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First record of *Archaeocercoides puchkovi* Simutnik, 2022 (Hymenoptera, Chalcidoidea, Encyrtidae) from late Eocene Danish amber

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Encyrtidae are one of the largest and most diverse families of chalcidoid wasps found both today (Noyes, 2023) and in Eocene ambers (Simutnik, 2021; Simutnik & Perkovsky, 2023). The earliest known Encyrtidae have been found in middle Eocene Sakhalinian amber (Simutnik, 2021; Simutnik *et al.*, 2021b). They differ significantly from both extant encyrtids as well as those occurring in late Eocene European ambers, many of which feature peculiar characters (Simutnik *et al.*, 2020, 2023; Simutnik, 2021). To date, some 20 species in 18 extinct genera of Encyrtidae have been described from late Eocene Baltic, Danish and Rovno ambers (Simutnik *et al.*, 2021a, 2022c, 2023; Simutnik & Perkovsky, 2023).

Baltic, Danish and Rovno ambers are coeval but have different geographical origins (Dlussky & Rasnitsyn, 2009; Jenkins Shaw *et al.*, 2023 and references therein). This probably explains why the species composition of their flora and entomofauna also differed somewhat. The Danish amber fauna appears more similar to the fauna in Rovno amber than in Baltic amber (Perkovsky, 2016, 2017; Simutnik & Perkovsky, 2017, 2018). New insect taxa described from Danish amber in the last 18 years are listed in Anisytukin *et al.* (2023) and Viertler *et al.* (2023).

Five encyrtid species, *Sulia glaesaria* Simutnik, 2015 (later reported from Rovno amber in Simutnik *et al.*, 2021a); *Protocopidosoma kononovae* Simutnik, 2017; *Dencyrtus vilhelmseni* Simutnik, 2018; *Efesus trufanovi* Simutnik, 2020; and *Electroanellus belokobylskiji* Simutnik, 2023 featuring an antenna with a distinct anellus (Simutnik & Perkovsky, 2023) have been described from a collection of late Eocene Danish amber deposited in the Natural History Museum of Denmark (NHMD). In the present study, *Archaeocercoides puchkovi* Simutnik, 2022, originally described from Rovno amber (Simutnik *et al.*, 2022a), is newly recorded from Danish amber based on a single well-preserved female specimen. Thus, this is the second species of chalcidoid (along with *Sulia glaesaria*) known from both Danish and Rovno ambers and not from other

Eocene ambers. In contrast, two species of the chalcidoid wasp, *Eocencyrtus zerovae* Simutnik, 2001 (Encyrtidae) (Simutnik *et al.*, 2014) and *Leptoomus janzeni* Gibson, 2008, belonging to a recently described family Leptoomidae Gibson, 2023 (Gibson & Fusu, 2023), have been recorded in both Baltic and Rovno ambers only (Simutnik *et al.*, 2020, 2021a).

In the present study, high-resolution photomicrographs as well as measurements of the new Danish amber specimen of *A. puchkovi* are provided along with measurements of the holotype from Rovno amber. The proportions of antennal segments, the notaular lines and the ovipositor sheaths clearly visible in the new specimen complement the data about this interesting taxon.

Archaeocercoides puchkovi differs from the majority of extant encyrtids in the subapical position of the cerci (Fig. 2: cer). It is easily recognized and can be distinguished from the similar genus *Archaeocercus* Simutnik, 2018 by the presence of a long, thick, slightly upwardly bent ovipositor stylet (Fig. 2). Only two species featuring a long ovipositor stylet, *A. puchkovi* and *Rovnopositor voblenkoi* Simutnik, 2022, are known from European Eocene ambers (Simutnik *et al.*, 2022a).

Most extant encyrtids are parasitoids of mealybugs (Hemiptera: Pseudococcidae). The biology of Eocene encyrtids is unknown, but the holotype of *A. puchkovi* was found in amber near an undescribed Coccoidea crawler (Simutnik *et al.*, 2022a: fig. 1C, D).

Material and methods. The clear, yellow Rovno amber piece containing the holotype of *A. puchkovi* is housed in the collection of the Schmalhausen Institute of Zoology of the National Academy of Sciences of Ukraine, Kiev (SIZK). The piece of Danish amber with the new specimen from the NHMD collection is reddish and not very transparent. No differences were found in the proportions of its body parts.

