Rophalis relicta HAGEN (Neuroptera, Nevrorthidae) in the Late Eocene Rovno amber, with a discussion of the taxonomic status of the genus

Vladimir N. MAKARKIN & Eugeny E. PERKOVSKY

Abstract: *Rophalis relicta*, previously known from the Late Eocene Baltic amber, is recorded from the nearly contemporaneous Rovno amber, Ukraine. The species is characterized in particular by the loss of the crossveins 3rs-rs3, 3rs3-rs2 in the forewing, and the mainly simple branches of CuA in the hindwing. The genus *Rophalis* is most closely related to the extant genus *Nevrorthus*. However, the differences in wing venation and the structure of female terminalia do not allow the two genera to be synonymized.

Key words: Baltic amber, *Nevrorthus*, female terminalia.

Santrauka: Publikacijoje kalbama apie gintarą iš Rovno (Ukraina), kuris susidarė beveik tuo pačiu metu kaip vėlyvojo eoceno Baltijos gintaras. Aprašomas *Rophalis relicta* (Neuroptera, Nevrorthidae), kuris iki šiol buvo žinomas tik iš Baltijos gintaro. Rūšiai ypač būdinga tai, kad ji priekiniame sparne yra netekusi skersinių gyslų 3rs-rs3, 3rs3-rs2 ir turi palyginti paprastas CuA šakotas gyslas užpakaliniame sparne. Gentis *Rophalis* yra artimiausia dabartinei genčiai *Nevrorthus*, tačiau dėl sparnų gyslotumo skirtumų ir patelių terminalijų struktūros ypatumų šių genčių negalima sutapatinti.

Raktiniai žodžiai: Baltijos gintaras, *Nevrorthus*, patelės terminalijos.

Introduction

The relict family Nevrorthidae is currently represented by three genera with 12 species: *Nevrorthus* COSTA, 1863 (South Europe, North Africa; four species), *Nipponeurorthus* NAKAHARA, 1958 (Japan, Taiwan; six species), and *Austroneurorthus* NAKAHARA, 1958 (Australia; two species) (MONSERRAT 1977; H. ASPÖCK et al. 1980; U. ASPÖCK & H. ASPÖCK 1983; U. ASPÖCK 2004; U. ASPÖCK & H. ASPÖCK 2007: figs 74-76 [maps]).

Hitherto, fossil nevrorthids were confidently known only from Baltic amber where they appear to be rather abundant. MACLEOD (1970) reported 24 nevrorthid specimens to be present in Baltic amber without providing any further detail; it is probable that one of these specimens was figured by PARFIN & GURNEY (1956: pl. 3, fig. 5) as "a sisyrid fossil". The photographs of two other different adult specimens from Baltic amber were provided by WICHARD & WEITSCHAT (1996: pl. 9, bottom figure; 2004: figure on p. 137). Also, WICHARD & WEITSCHAT (1996: pl. 10) and WEITSCHAT & WICHARD (1998: pl. 54, figs d, e) figured a nevrorthid larva very similar to the larva of the extant *Nevrorthus* (see ZWICK 1967). A larva of "apparent Nevrorthidae" affinity was recorded from the Albian Burmese amber (GRIMALDI et al. 2002: fig. 28e; GRIMALDI & ENGEL 2005: 342), but its assignment to this family is not clear judging from the photograph.

Two nevrorthid species of the extinct genus *Rophalis* were described from Baltic amber, as "*Sisyra (Rophalis) relicta*" and "*Sisyra (Rophalis) amissa*" (PICTET-BARABAN & HAGEN 1856). The latter species was described from a single specimen, which is now most likely lost; its assignment to the genus *Rophalis* and even its affinity to the family Nevrorthidae are questionable and it has now been provisionally placed in Sisyridae (ENGEL & GRIMALDI 2007). The type species of the genus, *Rophalis relicta*, may therefore be the only described fossil species in Nevrorthidae. KRÜGER (1923a, b) and NEL & JARZEMBOWSKI (1997) redescribed this species (see below for discussion). In the present paper, we report a female specimen of *Rophalis relicta* from Rovno amber. Prior to this study, nothing was known about the female terminalia of this genus.

Amber from the Rovno Region of Ukraine is currently under intense study (see PERKOVSKY et al. 2007 for review). Up until now, only one species of Neuroptera had been recorded from Rovno amber, *Archico-*

Denisia **26**, zugleich Kataloge der oberösterreichischen Landesmuseen Neue Serie **86** (2009): 137–144

niocompsa prisca ENDERLEIN (Coniopterygidae), a species previously known from Baltic amber (KUPRYJANOWICZ & MAKARKIN 2008).

