A. Suvorkin (Kiev). Preliminary review is published in the "Fossil insects" [Perkovsky *et al*., 2003].

Our data have been compared with information concerning the taxonomic composition of a representative collection of fossils in Baltic amber offered by Prof. A.P. Rasnitsyn (PIN). The collection was accumulated randomly from raw amber mass at the amber plant in Yantarnoye (former Palmniken), Kaliningrad Region, Russia, in September 1992. The amber was extracted mechanically and graded by size with a mesh of 23 or, rarely, 32 mm before any other hand could touch it. As no other sorting has been applied to the amber, the collection is relatively unbiased in respect to the original composition of the animal inclusions once trapped into fluid resin of ancient pine trees. This is an advantage of that collection relative to all others that have been amassed either by jewellers or workers of amber industry who commonly missed small fossils and gave strong preference to large and rare forms. Now the collection is housed at the Booth Museum of Natural History, Brighton, UK.

In comparison to the Baltic amber fauna [Wheeler, 1915; Larsson, 1978], in Rovno amber both Hemiptera sensu lato (4.2 vs. 6.3–7.1 %) and Trichoptera (1 vs. 2–5.6 %) are poorly represented. The first Microphysidae of Eocene age, a new representative of *Loricula* Curt. from Rovno amber was described by P.V. Putchkov and Yu.A. Popov [2003]. Highly interesting are the discoveries in the first 1000 inclusions of members of Embioptera and, especially, gryllids (Fig. 1) from the currently tropical phytophilic subfamily Phaloriinae, a second Late Eocene amber representative of phalorines [Gorokhov, 1995]. Among the first three Rovno amber caddis-flies identified by Dr. I.D. Sukacheva, there occur Hydroptilidae (*Allotrichia* sp.) (Fig. 3) with the genus being quite rare in the Baltic amber, a species of *Palaeocrunoecia* (Lepidostomatidae) being close to *P. crenata* Ulmer, 1912 from the Baltic amber, where this genus is generally rare, and *Nyctiophylax* sp. (Polycentropodidae). Among the Rovno amber beetles, Staphylinidae sensu lato [Perkovsky *et al*., 2003] are the most numerous [Semenov *et al*., 2001; Perkovsky *et al*., 2003, fig. 2]; weevils are represented by a new genus and species of Molytinae (Fig. 2). Diptera are less abundant in Rovno amber, i.e. 65 vs. 72 % in the representative Baltic amber collection kept at Brighton. The main comparisons are summarized in Tab. 1.

The Rovno amber dipteran fauna appears to include far fewer chironomids and ceratopogonids. So summarily they are evidently less strongly represented, even much less than mentioned before [Perkovsky, 2001], i. e. 28 vs. 40+6 %. In Rovno amber, Dr. N.I.

Table 1. Comparison of the insect faunas of Rovno and Baltic ambers.
Таблица 1. Сравнение фаун насекомых ровенского и балтийского янтарей.

Taxon	Baltic amber	Rovno amber
Hemiptera s. l.	6.3–7.1%	3.2%
Trichoptera	2–5.6%	0.5%
Allotrichia sp. (Hydroptilidae)	Quite rare	+ (see text)
Paleocrunoecia sp. (Lepidostomatidae)	Generally rare	+ (see text)
Diptera	72%	54%
Chironomidae+ Ceratopogonidae	40+6% of dipteran fauna	28% of dipteran fauna
Lasius schiefferdeckeri /*Formica* sp.	0.9 (after Wheeler 1915)	3 (see text)

Zelentsov and Dr. N.A. Shobanov (personal communication) have identified 10 chironomid genera from 4 subfamilies. Of them, 9 genera and 1 subfamily (Telmatogetoninae) have hitherto been unknown from the Eocene. They are widely represented by genera containing numerous non-aquatic species. Species of 8 or 9 genera of 22 known Eocene (mostly Baltic) amber dolichopodid genera have been found in Rovno amber [Grichanov, 2000]. Sciarids are evidently more numerous (21 vs. 15 %).

Lepidoptera in Rovno amber are not so common, found mostly in one piece of amber containing, except for a series of adults (Fig. 4), 3 larvae of Psychidae [Perkovsky *et al.*, 2003, fig. 3].

