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Contributions to the palaeofauna of Ptinidae (Coleptera) known from Baltic amber

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Hemicoelus favonii **sp. nov.** is described and illustrated from Eocene Baltic amber. This new fossil species differs from extant congeners in having 11-segmented antennae; a metathoracic ventrite with large impression in its anterior portion; a pronotum distinctly narrower than the elytral base region; the posterior suture of abdominal ventrite 1 weakly arcuate medially; sharp lateral pronotal margins that are incomplete and distinct in their basal half only; elytral striae that are not grouped in pairs; posterior pronotal angles that are rounded; elytral intestriae 3, 5, 7 and 9 that are distinctly convex; and a comparatively small total body size. The presence of *Hemicoelus* in Baltic amber suggests that moist, rotting wood was available as a microhabitat in the ancient forest. Beyond the new species description, the systematic placement of *Anobium jacquelinae* Hawkeswood, Makhan & Turner is discussed. A new fossil record for *Microbregma waldwico* Bukejs & Alekseev, and the first report of the genus *Trichodesma* LeConte from Eocene Baltic amber are also presented.

The family Ptinidae is well represented by fossils. Up until now 48 species belonging to 27 genera and 8 subfamilies have been described, these include: Mesernobiinae—1 sp., Ptininae—14 spp., Eucradinae—1 sp., Dryophilinae—2 spp., Ernobiinae—10 spp., Anobiinae—14 spp., Dorcatominae—2 spp., Xyletininae—3 spp. and *incertae sedis*—1 sp. (reviewed in Zahradník & Háva 2014a; Bukejs & Alekseev 2015). Descriptions from Baltic amber are the most numerous, consisting of 23 species in 14 genera and 6 subfamilies. However, despite their abundance (the family is one of the more frequent elements among Coleoptera of this Konservat-Lagerstätte), the species-level diversity of these fossils has been insufficiently studied.

The genus *Hemicoelus* LeConte, 1861 comprises 12 extant species distributed in the Holarctic (White 1982; Zahradnik 2007). The North American list of deathwatch beetles (White 1982) contains 7 species of the genus *Hemicoelus*, keyed by White (1976) and Arango & Young (2012): *H. laticollis* (Fall, 1905), *H. defectus* (Fall, 1905), *H. gibbicollis* (LeConte, 1859), *H. nelsoni* (Hatch, 1961), *H. carinatus* (Say, 1823), *H. umbrosus* (Fall, 1905), and *H. pusillus* (Fall, 1905). Five species are known in the Palaearctic region (Zahradnik 2007), and these have been keyed by Toskina (2004), Terekhova & Drogvalenko (2011), and Logvinovskij (1985, 1992): *H. canalicularis* (Thomson, 1863), *H. costatus* (Aragona, 1830), *H. fulvicornis* (Sturm, 1837), *H. rufipennis* (Duftschmid, 1825), and *H. ussuriensis* (Karapetyan, 1980). Some species are most economically significant species of the subfamily Anobiinae: *Hemicoelus gibbicollis* (LeConte, 1859) is a serious pest species in the Pacific coastal region of the USA (Suomi & Akre 1992), and *Hemicoelus carinatus* (Say, 1823) is the most frequent wood-damaging anobiine throughout eastern North America (Arango & Young 2012). Although the genus includes numerous species that infest timber and wood construction (thereby successfully coexisting in modern, human-made ecosystems), it is actually an ancient and relict genus from the Eocene. In the present paper, a new fossil species is assigned to the extant genus *Hemicoelus*, from the Baltic amber of Fennosarmatia, and the new species is described and illustrated.

Material and methods

The material examined is deposited in the following collections:

- Royal Saskatchewan Museum (Regina, Saskatchewan, Canada) Palaeontology Collection [RSM, "P" specimen number prefix];

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- the private collection of Christel and Hans Werner Hoffeins (Hamburg, Germany) [CCHH].

The amber piece was prepared by vacuum-injecting the amber piece with EpoTek 301 mineralogical grade epoxy (for stabilization), then manually polishing the amber piece to for a block (10 x 4 x 2 mm) with ideal anatomical views for light microscopy, and a reduced amount of amber surrounding the longitudinal axis for synchrotron imaging.

Light microscope observations were made using a Nikon® SMZ 745T stereomicroscope. The photographs were taken using a Nikon® SMZ 745T stereomicroscope with Nikon® DSFi1 digital camera. Extended depth of field at high magnifications was achieved by combining multiple images from a range of focal planes using Helicon Focus 5.3.14 software. Measurements were taken with an ocular micrometer, and are expressed in millimeters.

