Zootaxa 5195 (1): 087–091
https://www.mapress.com/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5195.1.5
http://zoobank.org/urn:lsid:zoobank.org:pub:7BCF5C20-88D0-4740-8698-87919D9F8D58

A new fossil *Silis* Charpentier, 1825 from Baltic amber (Cantharidae, Silinae, Silini)

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Abstract

A new fossil species of the family Cantharidae from Eocene Baltic amber, *Silis* (*Silis*) *boninoi* **sp. nov.**, is described, diagnosed and illustrated. The new species is characterized by its extremely small body size along with a very wide and transverse pronotum with two short and quite robust lobes on each side. It is compared with other known taxa of the genus *Silis* from Baltic, Dominican and Mexican ambers.

Key words: soldier beetle, paleoentomology, Eocene, *Silis*, new species

Introduction

The subfamily Silinae Mulsant, 1862 is currently widespread in all continents except Antarctica (Delkeskamp 1977; Kazantsev 1997; Ramsdale 2002; Kazantsev & Brancucci 2007; Constantin 2009, 2017; Parisi & Fanti 2019). The subfamily is quite well represented in Tertiary deposits. Eocene Silini are known from three extinct genera found in Baltic amber: *Electrosilis* Kazantsev, 2013; *Curche* Alekseev & Kazantsev, 2014; and *Markus* Fanti & M. J. Pankowski, 2018 (Kazantsev 2013; Alekseev & Kazantsev 2014; Fanti & Pankowski 2018). In addition, there is one known fossil of the extant genus *Autosilis* Kazantsev, 2011 and one of the extant genus *Podosilis* Wittmer, 1978 from Baltic amber (Fanti & Damgaard 2018; Kazantsev 2020). An adpression fossil species of the extant genus *Polemius* has been found in the deposits of Florissant, Colorado, USA (Wickham 1914; Fanti 2017), and an undescribed specimen similar to *Autosilis nitidula* has been discovered in the argillaceous limestone of the Tertiary strata (Eocene/Oligocene) of Aix-en-Provence, France (de Serres 1843; Pictet 1854; Fanti 2017).

Silis Charpentier, 1825 is present today in Europe with two species (Parisi & Fanti 2019) and is widespread in the Americas. It is very common in the Neotropical realm including the Antilles, with just under 200 species (Delkeskamp 1977; Constantin 2009, 2012, 2017). But in the fossil record, only four species of *Silis* have been described: one from Baltic amber (Parisi & Fanti 2019), one from Mexican amber (Wittmer 1963) and two from Dominican amber (Fanti & Pankowski 2021). In addition, a few specimens of *Silis* are known at the generic level from Baltic amber (Klebs 1910; Bachofen-Echt 1949; Fanti 2017). In this paper, we describe another new representative of the genus *Silis* from Eocene Baltic amber.

Material and methods

The amber piece was discovered in a mine in the Yantarny settlement in the Sambian Peninsula, Russia. It was cleaned and polished for a better view. Photos of the specimen were taken by Enrico Bonino using a SONY a7R II mirrorless camera with a 208 mm tube lens, a Raynox DCR-150 and a Mitutoyo 5× objective. To get clearer photos of the inclusion, the specimen was placed in a Petri dish, positioned with white plasticine, and the amber piece completely immersed in 99.5% vegetable glycerol. Camera movement was managed using an MJKZZ Ultra

Accepted by L. Bocak]: 13 Sept. 2022; published: 10 Oct. 2022

Rail MINI V2. Lighting was provided by the cylindric OGGLAB LED system DB 120EB. One hundred images (in 16bit, RAW format) were acquired using a step of 10 µm between each frame. The frames were stacked using Helicon Focus software and the final enhancing made with Adobe Photoshop and Topaz DeNoise software. Figures were then re-processed using Ulead PhotoImpact Viewer SE. The holotype is deposited at the Back to the Past Museum in Cancún, Mexico.

