

An extraordinary ‘nogodinid’ planthopper (Hemiptera: Fulgoroidea) from the earliest Eocene Fur Fm. of Denmark


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
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The Ypresian Fur Formation in northwestern Denmark is one of the most famous and important sources of insect fossils from the early Eocene (*ca.* 55–54 Ma, Pedersen *et al.*, 2012; Madsen & Rasmussen, 2021). The first insect fossils from the formation were described more than 100 years ago by Henriksen (1922), and today approximately 100 species have been described from more than 20,000 known fossils (TJS, JAR, RLS pers. observ.). Although the hemipteran suborder Auchenorrhyncha (cicadas, leafhoppers, planthoppers and allies) comprise one of the major components of this massive body of fossils (Rust, 1999; pers. unpublished obs.) only six species have been formally described to date. Of these the most recently described species, *Archerythrogonia furens* Dietrich & Perkovsky, 2023 belongs to the infraorder Cicadomorpha (Dietrich & Perkovsky, 2023). The remaining five species all belong to the infraorder Fulgoromorpha (Szwedo *et al.*, 2004).

Within Fulgoromorpha, Nogodinidae have traditionally been considered a small family comprising by less than 400 species in approximately 100 genera distributed mainly in the tropics (Holzinger, 2019; Szwedo *et al.*, 2022). However, the family have remained difficult to both define and subdivide—especially based on wing characters (*e.g.*, Fennah, 1978; Shcherbakov, 1981; Stroiński & Szwedo, 2000; Gnezdilov, 2017; Szwedo *et al.*, 2019, 2022), and the taxonomy of the family has been in a state of flux (see Szwedo *et al.*, 2022 for a summary of the taxonomic history of Nogodinidae). Petrulėvičius (2005) did list some potentially useful characters that could allow for tentative placement of fossils with only wing characters visible. Recent molecular phylogenetic studies (*e.g.*, Urban & Cryan, 2007; Deng *et al.*, 2025) have been unable to recover Nogodinidae as monophyletic, and in Deng *et al.* (2025), the family was recovered as polyphyletic explaining why attempts to classify the family have been difficult.

Our knowledge of fossil ‘Nogodinidae’ has increased considerably since Petrulėvičius (2005) stated that their fossil record was ‘extremely poor’ (Petrulėvičius, 2005: 299), and their numbers have increased from seven to 13 species in seven tribes (Lou *et al.*, 2023). Of these, one species is from the Cretaceous, seven are from the Paleogene, and five are from the Neogene (see Lou *et al.*, 2023 for an overview). Here, we describe a new species from the Fur Formation, which we tentatively place near the subtribe Varcini Fennah, 1978. The new species is the second ‘nogodinid’ described from the Fur Formation, and the first fossil representative of Varcini.

Materials and methods. We examine a single fossil, part and counterpart, in a concretion block (from the informal, so-called “striated” concretionary level near ash layers -29 to -25) from the Danish Fur Formation using an Olympus SZ60 stereomicroscope. The fossil was photographed using a Canon EOS 7D and an EF-S 60mm f/2.8 Macro lens. To enhance the contrast, a few drops of ethanol were added when the photo was taken. Wing venation terminology follows Bourgoin *et al.* (2015) with the following abbreviations used in the text and figures: BC, basal cell; CA, costa anterior; CP, costa posterior; CuA, Cubitus anterior; MP, media posterior; Pc, Precosta; Pt, pterostigma; R, radius; RA, radius anterior; RP, radius posterior; ScP, subcosta posterior.

Order Hemiptera Linnaeus, 1758

Suborder Auchenorrhyncha Duméril, 1805

Infraorder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family ‘Nogodinidae’ Melichar, 1898

Tribe *cf.* Varcini Fennah, 1978

Genus *Eosassula* **gen. nov.**

<http://zoobank.org/urn:lsid:zoobank.org:act:2CA18121-8CA1-47D5-9654-B55EE5BBE0C2>

Type species and included species. The type species *Eosassula szwedoi* **gen. et sp. nov.**, here designated, is the only known species.

Etymology. *Eo* = dawn or earliest (classic Greek), and *Sassula*, a ‘nogodinid’ genus with which the new genus bears a considerable resemblance (*e.g.*, Melichar, 1898: plate XII, 1–3, 5–8), indicating the genus is described from Eocene material as well as its likely systematic affiliation with *Sassula*.

Diagnosis. *Eosassula* can be distinguished from other known fossil ‘nogodinid’ taxa by the following combination of characters in the forewing: RA posterior to the ScP+RA fork with a distinct, sigmoid ‘kink’; ScP+RA and RP with a common stem longer than BC, originating on BC; area between RA and RP distal to ScP-RA fork with a network of veinlets; CuA recurved, not straight. Furthermore, hind wing venation appears simple with no disto-anterior cross veins.