Synchrotron X-ray micro-CT observations were made on specimen P3300.84 at the BioMedical and Imaging Therapy (BMIT) Insertion Device (ID) beamline (Wysokinski *et al*. 2008) at the Canadian Light Source (CLS) synchrotron facility. A customized micro-CT system developed by Bruker (Kontich, Belgium) was used to image the specimen at a voxel size of 0.9 microns and tomographic slices were generated from 900 rotations steps through 180 degrees (0.2 degree step) using NRecon (Bruker software). During imaging, the specimen was mounted on a brass pin holder on the stage, using dental wax as an X-ray translucent and removable mountant. Images were captured at 30 keV with a sample to detector distance of approximately 16 cm, resulting in significant phase contrast in the final images. The image data were binned (2 x 2 x 2) to 1.8 micron isotropic voxels and imported into the AMIRA (ver. 6.3) software platform for interactive segmentation and 3D visualization. Renderings were completed using Z-Brush software (ver. 4R7 P3).

Systematic Palaeontology

Family Ptinidae Latreille, 1802

Subfamily Anobiinae Fleming, 1821

Tribe Anobiini Fleming, 1821

Genus *Hemicoelus* LeConte, 1861

Remarks. The specimen considered here was assigned to the genus *Hemicoelus* within the tribe Anobiini, on the basis of the following morphological characters: (1) distinctly clubbed antennae with antennomeres 9–11 longer than the preceding five antennomeres combined; (2) procoxae distinctly separated by a parallel-sided intercoxal process; (3) pubescence of body dorsal surface unicolourous and homogeneous, without long erect setae; (4) all abdominal ventrite sutures distinct throughout length, with ventrites 3 and 4 subequal in length; (5) metathoracic ventrite with a deep anterior impression not reaching its middle; (6) elytral apices indistinctly truncated, not tapered.

Hemicoelus favonii Bukejs, Alekseev & McKellar sp. nov. (Figs 1–2)

Type material. Holotype: collection number P3300.84 [RSM], female. A rather complete beetle with partially exposed hind wings is included in small, transparent yellow amber piece embedded in block of Epotek 301 resin with overall dimensions 10×4×2 mm. Syninclusions: fungal hyphae, few small pieces of organic material, and small gas vesicles.

Type strata. Baltic amber, mid-Eocene to Upper Eocene.

Type locality. Baltic Sea coast, Yantarny settlement [formerly Palmnicken], Kaliningrad region, Russia.

Etymology. The species epithet, a noun in the genitive case, is derived from the Latin word "*favonius*" (west wind), referring to the most productive wind direction for amber collection in the Sambian peninsula.

Diagnosis. *Hemicoelus favonii* **sp. nov.** differs from extant species in combination of following characters: 11-segmented antennae; metathoracic ventrite with large impression in anterior portion; pronotum distinctly narrower than elytral base region; posterior suture of abdominal ventrite 1 weakly arcuate medially; sharp lateral pronotal margins incomplete, distinct in basal half only; elytral striae on disc not grouped in pairs; posterior pronotal angles rounded; elytral interstriae 3, 5, 7 and 9 slightly convex; and smaller body size.

Three fossil species of the tribe Anobiini have previously been described from Baltic amber (Kuśka 1992; Hawkeswood *et al*. 2009; Bukejs & Alekseev 2015): *Anobium jacquelinae* Hawkeswood, Makhan & Turner, 2009; *Microbregma sucinoemarginatum* (Kuśka, 1992); and *Microbregma waldwico* Bukejs & Alekseev, 2015. Apart from genus-level differences (such as variation in abdominal ventrite lengths, and relief of pronotum dorsally), differences between known fossil species and *Hemicoelus favonii* **sp. nov.** include: (1) comparative widths of pronotum and elytral base region: in *Microbregma waldwico*, *M. sucinoemarginatum* and *Anobium jacquelinae,* pronotum nearly as wide as elytral base, but in new species pronotum distinctly narrower than elytral base; (2) body length: 3.8–4.6 mm in *M. waldwico*, 3.5 mm in *M. sucinoemarginatum*, 3.0 mm in *A. jacquelinae*, and 1.8 mm in *Hemicoelus favonii* **sp. nov.**

Description. Body length 1.8 mm, maximum width 0.8 mm; body shape elongate, cylindrical; body color (as preserved) brown, with legs and antennae paler, rufous; head and pronotum with fine recumbent pubescence, elytra apparently glabrous.