Systematic paleontology

Family Cantharidae Imhoff, 1856

Subfamily Silinae Mulsant, 1862

Tribe Silini Mulsant, 1862

Genus *Silis* Charpentier, 1825

Subgenus *Silis* Charpentier, 1825

Silis (*Silis*) *boninoi* FANTI & M. G. PANKOWSKI sp. nov.

(Fig. 1)

Description. Adult, winged, male. Body length: 2.7 mm; elytra: approximately 2.4 mm long, and 1.0 mm wide at apex. Entirely blackish-dark brown.

Head large, slightly narrower than pronotum, smooth, equipped with several long setae, largely covered by pronotum. Eyes rounded and protruded, wide, inserted in upper and lateral part of the head. Maxillary palpi 4-segmented, unequal in length with last palpomere very elongated and securiform. Labial palps 3-segmented with last palpomere securiform. Antennal insertions and eyes not juxtaposed, antennae surpassing two-thirds of the elytra, 11-segmented, filiform, each antennomere covered with several setae; scape elongated, slightly club-shaped; antennomere II (pedicel) short, about 2.1 times shorter than scape; antennomeres III–V subequal in length, longer than antennomere II, rather robust; antennomeres VI–IX subequal in length, slightly longer than antennomeres III–V; antennomere X very slightly shorter and more slender than previous ones; antennomere XI filiform, oblong with extremely thin and pointed apex. Pronotum strongly transverse, surface undulating with concavities (pores) and equipped with sparse long setae, apparently without punctuation; anterior margin curved and protruding in the middle; sides strongly sinuous, with two very short processes on each side: Posterior processes are thicker and wider than anterior ones and rounded apically; anterior processes are shorter than posterior ones and rounded apically; posterior margin irregular and sinuous with two expansions in the middle. Scutellum triangular with rounded apex. Elytra wider than pronotum, elongated and surpassing last abdominal segments, enlarged at humeri and apex, restricted in middle, apex strongly rounded, surface with very superficial punctation and several very long setae. Posterior wings transparent, completely covered by elytra but just barely shorter than them. Metasternum very elongated with a strongly rounded posterior margin, abdominal segments transverse and pubescent. Legs relatively short, robust and strongly pubescent; coxae massive; trochanters elongated and triangular-shaped with rounded apex; femora enlarged and slightly curved; tibiae cylindrical, with one apical and robust spur, protibiae as long as profemora, mesotibiae slightly shorter than mesofemora, metatibiae just slightly shorter than metafemora. Tarsal formula 5-5-5; first tarsomere elongated; second tarsomere about 1.2 times shorter than first; third tarsomere triangular and shorter than tarsomere II; fourth tarsomere deeply bilobed at sides; fifth tarsomere very elongated, slender, flat and curved; claws simple without basal tooth.

Note. Female unknown. The specimen is a male, defined on the basis of long antennae and lateral sides of pronotum toothed. Sexual dimorphism is supposed because females of the genus *Silis* are characterized by a pronotum with sides without appendages or with very small teeth, and have shorter antennae and a wider abdomen than males.

Etymology. Named in honor of Enrico Bonino for donating the described specimen, photographing it and kindly giving us access to it.