Eosassula szwedoi **sp. nov.**

(Fig. 1)

<http://zoobank.org/urn:lsid:zoobank.org:act:5184B29E-F424-4C1B-A09F-F837F08BC5D2>

Material. Holotype FUM N-14265a, b, part and counterpart. Forewings mostly complete, but cubitus posterior, postcubitus and anal veins completely missing. CuA missing basally and most distally. Basal wing region only partially preserved. Some veins missing as well. Hind wings poorly preserved, but costal and distal margins, and distal venation preserved in both wings. Head and part of thorax outlined, but poorly preserved. Legs and abdomen completely missing. Found in a “striated concretionary interval” concretion block between ash layers -29 and -24, Knudeklint Member, Fur Stolleklint, by René L. Sylvestersen in January 2017.

Etymology. An eponym in honor of the Polish entomologist and paleoentomologist, Jacek Szwed, who has worked on fossil Auchenorrhyncha for several decades.

Diagnosis. As for the genus.

Locality and horizon. Ypresian Fur Formation; northwestern Denmark.

Description. Holotype (Fig. 1). Total length (frons to right forewing apex), 13 mm; frons probably triangularly protruded; mesonotum with distinct lateral and medial carinae. Tegmina hyaline with darker pigmented apex and disto-apical margin; length *ca.* 11.2 mm; width *ca.* 6.2 mm. Broad pterostigma present, centered around termination of ScP. Costal margin curved at base, otherwise mostly straight; at least 21 transverse veinlets in costal area, one in left tegmina forked, otherwise simple; costal area at least 1.25× wider than costal cell. Basal cell poorly preserved, between 1.5 and 2 times longer than wide. ScP+R with a common stem beyond the basal cell, longer than cell, equal in length to MP stem. Postcostal cell with at least six

transverse veinlets, at least two beyond the ScP-RA fork; RA sigmoidal curved beyond the fork, but before further branching. Wing between RA and RP with network of veinlets beyond ScP-RA fork. Apical and subapical cells clearly longer than wide. Radial and medial cells with numerous transverse veinlets and secondary branching. CuA poorly preserved but apparently recurved towards the disto-caudal corner of the wing. No veins beyond CuA preserved. No row of aligned transverse veinlet distal of rp-mp, and mp-cua crossveins. Hind wings poorly preserved. Right hind wing *ca.* 6.4 mm; venation apparently simple with few crossveins.

Discussion. Placing the new fossil in Nogodinidae is obviously not unproblematic if the family is polyphyletic (Deng *et al.*, 2025). However, there has been no revised classification proposed of the taxa traditionally included in Nogodinidae, and we therefore use characters previously mentioned in the literature to suggest a tentative taxonomic placement for the new genus and species. Among the characters discussed by Shcherbakov (1981) and Petrulėvičius (2005), three wing venation characters are of particular interest here: 1) in the closely related family Ricaniidae the RA vein reaches the wing margin in the forewing at the antero-apical corner of the wing, whereas in ‘Nogodinidae’ and other related families it more basally; 2) in the ‘Nogodinidae’ subfamily Gastriniinae the ScP and R veins share a very long stem, and the MP vein branches distally in the forewing; 3) the subfamily Nogodininae is characterized by a short and broad basal cell in the forewing (Petrulėvičius, 2005). 1) As the RA reaches the wing margin basal to the corner in the new taxon, we can rule out that it belongs to Ricaniidae; 2) as both the ScP-R stem and the MP stem are relatively short in the new taxon, we can rule out a placement in Gastriniinae; 3) the basal cell in the new taxon is short and broad (roughly comparable to *Tainosia quisqueyae* Szwed & Stroiński, 2001—see Szwed & Stroiński (2001) for details), which indicates that it could be placed with taxa traditionally placed in Nogodininae. Furthermore, Shcherbakov (1981) lists the presence of a pterostigma in fully winged individuals as a potential recognition character for Nogodinidae. Stroiński & Szwed (2000) and Petrulėvičius (2005) both list the presence of a transverse row of aligned veinlets distal to the *r-m* and *m-cu* cross veins as diagnostic for the tribe Nogodinini within Nogodininae. The new taxon lacks these veinlets, which rules out a placement in that tribe. On the other hand, the new taxon bears a strong visual similarity to some taxa in the tribe Varcini Fennah 1978, such as *Varcia*, *Tarundia*, and—especially—*Sassula*, see *e.g.*, Melichar (1898: plate XII, 1–3, 5–8). Unfortunately, Fennah (1978) did not list any wing venation characters in his diagnosis of Varcini. It does, however, also share with these taxa the broad costa field that is broader than the costal cell. It probably also shares with *Sassula* that three (and not four) veins originate from the basal cell, but the basal part of CuA is missing from the fossil and its origin is therefore uncertain. Finally, it shares with *Sassula* and *Mindura* (also Varcini) the sigmoid curve distally on the RA vein (Petrulėvičius, 2005). According to Petrulėvičius (2005) none of these characters are unique, but their combination supports a placement either in or