Material and methods

The material examined comes from the Pugach granite quarry of the Klesov locality, located c. 90 km NNE of Rovno in the Rovno Region, Ukraine. The specimen is embedded in a small translucent piece of amber (c. 5 g) with syninclusions, which include an oribatid and plant stellate hairs. The amber was prepared for this study by A.P. VLASKIN and A.P. RASNITSYN. The photographs were taken by A.P. RASNITSYN, and S.A. SIMUTNIK.

Venational terminology principally follows COMSTOCK (1918) in the interpretation of ARCHIBALD & MAKARKIN (2006). Terminology of wing spaces and designation of crossveins mainly follow OSWALD (1993). Principal crossveins are designated after the longitudinal veins which they connect, and numbered by the gradate series to which they belong in sequence from the wing base, e.g., 2m-cu, crossvein connecting M and Cu in 2nd gradate series, 4im, intramedian crossvein (i.e., between MA and MP) in the 4th gradate series. Abbreviations used in the text and figures are A1, A2, 1st and 2nd anal veins (A); CuA, CuP, anterior and posterior branches of the cubital vein (Cu); MA, MP, anterior and posterior branches of the medial vein (M); R1, anterior branch of the radial vein (R); Rs1, most proximal branches of the radial sector (Rs); Rs2, branch of the radial sector located distal to Rs1; Rs3, branch of the radial sector located distal to Rs2; Sc, the subcostal vein.

Systematic paleontology

Family Nevrorthidae NAKAHARA, 1915

Genus *Rophalis* HAGEN in PICTET-BARABAN & HAGEN 1856

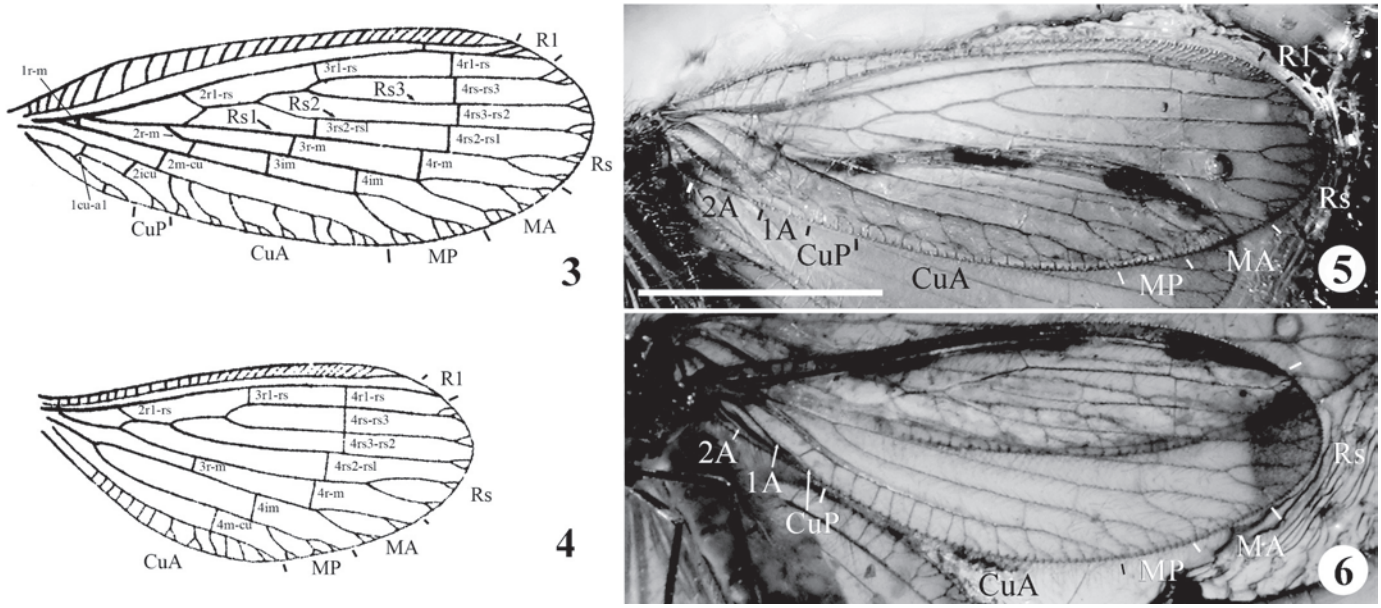
Rophalis relicta (HAGEN in PICTET-BARABAN & HAGEN 1856) Figs 1-8

Description of ♀ (K-4260): Head 0.7 mm wide (dorsal view), brown. Vertex raised, covered with long hairs. Eye diameter 0.3 mm. Palpi dark brown, almost black. Antenna dark brown, ca. 2 mm long, moniliform. Scape 0.1 mm long; pedicel 0.07 mm long, flagellum 25-segmented. Legs dark brown, slender, tibiae of all legs covered with rather long fine hairs and with two short terminal spurs. Pronotum dark brown, almost black, covered with long hairs, with two transverse, deep furrows across entire pronotum. Mesonotum brown, covered with rather sparse fine hairs.