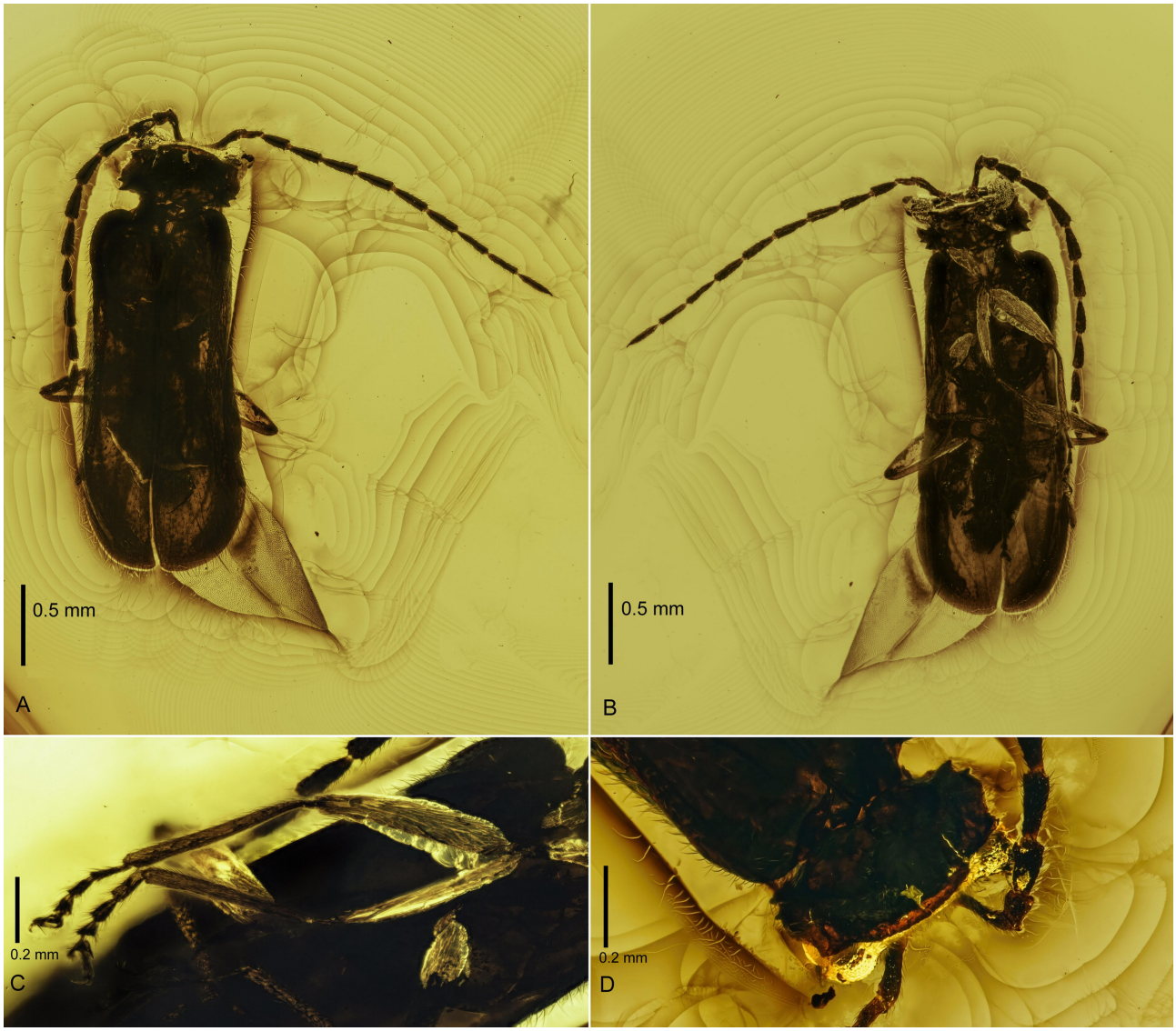

FIGURE 1. *Silis* (*Silis*) *boninoi* **sp. nov.** in Baltic amber. A: Holotype, dorsal view. B: Holotype, ventral view. C: Holotype, detail of prolegs. D: Holotype, detail of pronotum.

Holotype. Male, in Baltic amber, deposited at the Back to the Past Museum, Cancún, Mexico with accession no. BPM-1111.

Type locality. Yantarny mine, Sambian Peninsula, Kaliningrad Region, Russia.

Type horizon. Middle Eocene: Bartonian-Priabonian (45.0–38.0 Mya).

Syninclusions. A few botanical fragments (trichomes).

Systematic placement. The specimen is clearly a new species belonging to the subfamily Silinae and to the genus *Silis* (Brancucci 1980; Kazantsev 1997) based on its maxillary palpi sub-equal in length with their last palpomere securiform, elytra elongated, tarsomeres IV wider than other tarsomeres, pores on the anterior part of the pronotum, the internal claw simple, tibial spurs conspicuous and the lateral section of its pronotum having two lobes on each side.

