



<https://doi.org/10.11646/palaeoentomology.6.6.5>

<http://zoobank.org/urn:lsid:zoobank.org:pub:AFE82F69-9602-4D95-ACDD-B74D40F2D4AA>

A new fossil species of *Nausibius* (Coleoptera: Silvanidae) in Rovno amber: a beetle from Eocene forests with congeners thriving in warehouses today

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Abstract

A new species of silvanid flat bark beetle, *Nausibius radchenkoi* sp. nov., is described and illustrated based on a well-preserved inclusion in Eocene Rovno amber. It is the first fossil species of *Nausibius*, a cosmopolitan genus with representatives living worldwide today. The current finding confirms both the Eocene age of the genus and the presence of representatives of the genus in forest palaeoecosystems of Europe in that time. In addition, *Austronausibius aenigmatista* Alekseev & Bukejs, 2022, previously described from Rovno amber, is documented in Baltic amber for the first time. Thirteen common species of Coleoptera (including one newly recorded here) known from these two East European ambers are listed. The newly described species, as well as some other beetle taxa in Eocene European habitats (where Rovno and Baltic ambers were produced), have several congeners that live today in artificial synanthropic habitats, namely warehouses storing various food products.

Keywords: Cucujoidea, silvanid flat bark beetle, Cenozoic, fossil resin, palaeobiodiversity

Introduction

The extant genus *Nausibius* Lentz, 1857 belongs to the family Silvanidae (silvanid flat bark beetles) and is now found across the globe. The genus was native and primarily distributed in the New World until the introduction of *Nausibius clavicornis* (Kugelann, 1794) to all continents through human commerce transport (Halstead, 1980). The Recent European fauna of this genus consists of only two introduced species, *N. clavicornis* and *N. salutaris* (Parsons, 1974) (Halstead, 1993; Baena *et al.*, 2021), whereas the world fauna includes 13 valid extant species (Halstead, 1980, 2020): *N. clavicornis*; *N. brevicornis* Sharp, 1899;

N. gigas Grouvelle, 1896; *N. grouvellei* Sharp, 1899; *N. inermis* Grouvelle, 1896; *N. ingens* Grouvelle, 1896; *N. lophius* (Parsons, 1974); *N. major* Zimmermann, 1869; *N. repandus* LeConte, 1866; *N. sahlbergi* Grouvelle, 1896; *N. salutaris*; *N. silvanoides* Sharp, 1899; and *N. sinuatus* Grouvelle, 1896. The taxonomy and systematics of this group are not completely understood. The genus, as presently comprised, is probably polyphyletic (Halstead, 1980; Thomas, 1993), and several undescribed extant members of the group are known (Halstead, 1980). The extant representatives of *Nausibius* are found in subcortical habitats and old bees' nests; the cosmopolitan *N. clavicornis*, with the best studied biology (Breese & Wise, 1959), often lives among stored food products such as raw yellow-crystal sugar, rice, dried apples, ginger, cassia, nuts, dried meat, and seeds, as well as tobacco and other plant products (Thomas, 1993; Thomas & Ghahari, 2016).

The extant genus *Nausibius* was first reported from Baltic amber by Klebs (1910). Since then, no descriptions, illustrated reports, or any additionally detailed data have been published on the taxon in Eocene amber inclusions; however, the genus has been cited by Bachofen-Echt (1949), Larsson (1978), and Spahr (1981) after that. More recently, new genera have been distinguished (Halstead, 1980) and a number of extinct species from Eocene ambers have been described (see key in Alekseev & Bukejs, 2022) among beetles morphologically close to *Nausibius*. In this regard, the generic record of *Nausibius* from Baltic amber made by Richard Klebs in the early 20th century may correspond to a whole group of different genera in the modern sense and cannot be verified.

In the current paper, the third known silvanid flat bark beetle from Rovno amber and the first extinct species attributed to the genus *Nausibius* is described and figured

from Rovno amber. This report confirms both the Eocene age of the genus and the presence of representatives of the genus in forest palaeoecosystems of Europe in that time.

Material and methods

The material examined is deposited in the collection of the Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine (Kyiv, Ukraine) [SIZK] and in the private collection of Jonas Damzen (Vilnius, Lithuania) [JDC]. The amber pieces were polished manually with emery papers of different grit sizes, allowing improved views of the included specimens. The amber pieces were not subjected to any supplementary fixation.