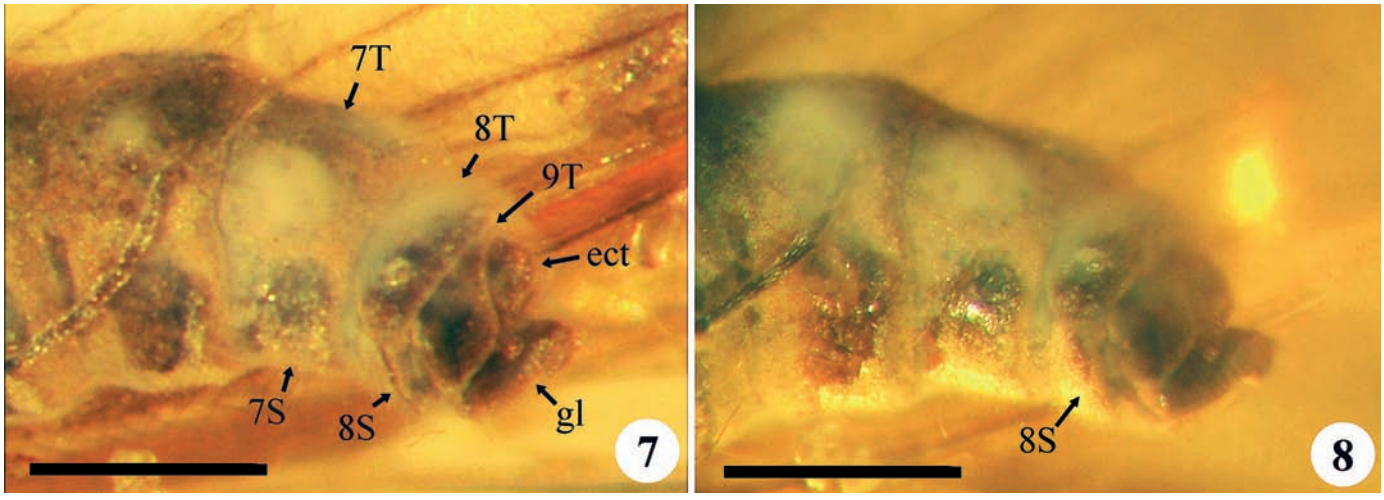
Forewing (Fig. 5) 5.75 mm long, 2.0 mm wide. Membrane unicolorous slightly tinged with brownish. Veins brownish. Distal nygma distinct, located well proximal to 3rs2-rs1. Trichosors distinct along entire wing margin except for costal space basally. Costal space widened most 1.1 mm distad of wing base; 0.3 mm wide at widest point, 0.1 wide at narrowest point. All subcostal veinlets simple, ca. 44 in number. Subcostal space 0.14 mm wide in widest point, 0.07 mm wide in narrowest point, with one proximal crossvein at origin of Rs and two distal crossveins, 0.5 and 0.6 mm basad apex of Sc. R1 distally with four short branches. Rs originated 0.84 mm distad of wing base, with three long branches. Origin of Rs1 0.73 mm distad origin of Rs. Rs1 nearly straight, forked dichotomously distal to outer gradate series. Other two branches of Rs and stem of Rs forked dichotomously near wing margin. Three crossveins between R1 and Rs, basalmost (2r1-rs) longest and oblique. M not fused basally with R, dividing into MA and MP slightly proximal to origin of Rs1. MA forked at outer series of gradate crossveins, both branches with three short terminal branches. MP nearly straight forked distal to outer series of gradate crossveins, both branches with 2-3 short terminal branches. Cu and M strongly approximated at their bases. Cu dividing into CuA and CuP 0.5 mm distad of wing base. CuA long, with marginal fork and seven (left wing) or eight (right wing) pectinate branches, of them five (left wing) or six (right wing) forked once or twice at wing margin and one or two distalmost short, simple. CuP 1.1 mm long, with only marginal fork (right wing) or additionally with one short branch (left wing). 1A long, with two marginal branches; 2A shorter, with one marginal branches. 3A simple. Wing fringe of ca. 0.3 mm long macrotrichia along entire wing margin. Two rows of macrotrichia along all main veins.