Photographs were taken using a Leica Z16 APO stereomicroscope equipped with a Leica DFC 450 camera

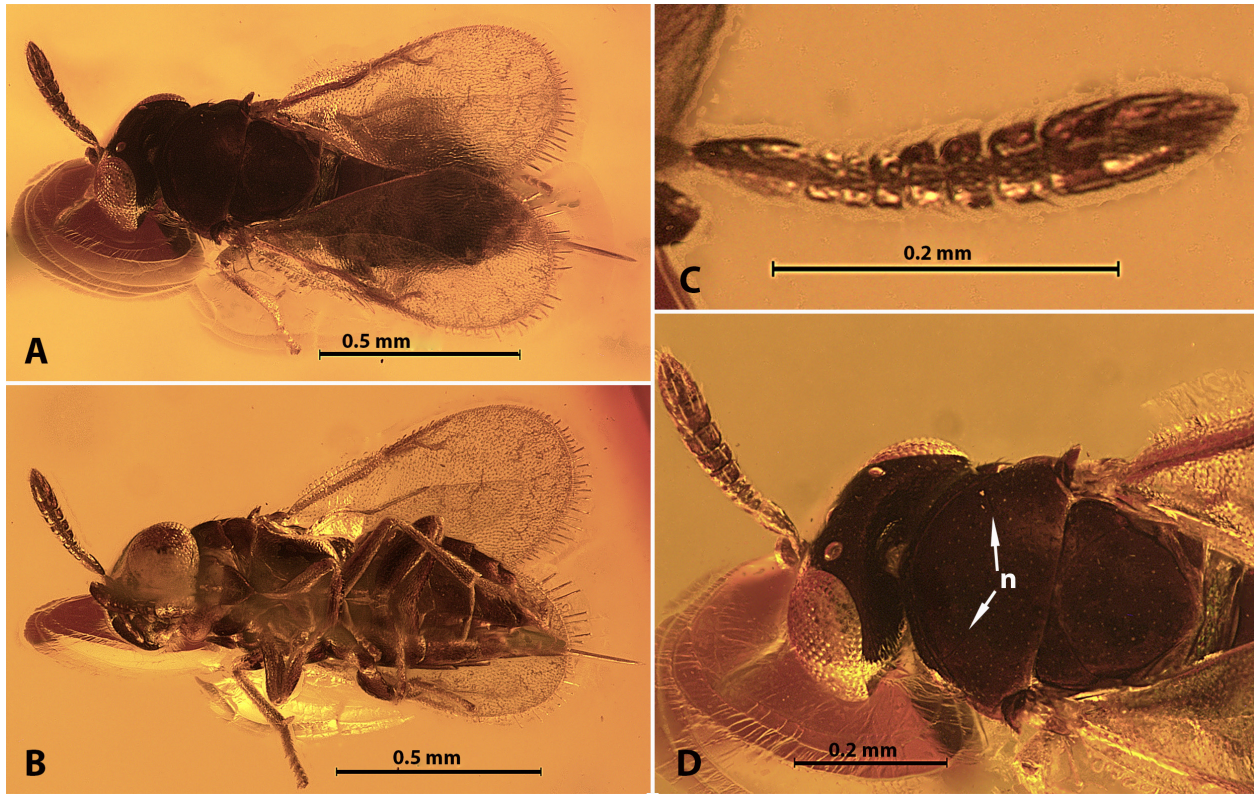


FIGURE 1. *Archaeocercoides puchkovi*, female, specimen from late Eocene Danish amber. **A**, Dorsal view. **B**, Ventral view. **C**, Antenna, ventral. **D**, Head, antenna and mesosoma, dorsal (n- notaular lines).

