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First records of species of Gelechioidae from Bitterfeld amber (Insecta, Lepidoptera) and notes on two gelechioid species from Baltic amber

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Abstract

Research on Lepidoptera from the Bitterfeld amber is still in a very early stage. The superfamily Gelechioidea is here recorded for the first time from this deposit. Descriptions of male individuals of two species are provided including parts of their external genitalia. The fossils differ from extant representatives of European Gelechioidea by several characters which justify the establishment of two new genera: *Barthelius pumilus* **gen. et sp. nov.** (family incertae sedis) and *Krutzschius nanarius* **gen. et sp. nov.** (family incertae sedis). The reasons of the unresolved family affiliation of both taxa are shortly discussed. Descriptions of males of two gelechioid species from Baltic amber, *Symmoca hoffeinsorum* **sp. nov.** and *Oegoconites rohdendorfi* Kusnetzov, 1941 provide additional taxonomic and biogeographical background.

Keywords

Bitterfeld and Baltic amber, new genera, new species descriptions, systematics, taxonomy

Introduction

In contrast to other insect orders, the research on Lepidoptera from Bitterfeld amber is still in a very early stage. In the survey of Rappsilber (2016) about the hitherto reported taxa the order Lepidoptera was mentioned as only six species from the family Micropterigidae. Of these, *Saxobatinca meyi* Skalski, 1995 is a nomen nudum and not available nomenclaturally. The Polish lepidopterist Andrzej W. Skalski was about to describe the species under this name on the basis of inclusions loaned from the Museum für Naturkunde, Berlin. His sudden and unexpected death left this, and other amber projects, unfinished (Nekrutenko 1997; Dobosz and Hadaś 1998). The loaned material was returned some years later and prompted the author to examine the fossils himself. Five species were identified tentatively as belonging to five different genera of Micropterigidae: genera A, B, C, D and E (sensu Mey 2013). In a subsequent publication these species were described and named (Mey 2019). Four genera were established to accommodate a total of 14 specimens: *Bitterfeldopterix* Mey 2019, *Klausnitzerellus* Mey, 2019, *Saxomicropterix* Mey, 2019 and *Wichardius* Mey 2019. These taxa are not known to occur in Baltic amber, which is further evidence for the unique and independent origin of Bitterfeld amber.

Specimens of Lepidoptera are not abundant among insects in Bitterfeld amber and are often overlooked because of their minute size, or are disregarded due to unfavourable position of the inclusions, which prevents precise determinations (Schumann and Wendt 1989). However, even in the first amber samples from the open coal mine Goitsche near Bitterfeld specimens of Lepidoptera were found (Barthel and Hetzer 1982). This material is now deposited in the amber collection of the Museum für Naturkunde, Berlin. During a recent inspection of this material, unidentified minute moths with expanded wings, a visible head

and genitalia came to attention and were withdrawn for further inspection. From this, the material was tentatively identified as members belonging to two families from the superfamily Gelechioidea. The description of these fossil species is the subject of the present article.

Descriptions of males of two other gelechioid species from Baltic amber, *Symmoca hoffeinsorum* sp. nov. and *Oegoconites rohdendorfi* Kusnetzov, 1941 are included in the article for providing additional taxonomic and biogeographical background.

Material and methods

The examined moths were cut out from a larger block of amber, ground and polished. The amber piece was embedded in a small block of polyester resin (dimensions 11 × 9 × 8 mm), which was afterwards polished (Fig. 1). The individuals were examined under a Leica MZ 12.5 dissecting microscope. Body parts were measured by means of an ocular grid. The morphological terminology and abbreviations of Gelechioidea follow Huemer and Karsholt (1999) and Gozmány (2008). Photographs were taken using a Leica stereomicroscope m 420 Apozoom in combination with a Canon EOS 80 D, and the Zerene Stacker software. Line drawings were produced by using a drawing tube attached to the microscope Leica MZ 12.5.

The holotypes of the new species are housed in the amber collection of the Museum für Naturkunde, Berlin. The deposition of some paratypes in other collections is indicated in the text.

Systematic Palaeontology

Bitterfeld amber
Superfamily Gelechioidea
Family incertae sedis

Barthelius gen. nov.

https://zoobank.org/5D37F2ED-C790-4D18-B786-C50749CC066D

Gender. Masculine.

Type species. *B. pumilus* sp. nov.

Etymology. The name is dedicated to the memory of Prof. Manfred Barthel, esteemed colleague, palaeobotanist and former director of the Museum für Naturkunde, Berlin. An obituary was published by Rößler (2019).