Crossveins posterior to R arranged in four gradate series. First (basal) series [="Basal-Reihe" of KRÜGER 1923a] includes five crossveins: 1r-m, located slightly proximad of origin of Rs; 1m-cu, oblique and long; 1cu-a1, rather long and oblique, connected CuA and 1A; long 1a1-a2; short 1a2-a3, located proximad of 1a1-a2. Second series [="Gabelungs-Reihe" of KRÜGER 1923a] consisted of four crossveins: 2r1-rs (oblique), 2r-m (slightly bent, strongly oblique, looking like branch of Rs), 2m-cu (slightly proximal to fork of M), 2icu (proximal to 2m-cu). Third ("inner") series [="Stigma-Reihe" of KRÜGER 1923a] incomplete, includes four crossveins: 3r1-rs, 3rs2-rs1, 3r-m (strongly proximal to 3rs2-rs1; in right wing there is an additional [abnormal] crossvein situated distal to 3r-m, i.e. 3r-m double), 3im (nearly opposite to 3r-m; in right wing 3im abnormally double, i.e. there are two closely spaced crossveins). Forth (outer) series [="Rand-Reihe" of KRÜGER 1923a]

Figs 1, 2: *Rophalis relicta* (Hagen in Pictet-Baraban & Hagen 1856), specimen K-4260. **1**, dorsal view; **2**, ventral view. Scale bar = 2 mm.



Figs 3-6: *Rophalis relicta* (HAGEN in PICTET-BARABAN & HAGEN 1856). **3**, syntype from Baltic amber, forewing; **4**, same, hindwing (both redrawn from PICTET-BARABAN & HAGEN 1856: Pl. 8, Fig. 19; designation of longitudinal veins and crossveins is ours); **5**, Specimen K-4260, forewing; **6**, Specimen K-4260, hindwing. Scale bar = 2 mm (for Figs 5, 6).



Figs 7, 8: *Rophalis relicta* (HAGEN in PICTET-BARABAN & HAGEN 1856). Specimen K-4260. **7**, apex of abdomen, nearly lateral view; **8**, same at different lighting; lateral/ ventral view. Ect, ectoproct; gl, gonapophyses laterales; S7, S8, 7th and 8th sternites; T7, T8, T9, 7th, 8th and 9th tergites. Scale bar = 0.5 mm.

complete, consisting of seven crossveins: 4r1-rs, 4rs-rs3, 4rs3-rs2 (all three crossveins nearly aligned, in left forewing 4r1-rs located clearly proximal to other two), 4rs2-rs1, 4r-m (both located somewhat proximal to previous), 4im (located strongly proximal to 4r-m), 4m-cu (located strongly proximal to 4im).

Hindwing (Fig. 6) 4.8 mm long, 1.8 mm wide. Membrane unicolorous, with slight brownish tinge. Distal nygma distinct, located well proximal to 3rs2-rs1. Trichosors distinct along entire wing margin except basally. Costal space distinctly narrower than that of forewing. Subcostal space also narrower than that of forewing, 0.5 mm wide. Sc not fused with R. R1 space (between R1 and Rs) broad, 0.3 mm maximum wide, with three crossveins; proximal crossvein distinctly oblique. Part of Rs proximal to m-r very short, 0.07 mm long. Portion of Rs between m-r and origin of Rs1 0.8 mm long. Rs with three branches; stem of Rs, Rs3, Rs2 forked very near to wing margin; Rs1 long, straight, forked 0.65 mm proximal to its apex. M forked 1.1 mm distal of wing base. MA forked 0.7 mm proximal to its apex and MP forked 0.8 mm proximal to its apex, all branches of M terminally forked once or twice. Convex longitudinal fold anterior to CuA present, running from 1m-cu to some distance proximal to 2m-cu nearly parallel and close to CuA. CuA long, nearly parallel to posterior wing margin, with 13 short branches, of them

Figs 9: *Rophalis relicta* (HAGEN in PICTET-BARABAN & HAGEN 1856). **9**, specimen GZG 5907 from Baltic amber, Geowissenschaftliches Zentrum der Universität Göttingen, lateral view; **9a**, same, apex of abdomen.

three (left wing) or four (right wing) branches forked. CuP simple, 0.6 mm long. 1A close to CuP, simple, 0.4 mm long. 2A simple.

Crossveins posterior to R arranged in four gradate series. First (basal) series consisting of two crossveins: 1r-m (rather short, nearly right, looking like continuation of Rs) and 1m-cu (somewhat oblique). Second series incomplete, consisting of three crossveins: 2r1-rs (long, oblique); 2icu (long); 2cu-a1 (short). Third ("inner") series incomplete, consisting of three crossveins: 3r1-rs, 3rs2-rs1, 3r-m. Fourth (outer) series complete, consisting of seven crossveins: 4r1-rs, 4rs-rs3, 4rs3-rs2 (all three nearly aligned, but in left wing 4r1-rs located clearly proximal to other two), 4rs2-rs1, 4r-m (both located somewhat proximal to previous), 4im (located strongly proximal to 4r-m), 4m-cu (located strongly proximal to 4im).