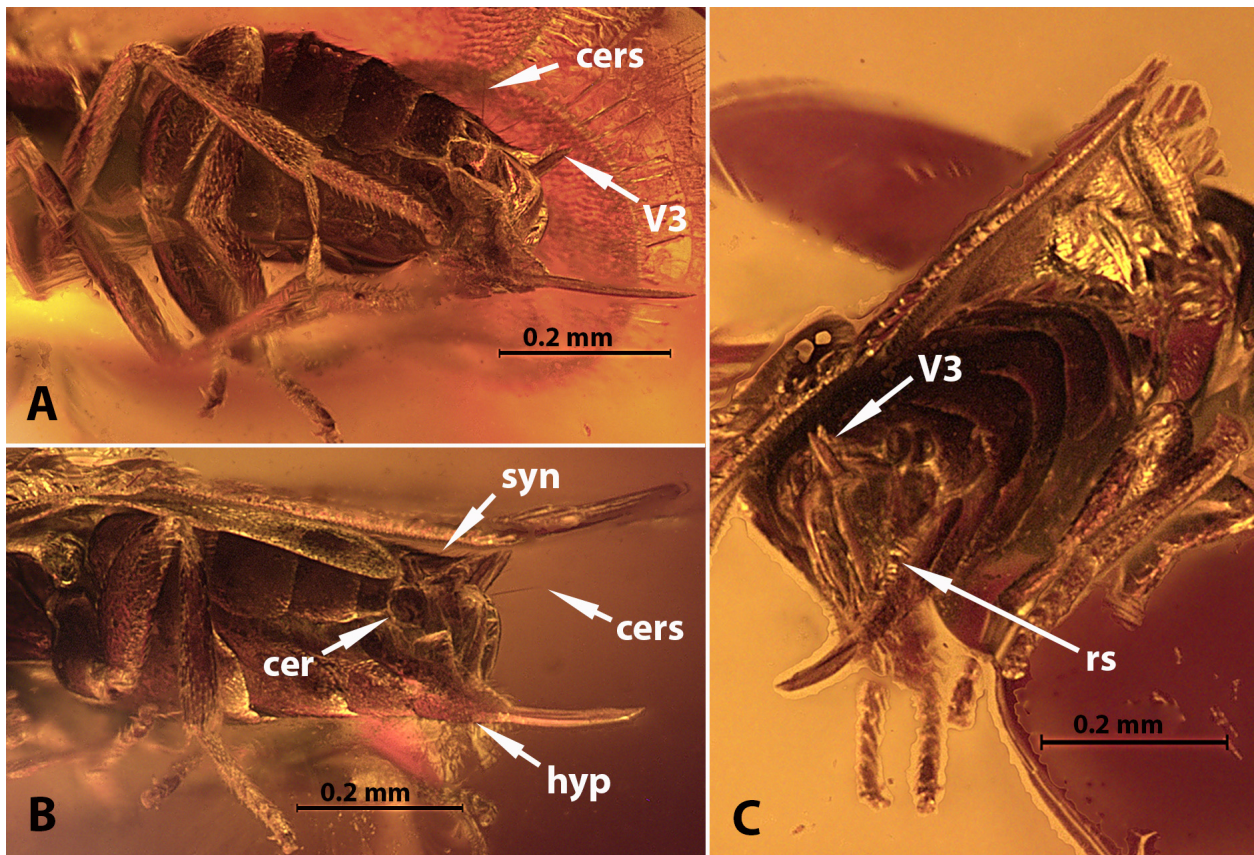


FIGURE 2. *Archaeocercoides puchkovi*, specimen from late Eocene Danish amber, gaster. **A**, Lateral view (cers-cercal seta, v3-ovipositor sheaths). **B**, Lateroventral view (cer-cercus, hyp-hypopygium, syn-syntergum). **C**, Posterolateral view (rs-row of setae).

and processed with LAS Core and Adobe Photoshop software (brightness and contrast only).

Some standard measurements and ratios given in the description may not be precise or could not be obtained due to the effect of light refraction in the amber, the effect of perspective or the inaccessibility of the necessary viewing angles.

Terminology and abbreviations follow Gibson (1997) and Noyes (2023). POL = minimum distance between the posterior ocelli; AOL = minimum distance between posterior ocellus and anterior ocellus. SIZK = I. I. Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine (Kiev); NHMD = Natural History Museum of Denmark.