Diagnosis. The assignment of *Barthelius* gen. nov. to Gelechioidea is based on (1) the heteroneurous wing venation, (2) up-curved labial palpi, (3) maxillary palpi absent and (4) scaled proboscis. The new genus has a long, dorso-ventrally depressed and apically triangular-shaped uncus with a sclerotized tip. The apical part of the uncus bears some resemblance with genera of the family Gelechiidae, (Gelechiinae, Litini). This character together with the strongly reduced adult size, posteroventral position of compound eyes and the smooth head, with appressed, lamellar scales on vertex and frons are considered diagnostic for *Barthelius* gen. nov.

Barthelius pumilus sp. nov.

https://zoobank.org/E2CA670C-5F6C-4CDC-9573-5B5FF1D0AAC3

Figs 1–9

Type. Holotype • ♂, Bitterfeld amber, Serie 11, 1987, Museum für Naturkunde, Berlin, inventory number: MB.I. 17.488; Paratype • ♂, coll. Goitzsche Bernstein GmbH, inventory number: T-I-SM-43.

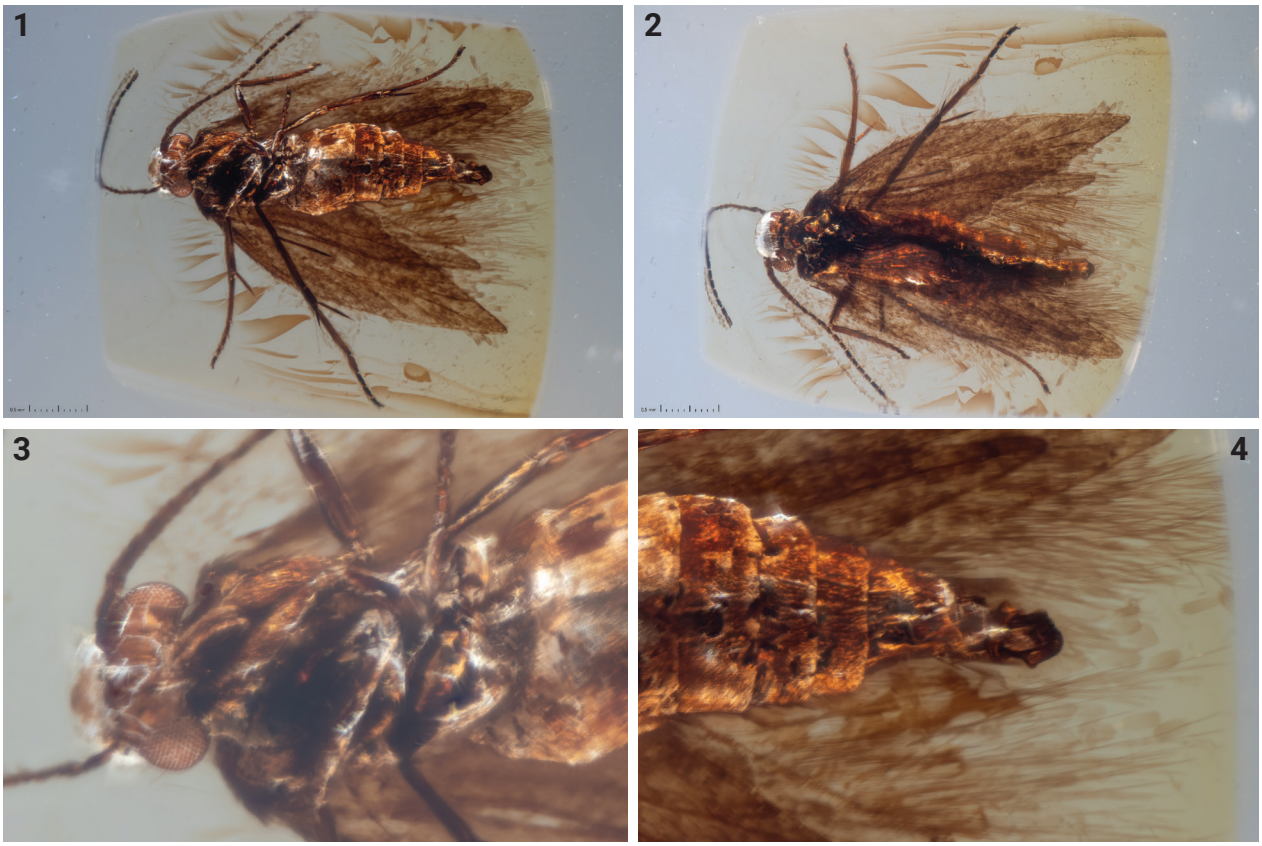
Etymology. The name is derived from the Latin “pumilus”, minute, referring to the tiny size of the species.