FIGURE 1. *Hemicoelus favonii* **sp. nov.**, holotype RSM P3000.84. A, B—dorsal habitus photomicrograph, and corresponding SR x-ray μCT rendering; C, D—ventral habitus photomicrograph, and corresponding SR x-ray μCT rendering. Scale bars represent 0.5 mm.

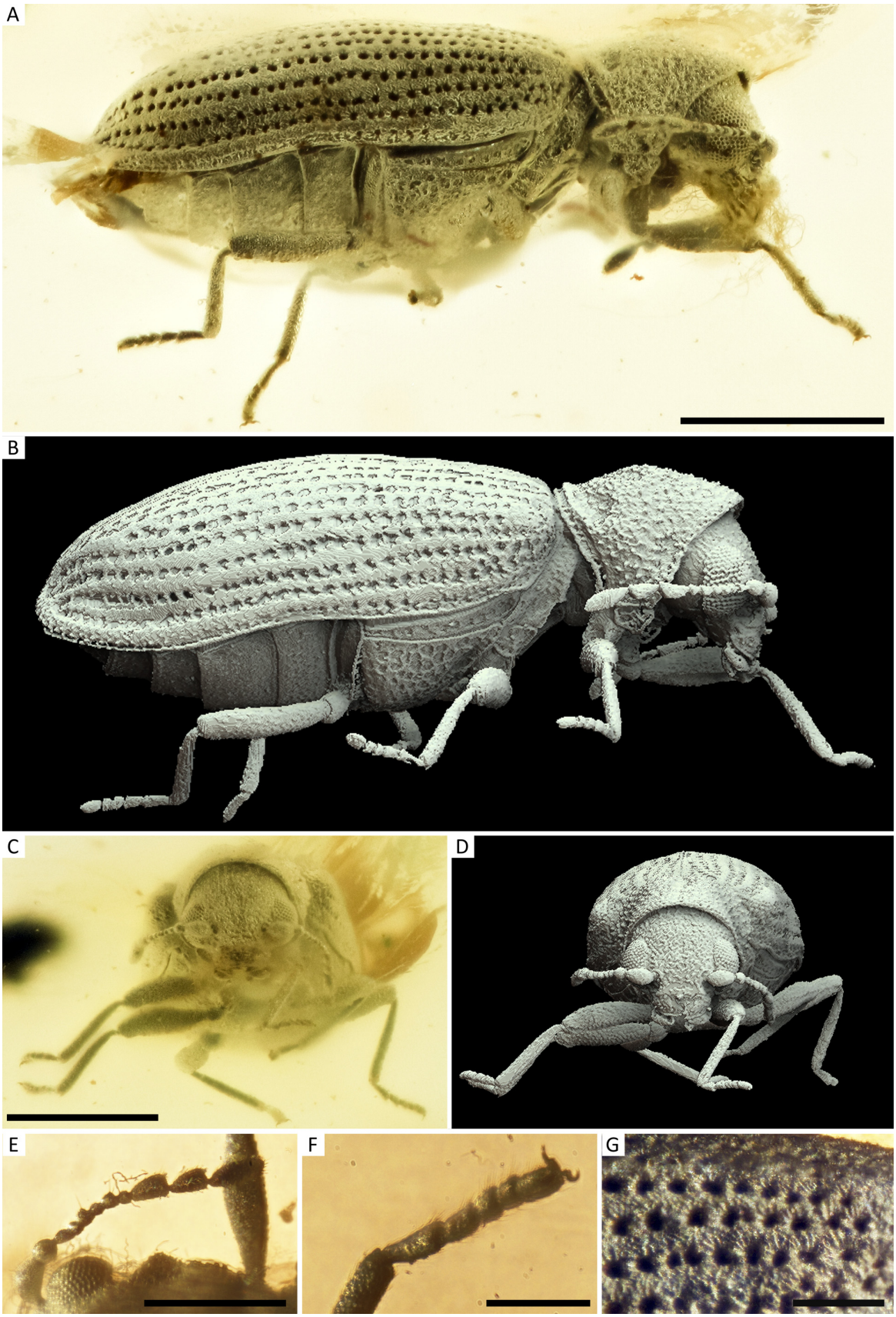

FIGURE 2. *Hemicoelus favonii* **sp. nov.**, holotype RSM P3000.84. A, B—lateral habitus photomicrograph, and corresponding SR x-ray µCT rendering; C, D—anterior habitus photomicrograph, and corresponding SR x-ray µCT rendering; E—detail of right antenna in dorsal view; F—detail of right mesotarsus in dorsal view; G—detail of elytral punctation and interstriae. Scale bars represent 0.5 mm in A, D; 0.25 mm in E; 0.1 mm in F, G.