Genus *Archaeocercoides* Simutnik, 2022

<http://zoobank.org:act:62CF153A-DC3A-4F49-8400-08C2E33AF26A>

Type species. *Archaeocercoides puchkovi* Simutnik, 2022

<http://zoobank.org/50A0A5E5-EFD7-4C7C-AD5B-2B095282C5A9>

Type material. *Holotype*, SIZK UA-28099, ♀, Varash District, Rovno Region, Ukraine; Rovno amber; late Eocene. The inclusion is in a clear, yellow piece of amber in the shape of a parallelepiped (*ca.* 40 × 10 × 9 mm), one side of which contains a layer of organic residues. All body parts are preserved.

Syninclusion: A Coccoidea crawler (Simutnik *et al.*, 2022: fig. 1C, D). Body length 420 µm.

Measurements. (µm) Holotype. (Measurements may be inaccurate due to the optical properties of amber.) Body length 1200; head width dorsal 406; frontovertex dorsal 154:210; POL 140; AOL 56; clava 125. Mesosoma length dorsal 490; mesoscutum 196:350; scutellum 210:210; mesotibia 280; mesotibial spur 70; fore wing 882:420; marginal vein 84; hind wing 700:154; metasoma 560.

New material. NHMD 115328, ♀, 01-05-1967; leg. C.V. Henningsen; Danish amber, late Eocene (deposited in NHMD). The inclusion is in a reddish, not very transparent parallelepiped piece of amber (*ca.* 6 × 5 × 3 mm).

Syninclusions: absent.

Measurements. (µm) The new specimen from Danish amber. Body length 1200; head width dorsal 406; frontovertex dorsal 154:210; POL 140; AOL 56; pedicel 70; funicle 140; clava 125. Mesosoma length 490; mesoscutum 196:350; scutellum 210:210; mesotibia 280; mesotibial spur 70; fore wing 882:420; marginal vein 84; hind wing 700:154; metasoma 600; exerted part of ovipositor stylet 210; gonostylus (third valvula) 56.

Measurements of the new specimen vary only slightly from the measurements of the holotype. The slight difference in metasoma length also may be a result of the effect of light refraction in the amber.

Male. Unknown.

Biology. Unknown.

Discussion. The encyrtid fauna found in European ambers was varied and peculiar. In particular, species have been discovered featuring a male antenna with a distinct anellus (Simutnik & Perkovsky, 2023); a four-segmented female funicle

(Simutnik *et al.*, 2023); an unusually small, bare (without microsetae) mesotibial spur (Simutnik *et al.*, 2022c); a peg or spicule originating from the round, deep pit at the apex of metatibia and a transverse row of thickened setae alongside the spur vein of the hind wing (Simutnik *et al.*, 2022d); a line of long setae alongside the costal cell of the hind wing (Simutnik *et al.*, 2022a, d); as well as other interesting characters. Such features are absent or very rare in extant encyrtids. The relationships of extinct and extant taxa have not yet been established.

The tentative placement of *A. puchkovi* in the subfamily Tetracneminae is supported by the absence of a filum spinosum on the linea calva of the forewing (Fig. 1A, B), and the hypopygium extending past the gastral apex (Fig. 2: hyp). It is characterized also by the notaular lines present anteriorly (Fig. 1D: n) (almost not visible in the holotype when lit from above); very long marginal, postmarginal, and stigmal veins of the forewing (Fig. 1A, B); lateral margins of the hypopygium appear to be serrated because of a row of setae (Fig. 2C: rs); the ovipositor stylet slightly upwardly bent (Fig. 2), long and thick relative to small, subtle ovipositor sheaths (Fig. 2A, C: v3). In extant Tetracneminae, the most similar position of the cerci is found only in *Savzdargia hofferi* (Pilipjuk, 1974). In the extinct Encyrtidae without the filum spinosum (supposedly the members of Tetracneminae (see Simutnik *et al.*, 2022d)), the apical position of the cerci is reported in a number of species, including all of the known earliest taxa from middle Eocene Sakhalinian amber (Simutnik, 2021; Simutnik *et al.*, 2021b).

With *Archaeocercoides* included, 48% of Danish amber hymenopteran genera remain unknown from Baltic amber (our data). The new finding confirms the close connection between the faunas of Danish and Rovno ambers, which have two common encyrtid species from six known from Danish amber.

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