The photographs of the specimens were taken using a Canon 90D camera with a macro lens (Canon MPE-65 mm). Extended depth of field at high magnifications was achieved by combining multiple images from a range of focal planes using Helicon Focus v.6.0.18 software, and the resulting images were edited to create figures using Adobe Photoshop CS5.

Specimens observations were made using a Nikon SMZ745T stereomicroscope. Measurements of the holotype were made using an ocular micrometer in a stereoscopic microscope.

The following references were used for the taxonomic placement and comparison with related extant and extinct taxa: Parsons (1974), Halstead (1980, 1993, 2020), Thomas (1993), McElrath *et al.* (2015), Baena *et al.* (2021), and Alekseev & Bukejs (2016, 2021a, 2022).

Systematic palaeontology

Superfamily Cucujoidea Latreille, 1802

Family Silvanidae Kirby, 1837

Subfamily Silvaninae Kirby, 1837

Genus *Nausibius* Lentz, 1857

Type species. *Cucujus clavicornis* Kugelann, 1794 [by synonymy of *Corticaria dentata* Marsham, 1802, type by monotypy].

Remarks. Morphological characters of the inclusion under study convincingly place it among Silvanidae within Cucujoidea (not moniliform 11-segmented antennae, closed procoxal cavities and open mesocoxal cavities, subparallel body form, pentamerous tarsi, head and pronotum without sublateral carinae or grooves) and namely within the subfamily Silvaninae (antennae gradually thickening toward apex, with loose club; antennal

scape comparatively short, about as long as wide; frons laterally without longitudinal sulcus; frontoclypeal suture absent; scutellary striole absent; tarsomere 4 smallest).

The specimen is assigned to the genus *Nausibius* based on the combination of the following characters, which distinguishes the specimen from other similar silvanine genera having six teeth or undulations on the lateral pronotal sides: (1) antenna 11 segmented (9-segmented in *Corimus* Halstead, 1980); (2) tarsomere 3 not incrassate (broadly incrassate in *Corimus*, incrassate in *Silvanopsis* Grouvelle, 1892 and *Oryzaepphilus* Ganglbauer, 1899); (3) dorsal pubescence weakly curved, pronotal and elytral margins not widely explanate (in contrast to dorsal pubescence composed of strongly curved setae and pronotal and elytral margins explanate in *Acorimus* Halstead, 1980 and *Afrocorimus* Halstead, 1980); (4) head without antennal grooves and antennal club not 2-segmented (head with antennal grooves ventrally and antennal club 2-segmented in *Afronausibius* Halstead, 1980); (5) femoral lines strongly produced posteriorly (not produced in *Oryzaepphilus*); and (6) pronotum with crescentic basal depression (pronotal depression crescentic or absent in different representatives of *Nausibius*; basal pronotal depression not crescentic if present in *Pseudonausibius* Halstead, 1980 and *Austronausibius* Halstead, 1980).

Nausibius radchenkoi sp. nov.

(Figs 1, 2)

Type material. Holotype deposited in the Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine (Kyiv, Ukraine), under catalog no. UA-3701 [SIZK] (ex coll. Jonas Damzen no. JDC-11999R); “Holotype / *Nausibius radchenkoi* sp. nov. / Alekseev, Pankowski et Bukejs des. 2023” [red printed label]. Adult, possibly female (genae not produced; metafemora and all tibiae simple, without secondary sexual characters, *i.e.* not curved and without tooth). The complete, well-preserved beetle is included in a transparent, yellow amber piece with approximate dimensions of 46×29 mm and a maximum thickness of 12 mm; preserved without any supplementary fixation. Syninclusions: a few stellate Fagaceae trichomes.

Etymology. The new species is named in honour of Dr. Alexander G. Radchenko (Kyiv, Ukraine), a highly esteemed specialist in the study of Recent and fossil ants.

Diagnosis. *Nausibius radchenkoi* sp. nov. differs from extant congeners by a combination of the following characters: (1) presence of basal crescentic depression on pronotum (absent, *e.g.*, in *N. repandus* and *N. sahlbergi*); (2) pronotal punctation not reticulate at sides; (3) striae and interstriae pubescence not forming “herringbone pattern” and directed apicad (in contrast, *e.g.*, to *N. clavicornis* or *N. salutaris*); (4) all interstriae not raised (in contrast to the



FIGURE 1. *Nausibius radchenkoi* **sp. nov.**, holotype, No UA-3701 [SIZK]. **A**, Habitus, dorsal view. **B**, Habitus, ventral view with inserted schematic drawing of pronotal process (yellow) and procoxae (blue). Scale bars = 0.5 mm.

elevated in varying degrees of some interstriae of elytra in most species of the genus); (5) femoral lines extending to suture between abdominal ventrites 1 and 2 (in contrast to femoral lines shorter, e.g., extending about to the middle of ventrite 1 in *N. clavicornis*); and (6) base of elytra not raised at either side of scutellum to form a ridge (in contrast to such ridge extending to bases of interstriae 5 in *N. clavicornis*).