Head hypognathous, evenly and weakly convex dorsally, finely and densely granulated; frons weakly convex, without tubercles or carinae. Compound eyes small, oval, convex, entire, with distinct facets, without ommatidial setae; distance between compound eyes nearly equal to 1.5× vertical diameter of one eye. Antennae short, reaches elytral base; 11-segmented, with 3-segmented club; scape subcylindrical, weakly thickened; pedicel globose, 0.5× length of scape and 0.35× length of antennomere 11; antennomere 3 elongate, as long as pedicel, or about 0.3× length of antennomere 11; antennomeres 4–8 small, nearly as long as wide; antennomeres 9–11 elongate, about 0.8× as long as antennomeres 1–8 combined; antennomeres 9–10 equal in length and similar in shape, distinctly dilated apically, antennomere 11 spindle-shaped, 1.4× as long as antennomere 10. Relative length ratios of antennomeres 1–11 equal to 15-7-7-4-5-4-5-4-13-13-19. Antennal insertions widely separated, distance equal to 0.75× width of frons.

Pronotum weakly transverse, about 1.1× as wide as long, length 0.45 mm, maximum width 0.5 mm, distinctly narrower than elytral bases; covered with fine, dense granulation. Anterior margin arcuate, posterior margin weakly convex; lateral margins crenulated, weakly convex in dorsal view, lateral edge sharp but incomplete, distinct in basal half only. Posterior pronotal angles rounded, anterior angles apparently rounded. Pronotum with two oblique, oval, latero-basal impressions on dorsal surface; narrow transverse impressions near posterior margin; and medial longitudinal impression in anterior half; with V-shaped ridge in basal half (almost divided by longitudinal medial impression), and two latero-basal gibbosities.

Scutellar shield large, transverse. Elytra subparallel, elongate, length 1.25 mm, maximum width 0.8 mm, about 1.6× as long as combined width, 2.8× as long as pronotum; humeral calli developed, basal margin weakly concave. Elytral apices indistinctly truncated. Elytral punctures small, dense, arranged in regular striae, each elytron with 10 striae plus shortened scutellar stria, striae distinct throughout entire length of elytron, distance between strial punctures equal to 0.3–1.2× diameter of one puncture, elytral striae on disc not grouped in pairs; interstrial intervals shagreened, interstriae 3, 5, 7 and 9 more or less convex, distance between striae about 1.0–2.0× diameter of one strial puncture. Pygidium completely covered by elytra. Hind wings apparently well developed, partially exposed.

Hypomera impunctate, distinctly concave, more or less enclosing head. Prosternal intercoxal process wide, about 0.7× as wide as diameter of procoxa, concave, with lateral margins parallel, and anterior margin widely emarginate. Mesothoracic ventrite almost impunctate, shagreened; with deep longitudinal medial drop-like impression, and with two subtriangular impressions at anterior margin (anterior to mesocoxae); impressions delimited by sharp carinae. Metathoracic ventrite convex, with large and dense punctures, distance between punctures less than puncture diameter; with large, oval transverse impression in anterior portion (joined to impression of mesoventrite), about 0.4× of metaventrite length (medially), and weakly concave, with impunctate medial area posteriorly. Metepisternum about 5× as long as wide, with large punctures, distinctly widened anteriorly and gradually narrowed posteriorly, anterior margin oblique, lateral margins nearly straight.

Legs moderately short. Procoxae oval, distinctly separated by about 0.7 times procoxal diameter; mesocoxae globose, separated by almost one mesocoxal diameter; metacoxae narrow, transverse, with groove for reception of metafemora. Trochanters subglobose; femora almost straight, short, barely projecting beyond lateral side of elytra, weakly dilated apicaly, clavate, ventrally with longitudinal groove for reception of tibiae; tibiae straight, nearly as long as femora; tarsi slender, about 0.85× length of tibia, tarsal formula 5-5-5. Relative length ratios of protarsomeres 1–5 equal to 11-9-7-5-9; metatarsomere 4 slightly emarginated. Claws free, falcate, thickened basally.