Terminal segments of abdomen (Figs 7, 8): 7th tergite and sternite long, unspecialized. 8th tergite band-like in lateral view, ventrally rounded, more than twice as short as 7th tergite. 8th sternite rather long and narrow, pointed apically, subtriangular in lateral view; probably broad, narrowed apically at middle in ventral view. 9th tergite strongly narrowed dorsally (possibly partly hidden under 8th tergite), rhomboid in lateral view, with distinct lateral furrow (= apodeme) directed dorso-ventrally, dorsally bent to anterior. Gonapophyses laterales large, rounded distally. Ectoproct rather small, subtriangular in lateral view.

Material: K-4260, deposited in the Schmalhausen Institute of Zoology (Kiev, Ukraine). A complete female specimen.

Locality and horizon: Ukraine, Rovno (= Rivne) region, Klesov (= Klesiv) locality, Pugach granite quarry, Rovno amber. Late Eocene.

Remarks: The original description of *Rophalis relicta* was based on seven specimens from the amber collection of Westpreussischen Provinzial-Museum (= Museum für Naturkunde und Vorgeschichte, WPM) in Danzig (now Gdańsk, Poland) (PICTET-BARABAN & HAGEN 1856). Up to now, the lectotype or the neotype had not been designated. The description of *Rophalis relicta* written by HAGEN is rather detailed, accompanied by two figures. Together with his drawing of the venation (pl. 8, fig. 19) HAGEN also included the drawing of Wilhelm ERICHSON (pl. 7, fig. 25); see KRÜGER (1923b: 83). The latter drawing is largely incorrect (especially concerning the venation), as HAGEN in PICTET-BARABAN & HAGEN (1856) and KRÜGER (1923a, b) are already mentioned. HAGEN's drawing of the venation (pl. 8, fig. 19) is much more adequate. A single neurorthid specimen from the collection of WPM is now deposited in the Westpreussisches Landesmuseum (Münster-Wolbeck, Germany) (W. WICHARD, pers. comm.); previous-

ly it was housed at the Museum für Naturkunde, Berlin (KEILBACH 1982). The specimen bears a modern label: "Coll. MENGE u. HELM" (written in black ink) and "*Neuroptera Sisyra* (*Rhophalis* [sic]) *relicta*" (written in pencil). The piece of amber with the specimen is very dark red and broken (W. WICHARD, pers. comm.). KEILBACH (1982) thought that this specimen was used for the drawing of W. ERICHSON: "Fragmente des Originals von HAGEN in BERENDT 1856, 87, Taf. VII, Fig. 25" (p. 284). Unfortunately, we were not able to examine this specimen and confirm its assignment to *Rophalis relicta*. It is unknown, therefore, if it is from the type series or not. It is probable, however, that the seven syntypes used by HAGEN for the description of *Rophalis relicta* may not belong to one species. Therefore, if this preserved specimen has features different from those figured in HAGEN's fig. 19, it should not be designated as a lectotype or neotype.

KRÜGER (1923b) revised the Neuroptera from the Baltic amber collection in WPM. He found that only three specimens may be assigned to *Rophalis relicta*, of them two are from the MENGE collection and one is from the HELM collection. HELM's amber collection was not examined by HAGEN (KRÜGER 1923b). Those two specimens from the MENGE collection, which HAGEN might have theoretically examined, were labelled "*Sisyra relicta*" and "*Hemerobius*". KRÜGER (1923a) provided a detailed description of the venation based probably on the former specimen. The two other specimens were not used by KRÜGER (1923a) for the re-description, probably because of the poor state of preservation. Analysis of KRÜGER's re-description shows that the specimen used by him for the re-description is not the one used for HAGEN's fig. 19. The main differences between these two specimens are: in the forewings: 4rs-rs3 is absent in KRÜGER's (1923a) specimen (present in HAGEN's fig. 19), the number of crossveins in the third series is six in KRÜGER's (1923a) specimen (four in HAGEN's fig. 19); in the hindwings: the number of crossveins between Rs and R1 is four in KRÜGER's (1923a) specimen (three in HAGEN's fig. 19); CuP has six branches forked (two in HAGEN's fig. 19). The study of undescribed Baltic amber nevrorthids indicates that this specimen may not even be conspecific with that used by HAGEN for fig. 19 (i.e. not *Rophalis relicta* as interpreted here).