The newly described extinct species resembles two fossil silvanine from Eocene East European amber, namely *Mistran ot* Alekseev & Bukejs, 2016 and *Austronausibius aenigmatista* Alekseev & Bukejs, 2022, both also

possessing six teeth on each lateral side of the pronotum. *Nausibius radchenkoi* **sp. nov.** can be distinguished from these taxa in the pronotum with crescentic basal depression (pronotum with three dorsal longitudinal ridges in *Mistran ot* and pronotum without any ridges or impressions in *Austronausibius aenigmatista*), and in all interstriae uniform and not raised (elytron with four entire carinae formed by raised interstriae 3, 5, 7, and 9 in *Mistran ot* and elytron with two lateral carinae formed by raised interstriae 7 and 9 in *Austronausibius aenigmatista*). Additionally, *Nausibius radchenkoi* **sp. nov.** differs from the Rovno amber *A. aenigmatista* in: (1)

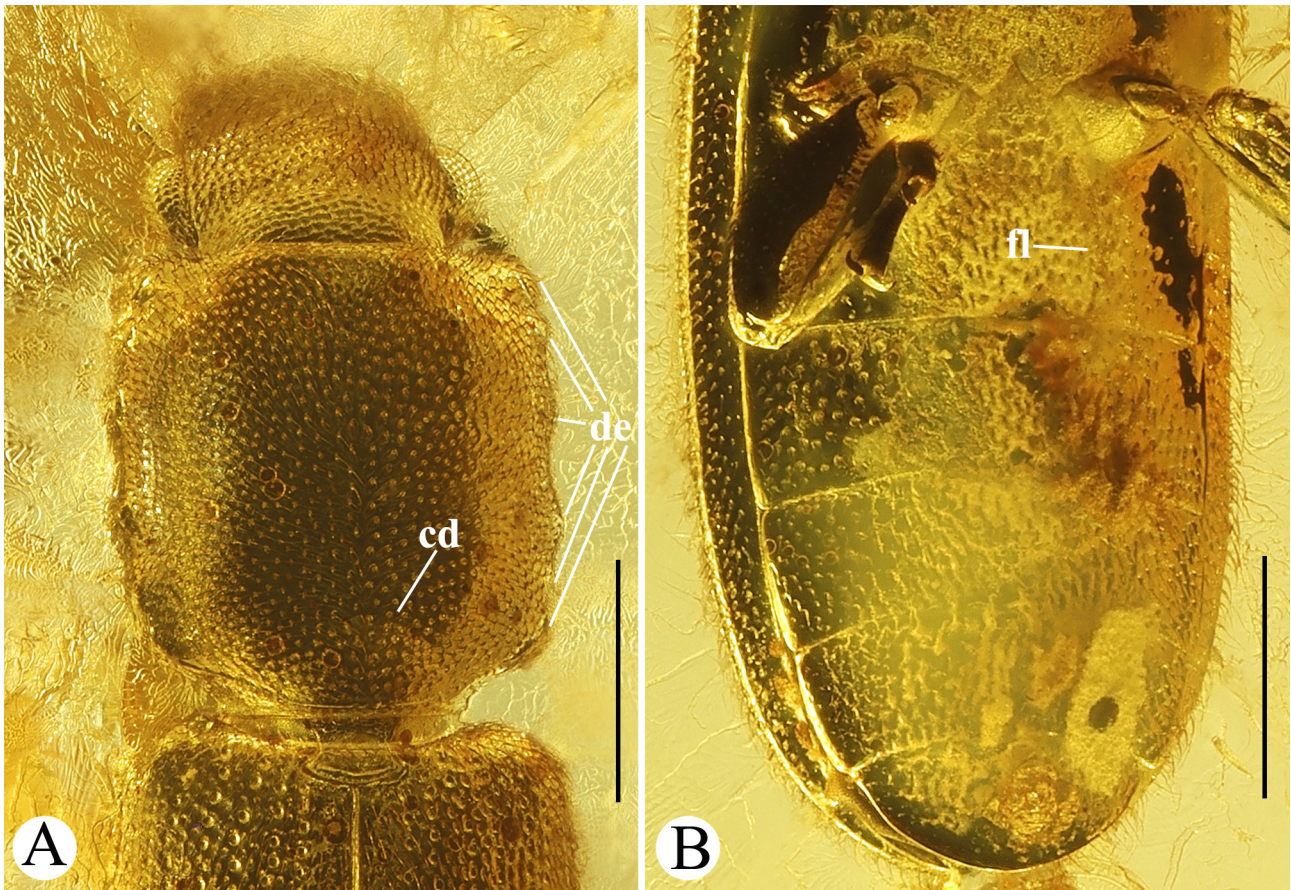


FIGURE 2. *Nausibius radchenkoi* sp. nov., holotype, No UA-3701 [SIZK]. **A**, Details of forebody, dorsal view. **B**, Abdomen, ventral view. Abbreviations: cd—crescentic depression; de—denticles; fl—femoral line (left femoral line is not visible because leg position). Scale bars = 0.5 mm.

humeral angles without distinct denticle; (2) femoral line strongly produced posteriorly in the form of an almost right triangle and posteriorly extending to the suture between abdominal ventrites 1 and 2 (compare Fig. 2B and Fig. 3B); (3) eyes with distinct interfacetal setation; and (4) not uniform pronotal lateral denticles.

Cathartosilvanus perkovskyi Alekseev & Bukejs, 2021, another silvanid flat bark beetle from Rovno amber, can be easily distinguished from the newly described species in the pronotal lateral sides finely crenulate and lesser body length (2.2 mm).

Type locality and horizon. Rivne Oblast (region), Ukraine. Rovno amber, late Eocene (Perkovsky *et al.*, 2007).

Description. Measurements: body length (from apex of labrum to apex of elytra in preserved position) about 3.4 mm; head length (from apex of labrum to neck) about 0.4 mm, head maximum width (across eyes) 0.6 mm; pronotum length (along median line) 1.0 mm, pronotum maximum width (including denticles) 0.9 mm; elytra length 2.1 mm, elytra maximum width 1.0 mm. Body elongate, nearly parallel-sided, weakly convex dorsally

and ventrally (Fig. 1A); integument unicolourous, dark brown (as preserved). Pubescence: head, pronotum and elytra with short, weakly curved, semi-erect setae; ventral side of specimen with fine, inconspicuous, recumbent setae.