Abdomen with five visible ventrites; ventrite 1 covered with fine punctation, shagreened, with subsequent ventrites smoother; abdominal sutures distinct throughout length; posterior suture of ventrite 1 slightly arcuate medially, other sutures nearly straight. Ventrites 3 and 4 subequal in length; relative length (medially) ratios of ventrites 1–5 equal to 6-5-4-3-4. Intercoxal process of abdominal ventrite 1 trapezoidal, with rounded anterior angles.

Note. Probable sex of fossil specimen was determined using synchrotron X-ray micro-CT observations. Sexual dimorphism is known for extant species of *Hemicoelus*: males and females may be separated based on their sexually dimorphic antennae in which the antennal club of males is more elongate and about one-half longer than that of females (Arango & Young 2012). Females also tend to be larger than males, although this character is unreliable.

Additional fossil records of Ptinidae

Genus *Microbregma* Seidlitz, 1889

Microbregma waldwico Bukejs & Alekseev, 2015 (Figs 3A–B)

Material examined. One specimen with collection number 1771-5 [CCHH], Baltic amber, Yantarny, Kaliningrad region, Russia. Complete beetle included in small, transparent, yellow amber piece with dimensions of 35×14×7 mm. Syninclusions consist of three specimens of Sciaridae (Diptera), one specimen of Chironomidae (Diptera), one specimen of Ceratopogonidae (Diptera), and many stellate Fagaceae trichomes. Body length of beetle is 3.8 mm, and preserved color is dark brown.

Note. Body length in holotype of *Microbregma waldwico* is 4.6 mm.