Another specimen from the Paläontologisches Museum in München was determined as belonging to *Rophalis relicta* by NEL & JARZEMBOWSKI (1997). This male specimen has a small clasper, whereas this structure seems to be strongly developed in a male syntype: "Ein Stück (coll. BER.), bei welchem zwei stark gebogene Haken ausgeklappt sind, ist offenbar ein Männchen…" (PICTET-BARABAN & HAGEN 1856, p. 87). As we mentioned above, however, this male syntype may belong (theoretically) to another species. In any case, the assignment of this specimen to *Rophalis relicta* needs to be confirmed.

Three descriptions of *Rophalis relicta*, i.e. those of HAGEN in PICTET-BARABAN & HAGEN (1856), KRÜGER (1923a) and NEL & JARZEMBOWSKI (1997), are based on different specimens, and only the description of HAGEN is founded on the examination of type material with certainty. Therefore, we compared features of the Rovno specimen with those described and figured in fig. 19 by HAGEN in PICTET-BARABAN & HAGEN (1856). The latter are extraordinarily concordant with our specimen. The wing venation is almost identical (of course, taking into account minor errors and the loss of some basal crossveins in HAGEN's drawing). Specimens with such venation occur rather rarely in Baltic amber. Besides these two specimens (the second is the Rovno specimen), we know of about three other specimens (including one figured in this paper, fig. 9). They are characterized in particular by the absence of the crossveins 3rs-rs3, 3rs3-rs2 in the forewing, and the branches of CuA being mainly simple, without a marginal fork in the hindwing. HAGEN wrote that the antennae of *Rophalis relicta* are constantly 25-segmented; the Rovno specimen has 27-segmented antennae (i.e. flagellum is 25-segmented). In other (undescribed) specimens from Baltic amber the antennae are 33–39-segmented (specimens with completely preserved antennae in Geowissenschaftliches Zentrum der Universität Göttingen). Unfortunately, KRÜGER (1923a, b) and NEL & JARZEMBOWSKI (1997) did not indicate the number of antennal segments in the specimens they examined. So, the identity of the Rovno specimen with a syntype of *Rophalis relicta* figured in HAGEN's fig. 19 is unquestioned.

Is the genus *Nevrorthus* a synonym of *Rophalis*?

Based on the similarity of the venation of *Rophalis* and *Nevrorthus* PARFIN & GURNEY (1956) asked: "the question is raised as to whether the living genus *Nevrorthus* is a synonym of the fossil genus *Rophalis*" (p. 522). Indeed, the venational similarity of *Rophalis* and *Nevrorthus* seems obvious. However, the wing venations of these genera have some clear differences, e.g. in the forewing, CuA has seven branches in *Rophalis*, and a maximum of five in *Nevrorthus*; in the hindwing, CuA has a maximum of three to four forked branches (of 11-13 branches) in *Rophalis*, and all branches are forked in all species of *Nevrorthus*. So, the wing venation of *Rophalis* and *Nevrorthus* is similar but different. The ve-

nation of the other two extant genera is still more different from *Rophalis* than that of *Nevrorthus* in various characters.

The female terminalia of *Rophalis relicta* from Rovno amber is very similarly constructed to those of the species of the extant genus *Nevrorthus* (particularly, in the structure of the 8th and 9th tergites, ectoprocts, and gonapophyses laterals). But the structure of the 8th sternite is different. The 8th sternite of three *Nevrorthus* species have been described by H. ASPÖCK et al. (1980) and U. ASPÖCK & H. ASPÖCK (1983). Unfortunately, the abdominal apex in the Rovno specimen cannot be examined from below, and the shape of the 8th sternite in the ventral view is only suggestive in this specimen. But one of female specimens from Baltic amber deposited in Geowissenschaftliches Zentrum der Universität Göttingen has similar terminalia. We determine that this specimen belongs to *Rophalis relicta* (based on the hindwing venation), although apices of both antennae are missing (Fig. 9). The terminalia can be seen in strong lateral view (Fig. 9a). The visible shape of the 8th sternite in *Rophalis relicta* is different from that of any *Nevrorthus* species. However, it should be noted that the terminalia in extant species are studied in specimens macerated in KOH, and sclerotized and unsclerotized parts may be easily distinguished. These parts in amber specimens are often hard to distinguish. The shape of the whole 8th sternite (i.e. sclerotized and unsclerotized parts together) in *Nevrorthus hannibal* U. ASPÖCK & H. ASPÖCK from North Africa is similar to the visible shape of the 8th sternite of *Rophalis relicta*. However, the shape of the 8th sternite in *Nevrorthus fallax* RAMBUR and *N. apatelios* H. ASPÖCK et al. is very much different from that of *Rophalis relicta* (see H. ASPÖCK et al. 1980: figs. 352, 353; U. ASPÖCK & H. ASPÖCK 1983: figs. 6, 7). Unfortunately, the female terminalia of the type species of the genus (*Nevrorthus iridipennis* COSTA) is very poorly known. The figure of NAVÁS (1935: fig. 8) is too schematic and does not show the 8th sternite at all. So, although the structure of female terminalia of *Rophalis* and *Nevrorthus* is rather similar, it is not identical.