Head (Fig. 2A) prognathous, transverse, about 1.5× wider than long, slightly convex; coarsely and densely punctate, punctures rounded and about as large as eye facet, distance between punctures 0.3–0.1× diameter of one puncture. Temple short, about 0.25× as long as eye length. Vertex and frons moderately convex. Frontoclypeal suture absent. Compound eyes hemispherical, rather small, prominent, with coarse facets; with distinct interfacetal setation; widely separated, distance between eyes about 5.5× transverse diameter of one eye. Antennal grooves beneath head absent.

Antenna rather robust, short, reaching slightly beyond middle of pronotum, gradually thickening toward apex, sparsely covered with fine semi-erect setae; with 11 antennomeres; with weakly delimited loose club composed of three weakly flattened antennomeres (Fig. 1B). Antennomere 1 subcylindrical, slightly elongate,

1.2× longer than wide; antennomeres 2–3 subequal in size, subconical, slightly dilated apically, elongate, about 1.4× longer than wide; antennomere 4 as long as wide, distinctly shorter than antennomere 3; antennomeres 5–7 trapezoidal, slightly transverse, 1.2–1.3× wider than long; antennomere 8 trapezoidal, dilated apically, transverse, 1.3× wider than long, slightly longer and wider than antennomere 7, slightly shorter and narrower than antennomere 9; antennomeres 9–10 trapezoidal, strongly dilated apically, transverse, about 1.4–1.5× wider than long; antennomere 11 ovoid, nearly as long as wide; relative length ratios of antennomeres 1–11 equal to 15-15-14-10-9-9-9-11-12-13-13.

Pronotum slightly elongate, 1.1× longer than wide, subparallel-sided; pronotal punctation rounded, small (each puncture smaller than eye facet) and dense (distance between punctures about 1.0–2.0× diameter of one puncture), punctures distinctly finer and sparser on disc. Pronotal disc evenly convex, with shallow crescentic depression basally (Fig. 2A). Anterior and posterior pronotal edges arcuate, almost straight medially. Each pronotal side with six rounded projections: first denticle (anterolateral) most prominent; second denticle and denticle at posterior angle (sixth) triangular, median lateral denticles (3–5) subequal in shape, widely rounded, sinuous (Fig. 2A). Prohypomera slightly convex; densely covered with small punctation. Prosternum with disc convex; with small, sparse punctation. Prosternal process elongate, weakly convex, dilated apically (Fig. 1B). Procoxal cavities closed externally and internally (Fig. 1B).