Genera that appear most similar to *Silis* are distinguished by a few different characters. The genus *Podosilis* has a complex pronotal armature at the sides and a cleft outer claw in males (Kazantsev 1997, 2019, 2020). *Autosilis* features the anterior half of its mesonotum smooth without clear pores, and the anal ring in the male has a tergite and sternite that are roughly equally wide (Kazantsev 1997).

Differential diagnosis. *Silis boninoi* **sp. nov.** differs from *Silis lombardii* Parisi & Fanti, 2019 (from Baltic amber) based on the new species' pronotum that is much more transverse and with shorter pronotal lobes on its sides, and by the new species' significantly smaller size: 2.7 mm vs. 5.2 mm for *S. lombardii* (Parisi & Fanti 2019).

In addition, *Silis chiapasensis* Wittmer, 1963 (found in Mexican Chiapas amber) differs based on its pronotum that is deeply incised at the sides and its lobes that are more curved and longer than on the new species (Wittmer 1963). Finally, *Silis curleri* Fanti & M. G. Pankowski 2021 and *Silis hegnai* Fanti & M. G. Pankowski 2021 (both from Dominican amber) have a very different pronotal shape, with lobes that are longer and more curved, and a less transverse pronotum (Fanti & Pankowski 2021).

The living and widely distributed species *Silis ruficollis* (Fabricius, 1775) has a pronotum with a lateral margin that is less toothed and indented compared to the new fossil species described here.

Remarks. The yellow amber piece has an elongated drop shape and measures approximately 22x11 mm. The inclusion is complete and well visible. Once trapped, the specimen struggled to get out of the sticky resin and thus created characteristic ripples ("fringes") in the amber. A photo of this new species is included in Enrico Bonino's forthcoming book on amber (Bonino, 2022), expected to be published in 2022.

Discussion

The Silinae had been considered a subfamily that evolved rather recently within the Cantharidae family (Brancucci 1980). However, new discoveries in amber — including this one — show unequivocally that the Silinae were already very diversified in the Eocene, suggesting an older evolution (Parisi & Fanti 2019). More molecular, morphological and paleontological studies are needed to shed light on the origin of Silinae. But fossil remains currently point toward a parallel evolution between Cantharinae and Silinae from an unknown common ancestor. This ancestor is likely to be found close to the K-T boundary because, in the Eocene, many current genera were present (both from Cantharinae and Silinae subfamilies), while these genera are missing in the previous Cretaceous period. Moreover, the Cretaceous species found so far have rather particular characters that do not show a definitive relationship yet between the two subfamilies. These Cretaceous species appear to have many more characters in common with the subfamily Cantharinae than Silinae (*e.g.,* Fanti & Ellenberger 2016; Poinar & Fanti 2016; Ellenberger & Fanti 2019).

Regardless of when the Silinae first evolved, species of *Silis* and other genera of Cantharidae were much more numerous in the Eocene than today in Europe (Parisi & Fanti 2020). Some reasons for this abundance of the genus could include the warm climate of the Eocene, followed by a rarefaction of the genus during the Oligocene cooling (Parisi & Fanti 2019; Fanti & Pankowski 2021), thus confirming a predilection of *Silis* for thermophilia millions of years ago. In fact, *Silis* is considered a hygrophilous genus that occupies a temperate climate in Europe and montane areas in California (Ramsdale 2002), while in South America — a land rich in species of this genus — *Silis* occupies more tropical climates (Constantin 2009, 2017).

Interestingly, *Sili*s is likely to be paraphyletic (Parisi & Fanti 2019; Fanti & Pankowski 2021), with the species of North and South America (including the Caribbean) placed in one or more different or new genera in the future. New research and findings will therefore be fundamental to better understand the evolutionary relationships of this intriguing subfamily of Cantharidae and of the genus *Silis*.

Acknowledgements

We are extremely grateful to Enrico Bonino (Liguria, Italy; email: enrico-bonino@outlook.com) for allowing us to study the specimen, taking the excellent photographs and assisting us during the drafting of the manuscript.

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