A comparison of the percentage of hymenopterans from the Rovno and Baltic ambers shows that the shares of ants are nearly equal (50% vs. 44%). In the entire currently available Rovno collection, the number of scelionids is twice as high as that of diapriids. In contrast, in the representative Baltic amber collection the situation is reverse, with the proportion of scelionids amounting to 6%, and that of diapriids to 12%. Dr. S.V. Kononova (personal communication) suggests this difference to be related to a drier climate in the north of the Ukrainian Crystalline Shield during the Late Eocene.

The first hymenopteran described from Rovno amber is the second genus and species of the subfamily Ghilarovitinae (Paxylommatidae) with 22–23-segmented antennae [Kasparyan, 2001], i.e., *Astigmaton ichneumonoides* Kasparyan, 2001 [Perkovsky *et al.*, 2003]. Four species of *Idris* Förster, 1856 (Scelionidae) are also found in the Rovno amber, three of them are described [Kononova, 2003], while only one *Idris* species was known from the Baltic amber. Two genera and two species of Encyrtidae (Fig. 5) have been described from the Rovno amber [Simutnik, 2001, 2002], including a highly primitive one. The metasoma of the latter [Simutnik, 2002], provisionally assigned to Tetracnemidae incertae sedis, shows an archaic structure with an apical position of the pygostyles.

The most evident difference is observed when the Rovno and Baltic amber ant faunas are compared. No Baltic amber species of *Dolichoderus* Lund was identified in the Rovno amber, but two new Rovno amber species was described: *Dolichoderus robustus* Dlussky and *D. polessus* Dlussky [Dlussky, 2002]. The first revision of Rovno amber ants [Dlussky & Perkovsky, 2002] includes the descriptions of *Dolichoderus zherichini* Dlussky [Perkovsky *et al.*, 2003, fig. 4], *Tapinoma aberrans* Dlussky (Fig. 6), *T. electrinum* Dlussky [Perkovsky *et al.*, 2003, fig. 5]; *Plagiolepis minutissima* Dlussky (Fig. 7), *Oligomyrmex nitidus* Dlussky (Fig. 8), *O. ucrainicus* Dlussky (Fig.9), *Aphaenogaster antiqua* Dlussky (Fig.10), as well as indication on the finding of two new genera and species of Myrmicinae [Dlussky & Perkovsky, 2002]. More than 26 % of the Rovno amber ants appear to represent new genera and species not found in the Baltic amber. In contrast, new collections of the Baltic amber of similar size yield much less proportion (normally 2–5%) of specimens belonging to new species. Also, about 63% of Rovno ant specimens belong to recent genera, as opposed to about 52% in the Baltic amber. Dolichoderinae are less abundant in the Rovno amber, i.e. 46 vs. 64 % in the Baltic amber, Myrmicinae are more common (15% vs. 2%) [Dlussky & Perkovsky, 2002]. Representatives of Formicinae and Myrmicinae prevail in the fauna of the Palaearctic since the Miocene with smaller proportion of Dolichoderinae. The well-studied Miocene fauna of Stavropol region, where Formicinae make 53% of all ants, Myrmicinae 40% and Dolichoderinae 4%, can be taken as an example [Dlussky, 1981]. Representatives of the genus *Dolichoderus* are more common in the Rovno amber, 14% vs. 5% in the Baltic amber.

Lasius schiefferdeckeri Mayr, 1868 in the Rovno amber (30 of 87 specimens identified to the species level) is as common as *Ctenobethylus goepperti* (Mayr, 1868), and 3 times more numerous than species of *Formica* Linnaeus, 1758. In contrast, in Baltic amber, according to Wheeler [1915], *L. schiefferdeckeri* is 4.6 times outnumbered by *C. goepperti* in the classic Königsberg collections, and *Formica flori* Mayr, 1868 is more abundant there than *L. schiefferdeckeri*. In the representative collection [Dlussky & Perkovsky, 2002] *L. schiefferdeckeri* is half as abundant as *C. goepperti,* but still 1.7 times more numerous than *Formica.*

A comparison with the Saxonian amber fauna [Schumann & Wendt, 1989] shows that Rovno amber dipterans are less numerous (65 vs. 80 %) while the caddisflies are 3 times less abundant, with none of their three genera being found in Rovno amber, and two of three families being unknown from Saxonian amber. The composition of the mentioned dipteran faunas differs drastically. For example, while according to F. Röschmann and W. Mohrig [1995] the mycetophilids composed 30% of Bitterfeld dipterans, in Rovno amber they are 9 times less common. Quite many species appear to be shared by the Baltic and Rovno ambers, but none species common exclusively to the Rovno and Saxonian ambers have been found yet.