Scutellar shield distinct, pentagonal with widely rounded apex, strongly transverse, 2.3× wider than long (Fig. 2A). Elytra elongate, 2.1× longer than wide combined, subparallel-sided and gradually tapered in posterior one-fourth, slightly wider than pronotum, punctate-striate, with narrowly explanate lateral margins. Elytral punctation arranged in nine striae rows of rather larger, round, setiferous punctures; rows slightly confused in posterior one-third of elytral length; shortened scutellar row absent; interstriae flat, covered with micropunctation, all interstriae equal in shape. Elytral setation fine, short, weakly curved, not arranged in herringbone pattern. Humeral angles simple, without denticle. Epipleura well-developed, reaching elytral apex, widest at humeri and gradually narrowed posteriad, densely covered with fine punctation. Relative length ratios of prothorax to mesoventrite to metaventrite to abdomen equal to 13:6:10:25. Mesoventrite convex, with small and dense punctation. Mesocoxal cavities open. Metanepisternum narrow, long, about 0.65× as wide as epipleuron maximum width; with dense and small punctures. Metaventrite with disc convex; moderately densely covered with small punctation, punctures distinctly sparser laterally; with

discrimen developed in posterior half of metaventrite length.

Legs short and robust. Procoxa nearly hemispherical; mesocoxa widely oval; metacoxa oval, transverse, not extending laterally to meet elytron. Trochanters apparently without spines. Femora widened medially, slightly swollen, simple (without denticles or teeth), with deep, longitudinal groove ventrally (for reception of tibia). Tibiae slightly curved, dilated apically. Tarsomeres simple (not incrassate or lobed); tarsomere 4 smallest; tarsomere 5 longest, about as long as all previous tarsomeres combined. Pretarsal claws simple, equal in size, long.

Abdomen (Fig. 2B) with five visible and similarly articulated ventrites; densely covered with small punctation. Ventrite 1 with femoral line closed, strongly produced posteriorly in form of almost right triangle and posteriorly extending to suture between ventrites 1 and 2 (Fig. 2B); intercoxal process of abdominal ventrite 1 small, triangular with acute apex. Ventrite 5 rounded widely apically. Relative length ratios of ventrites 1–5 equal to 19:11:10:10:10 (measured medially).

Remarks. The composition of antennal club (3 or 4 proximal antennomeres) is poorly identifiable on the inclusion. The antennal segments gradually increase toward the apex and are more or less uniformly setose. The character mentioned in description and diagnosis (3-segmented club) is determined on the basis of observation that antennomeres 9–11 are more flattened and fit more tightly to each other. Likely, the character state for the antennal club of the species should be diagnosed as “antennal club less obviously 4-segmented”.

Additional fossil records of *Silvanidae*

Austronauisibius aenigmatista Alekseev & Bukejs, 2022

(Fig. 3)

Material. One specimen, no. JDC-11140 [JDC], Baltic amber; adult, sex unknown. A complete beetle with partially exposed metathoracic wings is included in a transparent, yellow amber piece with dimensions of 42×7 mm and a maximum thickness of 7 mm. Syninclusions: some stellate Fagaceae trichomes.

Body length of the specimen is 3.7 mm, *i.e.*, lesser than in the holotype, which is about 4.1 mm (Alekseev & Bukejs, 2022).

Remarks. The amber inclusion reported and illustrated here represents the second known specimen of *A. aenigmatista*. It is worth noting that the holotype of the species is represented by an inclusion in Rovno amber, while the second specimen (JDC-11140) was found in Baltic amber. Thus, the species is now known from these two Eocene ambers.



FIGURE 3. Specimen of *Austronausibius aenigmatista* Alekseev & Bukejs from Baltic amber, No JDC-11140 [JDC]. **A**, Habitus, dorsal view. **B**, Habitus, ventral view. **C**, Habitus, lateral view. Abbreviations: fl—femoral line. Scale bar = 0.5 mm.