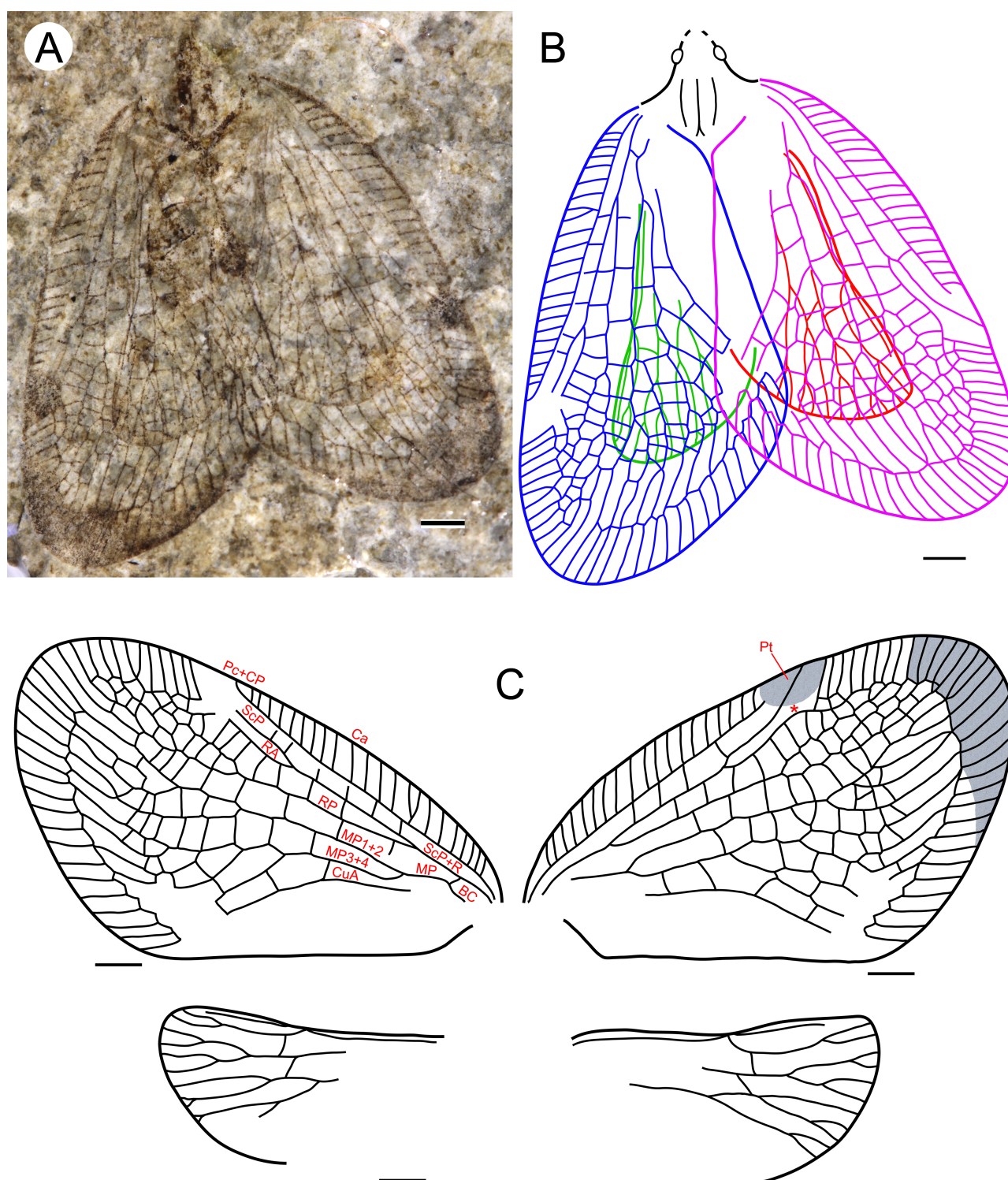


FIGURE 1. Illustration of *Eosassula szwedoi*. **A**, Photo of the holotype (FUM-N 14265), main part. **B**, Drawing of the holotype, based on both parts, with wings in different colours (blue: left forewing; magenta: right forewing; green: left hind wing; red: right hind wing). **C**, Drawing of wings folded out. Veins as listed in the text. Red asterisk marks sigmoid curve in *RA*. Pterostigma and dark pigmentation indicated in right forewing in **C**. Scale bars = 1 mm.

near the tribe Varciini. Interestingly, Varciini appears a sister to Ricaniidae in the phylogenomic analysis of Deng *et al.* (2025), and as the first fossil representative of Varciini, the new taxon thus represents a calibration point for the split between the two groups as well as for the divergence of the tribe. The new taxon is the second ‘nogonidid’ described from the Fur Formation,

and represents another example of a group from Paleogene Denmark that today is primarily tropical or subtropical in distribution, similar to the recently described apachyid Dermaptera, *Apachyus madseni* Simonsen & Rasmussen, 2024, whose current relatives are found in tropical Asia and Australia (Simonsen *et al.*, 2024).

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