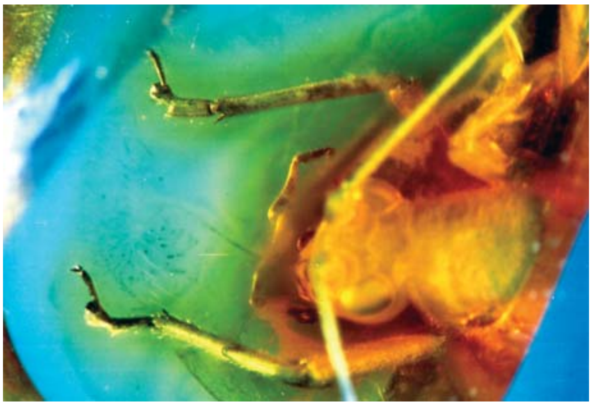

Fig. 1. A phaloriine gryllid from Rovno amber.
Рис. 1. Сверчок-фалориина.

Fig. 2. Representative of a new genus and species of Molytinae (Curculionidae) from Rovno amber.
Рис. 2. Представитель нового рода и вида Molytinae (Curculionidae).

Fig. 3. Caddis-fly from the genus *Allotrichia*.
Рис. 3. Ручейник из рода *Allotrichia*.

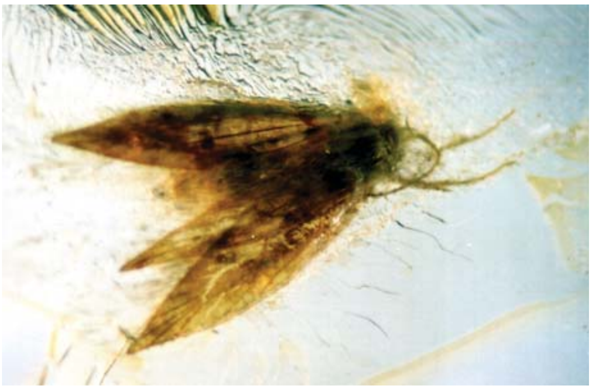

Fig. 4. A tineoid moth from Rovno amber.
Рис. 4. Тинеоидная моль.

Fig. 5. Holotype of *Eocencyrtus zerovae* Simutnik from Rovno amber.
Рис. 5. Голотип *Eocencyrtus zerovae* Simutnik.

Fig. 6. Holotype of *Tapinoma aberrans* Dlussky (UA–57).
Рис. 6. Голотип *Tapinoma aberrans* Dlussky.

Fig. 7. Holotype of *Plagiolepis minutissima* Dlussky (UA–1066).
Рис. 7. Голотип *Plagiolepis minutissima* Dlussky.

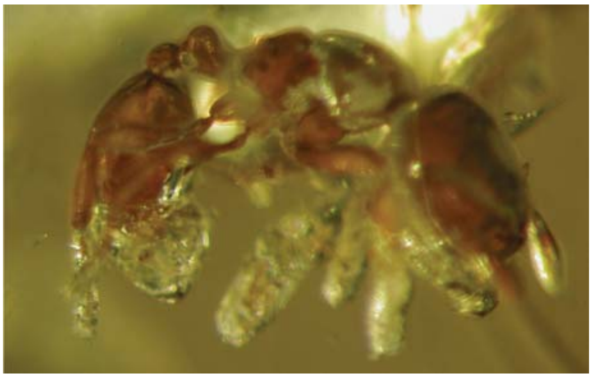

Fig. 8. Holotype of *Oligomyrmex nitidus* Dlussky(UA–509)
Рис. 8. Голотип *Oligomyrmex nitidus* Dlussky.

Fig. 9. Holotype of *O. ucrainicus* Dlussky (UA–767).
Рис. 9. Голотип *O. ucrainicus* Dlussky.