Discussion

The species *Austronausibius aenigmatista* is the 13th common beetle representative documented in Baltic and Rovno ambers. The list of such common coleopteran species includes representatives of 11 families at present: Cantharidae (*Mimoplatycis notha* Kazantsev, 2013) (Kazantsev, 2013; Kazantsev & Perkovsky, 2014), Cryptophagidae (*Micrambe sarnensis* Lyubarsky & Perkovsky, 2010) (Lyubarsky & Perkovsky, 2010, 2021), Cupedidae (*Cupes groehni* Kirejtshuk, 2005) (Kirejtshuk, 2005; Bukejs *et al.*, 2021), Cyclaxyridae (*Neolitochropus bedovoyi* (Lyubarsky & Perkovsky, 2011)) (Lyubarsky & Perkovsky, 2011; Gimmel *et al.*, 2019; Gimmel & Szawaryn, 2020), Dermestidae (*Ranolus gedanicissimus* (Bukejs, Háva & Alekseev, 2020)) (Bukejs *et al.*, 2020; Háva, 2023), Latridiidae (*Latridius alexeevi* Bukejs, Kirejtshuk & Rücker, 2011) (Bukejs *et*

al., 2011; Sergi & Perkovsky, 2014; Reike *et al.*, 2017), Melandryidae (*Orchesia rasnitsyni* Nikitsky, 2011 and *Serropalpus ryzhkovianus* Alekseev, 2014) (Nikitsky, 2011; Alekseev, 2014, 2022; Alekseev & Bukejs, 2015, 2021b), Ptilodactylidae (*Ptilodactyla eocenica* Kundrata, Bukejs & Blank, 2021) (Kundrata *et al.*, 2021; Telnov *et al.*, 2023), Scrautiidae (*Anaspis horaki* Perkovsky & Odnosum, 2009) (Perkovsky & Odnosum, 2009), Silvanidae (*Austronausibius aenigmatista* Alekseev & Bukejs, 2022) (Alekseev & Bukejs, 2022; present paper), and Staphylinidae (*Baltostigus horribilis* Jałoszyński, 2016 and *Dysanabatium kechrimparens* Bogri, Solodovnikov & Żyła, 2018) (Jałoszyński, 2016; Borgi *et al.*, 2018; Jałoszyński & Perkovsky, 2019). At present, an ecological and biotopic analysis of beetle species common to these ambers seems premature due to the small data set, although such work may yield interesting results in the future.

Of the 40 families of Coleoptera associated with stored products in commercial and domestic premises throughout the world and listed by Halstead (1986), about 88% have described representatives from Eastern European Eocene (Rovno and Baltic) ambers. Reliable reports from amber for five families on this list (Cucujidae, Discolomatidae, Laemophloeidae, Murmidiidae, and Phalacridae) are still absent, which may partly be the reason for the incomplete study of the amber fauna. Such a high commonality at the family level (90%) between storage inhabitants found associated with products of plant and animal origin and coleopteran assemblages of Eocene ambers is hardly a mere coincidence. Among the beetle genera known from Eastern European Eocene ambers (Spahr, 1981; Alekseev, 2017; Alekseev *et al.*, 2020; Háva & Zahradník, 2022), there are also numerous taxa that have living representatives among the coleopteran warehouse inhabitants, all with a cosmopolitan or very wide (due to human activity) distribution in the world. These include such genera as *Anthrenus* Geoffroy, 1762; *Atomaria* Stephens, 1829; *Attagen* Latreille, 1802; *Cartodere* Thomson, 1859; *Corticarina* Reitter, 1881; *Cryptophagus* Herbst, 1863; *Dienerella* Reitter, 1911; *Holoparamecus* Curtis, 1833; *Lasioderma* Stephens, 1835; *Latridius* Herbst, 1793; *Litargus* Erichson, 1846; *Micrambe* Thomson, 1863; *Nausibius* Lentz, 1857; *Ptinus* Linnaeus, 1766; and *Trogoderma* Dejean, 1821. An objective analysis of the reliability of the observation of an association of the inhabitants of Eocene amber forests (known from amber) with storage areas in the modern world is still premature due to insufficient representativeness of the described material and our incomplete knowledge of the beetle communities in amber forests.

Acknowledgements

We are sincerely grateful to Messrs. Aleksej and Jonas Damzen (Vilnius, Lithuania) for loaning the amber material, donating the holotype of the newly described species to the SIZK, and providing the photographs as well as assistance during our amber research. We are also grateful to Dr. Evgeny E. Perkovsky (Copenhagen, Denmark) for his constructive advice. Finally, special thanks are given to Dr. David Peris (Barcelona, Spain) and Dr. Chenyang Cai (Nanjing, China) for their valuable comments, reasonable and fair critique, and corrections to an earlier version of this manuscript.

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