The female terminalia of the two other genera (*Nipponeurorthus* and *Austroneurorthus*) have marked differences from those of both *Rophalis* and *Nevrorthus*: e.g. apodeme of the 9th tergite is absent in *Nipponeurorthus* and restricted to only ventral part in *Austroneurorthus* (NAKAHARA 1958: fig. 1E; U. ASPÖCK 2004: fig. 8).

In summary, the genus *Rophalis* is undoubtedly most closely related to *Nevrorthus*. However, the differences in wing venation and the structure of the female terminalia do not allow the two genera to be synonymized.

Zusammenfassung

Der Netzflügler *Rophalis relicta* HAGEN (Neuroptera, Nevrorthidae), der bislang nur aus dem späteozänen Baltischen Bernstein bekannt war, wird hier aus dem nahezu zeitgleich entstandenen Rovno Bernstein aus der Ukraine beschrieben. Die Art ist hauptsächlich durch den Verlust der Queradern 3rs-rs3, 3rs3-rs2 im Vorderflügel und den meist einfach verzweigten CuA im Hinterflügel. Rophalis ist sehr nah verwandt mit der rezenten Gattung Nevrorthus. Die Unterschiede beschränken sich lediglich auf die Flügeladerung und die Struktur der weiblichen Terminalia, welche eine Synonymisierung der beiden Gattungen jedoch nicht erlauben.

Acknowledgements

We thank Wilfried WICHARD (Institut für Biologie, Universität zu Köln, Germany) for information on the specimens from Westpreussisches Landesmuseum; Mike REICH (Geowissenschaftliches Zentrum der Universität Göttingen, Germany) for providing us with the photographs of Baltic amber Nevrorthidae; Alexandr RASNITSYN (Paleontological Institute of the Russian Academy of Sciences, Moscow, Russia) and Sergey SIMUTNIK (Schmalhausen Institute of Zoology, Kiev, Ukraine) for help with photography; John OSWALD (Texas A&M University, USA) for help with literature; and James JEPSON (Palaeontology Research Group, University of Manchester, United Kingdom) for help with the English.

References

ARCHIBALD S.B. & V.N. MAKARKIN (2006): Tertiary giant lacewings (Neuroptera: Polystoechotidae): revision and description of new taxa from western North America and Denmark. — J. Syst. Palaeontol. **4**: 119-155. [Errata: **4**: 307].

ASPÖCK H., U. ASPÖCK & H. HÖLZEL (1977): *Neurorthus apatelios* n.sp. – eine verkannte europäische Neurorthiden-Species (Neuroptera: Planipennia). — Entomol. Z. **87**: 53-57.

ASPÖCK H., U. ASPÖCK & H. HÖLZEL (1980): Die Neuropteren Europas. 2 Vols. — Goecke and Evers, Krefeld.

ASPÖCK U. (2004): *Austroneurorthus horstaspoecki* nov.spec. – eine neue Art der Familie Nevrorthidae aus Australien (Neuropterida: Neuroptera). — Denisia **13**: 177-182.

ASPÖCK U. & H. ASPÖCK (1983): Über das Vorkommen von *Neurorthus* Costa in Nordafrika (Neuropteroidea: Planipennia: Neurorthidae). — Nachrichtenbl. Bayerischen Entomol. **32**: 48-51.

ASPÖCK U. & H. ASPÖCK (2007): Verbliebene Vielfalt vergangener Blüte. Zur Evolution, Phylogenie und Biodiversität der Neuropterida (Insecta: Endopterygota). — Denisia **20**: 451-514.

COMSTOCK J.H. (1918): Wings of Insects. — Comstock Publishing Company, Ithaca, NY.

COSTA A. (1863): Nuovi studii sulla entomologia della Calabria ulteriore. — Atti Accad. Sci. Fis. Matem., Napoli (ser. 1) **1** (2): 1-80.

ENGEL M.S. & D.A. GRIMALDI (2007): The neuropterid fauna of Dominican and Mexican amber. — American Mus. Nov. **3587**: 1-58.