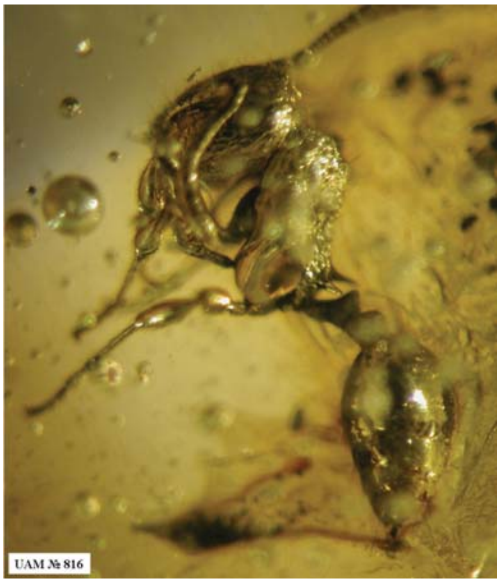

Fig. 10. Holotype of *Aphaenogaster antiqua* Dlussky (UA–816).
Рис. 10. Голотип *Aphaenogaster antiqua* Dlussky.

A list of the insect orders and families reported currently from the Rovno amber is given in Tab. 2.

Conclusions

The above analysis of the Rovno amber fauna confirms its Late Eocene age and autochthonous origin, with the latter being rather different from that of Baltic amber. It also provides no evidence of its close relationships with the Saxonian amber fauna. The origin and relationships of Saxonian amber known to occur in the Lower Miocene sediments near Bitterfeld, East Germany are still hotly debated [Weitshat & Wichard, 2002]. Based on the sciarid and ceratopogonid faunas in the Baltic and Saxonian ambers, F. Röschmann [1999] concludes that the discrepancies between them are due to ecological reasons rather than to time differences. However, if Saxonian amber is autochthonous and Eocene in age, it should originate from the same southern sea shoreline as Rovno amber did. The absence of Rovno elements in the Saxonian amber fauna evidences that their origins were different either in time, or in space, or both.

Table 2. A list of the insect orders and families know to occur in Rovno amber.
Таблица 2. Список отрядов и семейств насекомых, известных из ровенского янтаря.

- Archaeognatha
  - Machilidae
- Ephemeroptera
  - Heptageniidae
- Embioptera
  - Embiidae
- Orthoptera
  - Gryllidae
- Isoptera
  - Kalotermitidae
  - Rhinotermitidae
- Homoptera
  - Pemphigidae
  - Drepanosiphidae
  - Matsucoccidae
  - Cicadomorpha
    - Cicadellidae
  - Fulgoromorpha
- Heteroptera
  - Schizopteridae
  - Saldidae
  - Reduviidae
  - Microphysidae
  - Miridae
  - Anthocoridae
  - Piesmatidae
- Blattoptera
- Thysanoptera
- Psocoptera
  - Sphaeropsocidae
- Hymenoptera
  - Megalyridae
  - Megaspilidae
  - Ceraphronidae
  - Bethylidae
  - Paxylommatidae
  - Ichneumonidae
  - Braconidae
  - Scelionidae
  - Platygastridae
  - Diapriidae
  - Pteromalidae
  - Signiphoridae
  - Aphelinidae
  - Trichogrammatidae
  - Encyrtidae
  - Mymaridae
  - Mymarommatidae
  - Pompilidae
  - Mutillidae
  - Formicidae
- Coleoptera
  - Carabidae
  - Ptiliidae
  - Leiodidae
  - Scydmaenidae
  - Staphylinidae (including Pselaphidae)
  - Elateridae
  - Throscidae
  - Cleridae
  - Melyridae
  - Helodidae
  - Artematopidae
  - Anobiidae
  - Ptinidae
  - Dermestidae
  - Silvanidae
  - Mycetophagidae
  - Lathridiidae
  - Zopheridae
  - Monotomidae
  - Melandryidae
  - Nitidulidae
  - Scraptiidae
  - Mordellidae
  - Anthicidae
  - Aderidae
  - Curculionidae (including Scolytidae)
- Trichoptera
  - Hydroptilidae
  - Lepidostomatidae
  - Polycentropodidae
- Mecoptera
  - Bittacidae
- Lepidoptera
  - Tineoidea
  - Gelechioidea
  - Psychoidea
    - Psychidae
- Diptera
  - Cecydomyidae
  - Chaoboridae
  - Chironomidae
  - Dixidae
  - Ceratopogonidae
  - Simuliidae
  - Psychodidae
  - Tipulidae
  - Sciaridae
  - Scatopsidae
  - Mycetophilidae
  - Keroplatidae
  - Mycetobiidae
  - Asilidae
  - Rhagionidae
  - Dolichopodidae
  - Empididae
  - Bombyliidae
  - Syrphidae
  - Phoridae

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