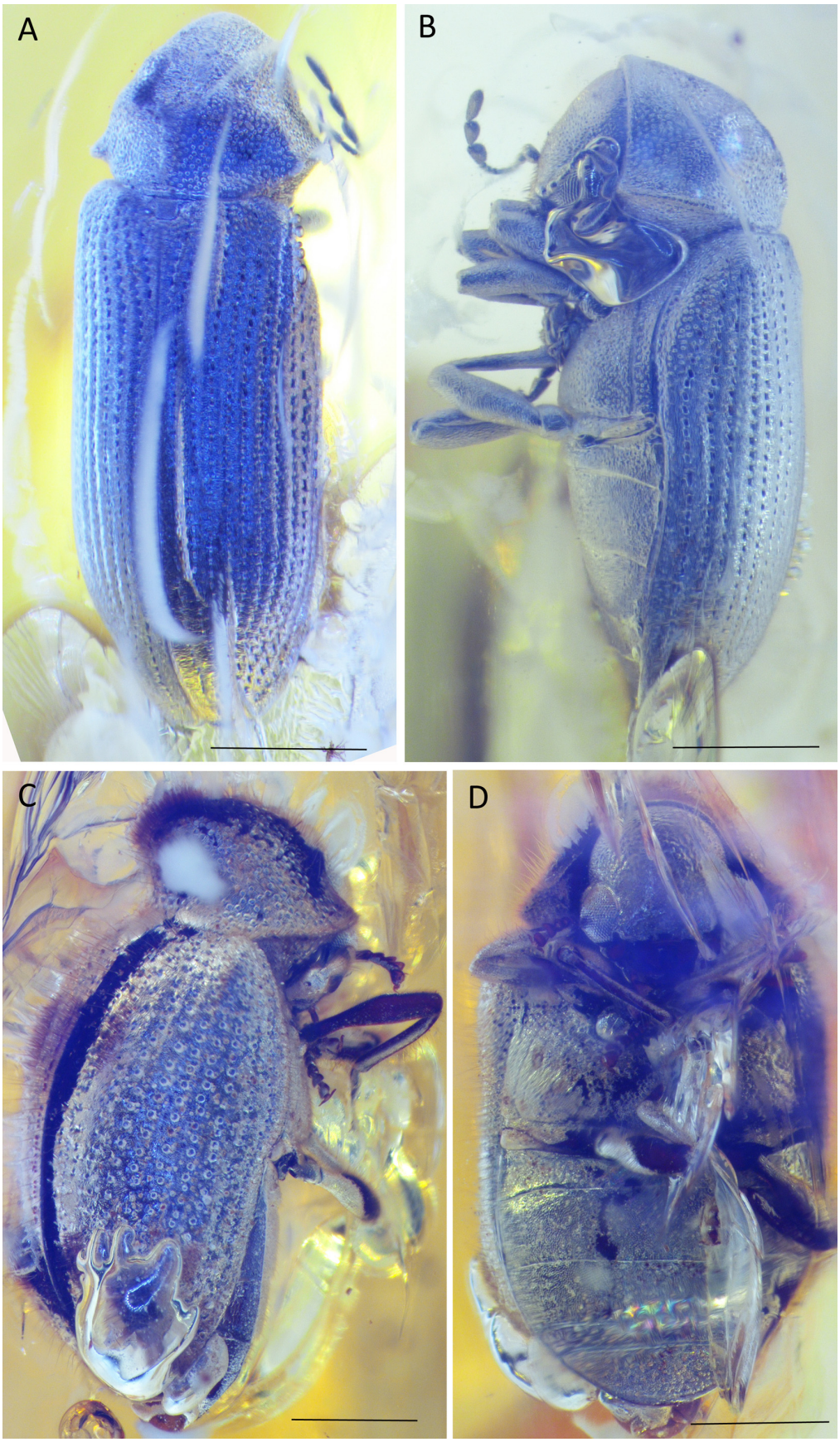

FIGURE 3. Fossil Ptinidae in Baltic amber. A-B *Microbregma waldwico* Bukejs & Alekseev, specimen 1771-5 [CCHH]: A—habitus, dorsal view, B—habitus, lateral view; C–D *Trichodesma* sp., 1771-1 [CCHH]: C—habtus, dorso-lateral view, D—habitus, ventral view. Scale bars represent 1 mm.

Tribe Nicobiini White, 1982
Genus *Trichodesma* LeConte, 1861
Trichodesma sp. (Figs 3C–D)

Material examined. One specimen of *Trichodesma* sp. with collection number 1771-1 [CCHH], Baltic amber, Yantarny, Kaliningrad region, Russia. Complete beetle included in small, transparent, yellow amber piece with dimensions of 11×8×5 mm. Body length of beetle is 5.2 mm. Syninclusions consist of one small specimen of Diptera, many small pieces of organic material, and few gas vesicles.

Note. The present finding from an Eocene deposit is the first report of a fossil representative of *Trichodesma*. Extant species of this genus are distributed in warm climatic zones of the Nearctic, Neotropic, eastern Palaearctic, Afrotropical and northern Indomalayan regions (Español 1966; Peck 2005; Sakai 2005; Viñolas & Masó 2007; White 1982; Zahradník 2007; Zahradník & Háva 2014b). The studied fossil specimen lacks reliable diagnostic characters and remains unnamed.

Discussion

Additional systematic comments. Beyond the specimens examined for this work, the holotype of *Anobium jacquelinae* Hawkeswood, Makhan & Turner, 2009 [deposited in the private collection of Dr. T.J. Hawkeswood (Richmond, Australia) under number TJH0102 according to the original description] should be studied for the clarification of its generic and tribal placement. Unfortunately, there are no mentioned morphological characters from the ventral side for this species (Hawkeswood *et al.* 2009), making identification practically impossible, and comparisons difficult and vague. *Anobium jacquelinae* should be currently considered as *insertae sedis* within the subfamily Anobiinae, at least until a more complete set of observations can be made for the type specimen.

Ecological implications. Recently, the importance of trophic connections among the beetles from Baltic amber for the reconstruction of paleoecosystem has been discussed and emphasized by Alekseev & Alekseev (2016). The palaeoclimate reconstruction of the Eocene Baltic amber forests based on fossil beetles has been made by Alekseev (2017). Species of *Hemicoelus* have been recorded in a variety of deciduous (both hardwood and softwood) as well as conifer trees species, including *Abies*, *Acer*, *Betula*, *Carya*, *Fraxinus*, *Fagus*, *Picea*, *Pinus*, *Tilia*, *Tsuga*, *Quercus*, *Ulmus* (White 1982; Arango & Young 2012), *Pseudotsuga*, and *Thuja* (Suomi & Akre 1992). The European representatives of the genus develop in wood of *Acer*, *Alnus*, *Carpinus*, *Fagus*, *Quercus*, *Ulmus* (Terekhova & Drogvalenko 2011), as well *Corylus*, *Tilia*, *Salix*, and *Populus* (Ehnström & Axelsson 2002). The beetles inhabit areas with temperate humid climates. Probably the most important factor that allows these beetles to survive and reproduce is wood with moisture content between 13 and 19% (Suomi & Akre 1992). The association of the fossil *Hemicoelus favonii* **sp. nov.** with moist, rotten wood seems likely. The hyphae of mold fungi present in the amber as syninclusions provide additional support for such a hypothesis.

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