GRIMALDI D.A., M.S. ENGEL & P.C. NASCIMBENE (2002): Fossiliferous Cretaceous amber from Myanmar (Burma): its rediscovery, biotic diversity, and paleontological significance. — American Mus. Nov. **3361**: 1-72.

GRIMALDI D.A. & M.S. ENGEL (2005): Evolution of the Insects. — Cambridge University Press, Cambridge, UK.

KEILBACH R. (1982): Bibliographie und Liste der Arten tierischer Einschlüsse in fossilen Harzen sowie ihrer Aufbewahrungsorte. Teil 1. — Deutsche Entomol. Z. (N.F.) **29**: 129-286.

KRÜGER L. (1923a): Sisyridae. Beiträge zu einer Monographie der Neuropteren-Familie der Sisyriden. — Stettiner Entomol. Z **84**: 25-66.

KRÜGER L. (1923b): Neuroptera succinica baltica. Die im baltischen Bernstein eingeschlossenen Neuroptera des Westpreussischen Provinzial-Museums (heute Museum für Naturkunde und Vorgeschichte) in Danzig. — Stettiner Entomol. Z. **84**: 68-92.

KUPRYJANOWICZ J. & V.N. MAKARKIN (2008): *Archiconiocompsa prisca* ENDERLEIN (Neuroptera: Coniopterygidae): The first neuropteran fossil in Rovno amber (Ukraine). — Entomol. Fennica **28**: 25-31.

MACLEOD E.G. (1970 [1971]): The Neuroptera of the Baltic Amber. I. Ascalaphidae, Nymphidae, and Psychopsidae. — Psyche **77**: 147-180.

MONSERRAT V.J. (1977): A systematic and alphabetic list of Neurorthidae and Sisyridae (Neuroptera). — Nouv. Rev. Entomol. **7**: 91-96.

NAKAHARA W. (1915): On the Hemerobiinae of Japan. — Annot. Zool. Japonenses **9**: 11-48.

NAKAHARA W. (1958): The Neurorthinae, a new subfamily of the Sisyridae (Neuroptera). — Mushi **32**: 19-32.

NAVÁS L. (1935): Monografía de la familia de los Sisíridos (Insectos Neurópteros). — Mem. R. Acad. Cien. Exact., Fis.-Quim. Nat. Zaragoza **4**: 1-87.

NEL A. & E. JARZEMBOWSKI (1997): New fossil Sisyridae and Nevrorthidae (Insecta: Neuroptera) from Eocene Baltic amber and Upper Miocene of France. — European J. Entomol. **94**: 287-294.

OSWALD J.D. (1993): Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). — J. New York Entomol. Soc. **101**: 143-299.

PARFIN S.I. & A.B. GURNEY (1956): The spongilla-flies, with special reference to those of the western hemisphere (Sisyridae, Neuroptera). — Proc. US Nat. Mus. **105**: 421-529.

PERKOVSKY E.E., A.P. RASNITSYN, A.P. VLASKIN & M.V. TARASCHUK (2007): A comparative analysis of the Baltic and Rovno amber arthropod faunas: representative samples. — African Invertebr. **48**: 229-245.

PICTET-BARABAN F.J. & H.A. HAGEN (1856): Die im Bernstein befindlichen Neuropteren der Vorwelt. — In: BERENDT G.C. (Ed.), Die im Bernstein befindlichen organischen Reste der Vorwelt, Band 2, Abteilung 2. Nicholaischen Buchhandlung, Berlin: 41-125.

WEITSCHAT W. & W. WICHARD (1998): Atlas der Pflanzen und Tiere im Baltischen Bernstein. — Dr. Friedrich Pfeil Verlag, München.

WICHARD W. & W. WEITSCHAT (1996): Wasserinsekten im Bernstein. Eine paläobiologische Studie. — Entomol. Mitt. Löbbecke-Mus. + Aquazoo **4**: 1-122.

WICHARD W. & W. WEITSCHAT (2004): Im Bernsteinwald. — Gerstenberg Verlag, Hildesheim.

ZWICK P. (1967): Beschreibung der aquatischen Larve von *Neurorthus fallax* (RAMBUR) und Errichtung der neuen Planipennierfamilie Neurorthidae fam. nov. — Gew. u. Abwässer **44/45**: 65-86.

Address of authors:

Vladimir N. MAKARKIN
Institute of Biology and Soil Sciences
Far East Branch of the Russian Academy of Sciences
Vladivostok, 960022, Russia
E-Mail: vnmakarkin@mail.ru

Eugeny E. PERKOVSKY
Schmalhausen Institute of Zoology
National Academy of Sciences Ukraine
15 Bogdan Khmelnitsky Str.
Kiev, 01601, Ukraine
E-Mail: perkovsky@fromru.com
perkovsk@gmail.com