Preservation. The individual is nearly completely preserved except missing left hindleg and tip of right antenna. Left fore- and hindwings are overlapping, right wings partly overlapping. Ventral side of head and abdomen sufficiently visible. From the male genitalia only the terminal part of uncus is visible. The small amber piece with the inclusion is embedded in a block of polyester resin (Figs 1, 2).

Description. Imago, male (Figs 1–9): Small adult moth with 2.25 mm wing length, and 2.1 mm body length wing expanse approximately 5.0 mm. Wings densely covered by scales not forming a pattern.

Head in ventro-frontal view (Fig. 3) with vertically enlarged vertex covered by appressed, laminate, shining scales, appressed scales also on frons; eyes small, in ventro-lateral position, interocular index 0.3; ocelli and chaetosema absent; antenna filiform, weakly scaled, about half the length of forewing, scape and pedicel each longer than following segments, 18 flagellomeres present, somewhat longer than wide (Fig. 5); anterior tentorial pits large. Mandibles, pilifers and maxillary palpi not visible (probably vestigial), proboscis long, two to three times as long as height of head capsule, scaled, with both galea halves separate from each other and curved ventro-caudad, labial palpi thin, moderately diverging and slightly up-curved, scaled, two segments visible, terminal segment pointed apically.

Thorax slightly wider than head, scaled; fore- and hindwings lanceolate, wing index 0.34 (forewing) and 0.21 (hindwing). Legs slender, small epiphysis on middle of foreleg present, two spurs on median tibia and four spurs on hind tibia, medial pair on hind tibia well before middle, spurs extremely acute at tips and covered by fine hairs; length of basal tarsomere nearly as long as remaining tarsal segments together, all tarsal segments with apical pair of short spines ventrally (Fig. 6). Venation heteroneurous (Fig. 7): forewing with four radial veins and a single, unbranched media present, Cu1a and Cu1b present, underside of Sc with short retinaculum; hindwing venation reduced, with one radial and one medial vein present; one frenular bristle present which hooks behind some scales forming a retinaculum at ventral base of forewing Sc; cover scales on forewings elongate, deeply serrate at apical margin, ground scales smaller, weakly serrate apically (Fig. 8).



Figures 1–4. *Barthelius pumilus* gen. et sp. nov., male holotype: **1.** Ventral view; **2.** Dorsal view; **3.** Head, ventral view; **4.** Abdomen, ventral view.

Abdomen sternum V with pair of small, indistinct protuberances, sternum VII longer than preceding sterna, apical margins with long scales covering uncus partially on lateral and dorsal sides.

Male genitalia (Figs 4, 9): segment VIII tubular, not concealed by sternum VII ventrally; base of segment IX partially covered by preceding segment, not disclosing valvae, elongate uncus dorso-ventrally depressed, 0.15 mm wide, with rounded apical margin and protruding lateral sides forming a triangular-shaped apex; apical margin of uncus with recurved, medial hook and with short denticules and longer bristles (= sensilla trichodea).

Remarks. When identification keys for extant taxa (e. g. Carter and Kristensen 1998; Heppner 1998; Holloway et al. 2001) are consulted to resolve the taxonomic placement of the new fossil taxon, *Barthelius* gen. nov. always keys out at Gelechioidea. The shape of the male uncus, which resembles species in the tribe Litini of Gelechiidae was suggestive to assign the new genus to Gelechiidae. However, the uncus is only partly visible and makes the significance of this character unclear. The important synapomorphy of Gelechiidae, the angular hindwing and its emarginated termen below apex, is absent. The hindwings are lanceolate, which is unusual for Gelechiidae. In addition, the reduced wing venation and the small size of the species are further unusual characters in Gelechiidae not supporting a placement in this family.

The systematic position of the new genus within Gelechioidea is unclear. With about 5 mm wingspan the new species and genus belong to the smallest included in Gelechioidea. The new genus has a forewing venation, similar to other gelechioid families like Coleophoridae, Elachistidae or Cosmopterigidae. Unfortunately, the hind wing venation is hardly visible and only one R and one M vein are discernible, representing a reduced stage. In the absence of any other derived, discernible characters the new genus cannot be assigned to any of the many gelechioid families at present.

The superfamily Gelechioidea is represented in Baltic amber by a species-rich and diverse fossil record for many families, e.g. Autostichidae, Coleophoridae, Cosmopterigidae, Blastobasidae, Elachistidae, Momphidae, Oecophoridae (Sohn et al. 2012). In the Bitterfeld amber as similar diversity can be expected to occur.

Family incertae sedis

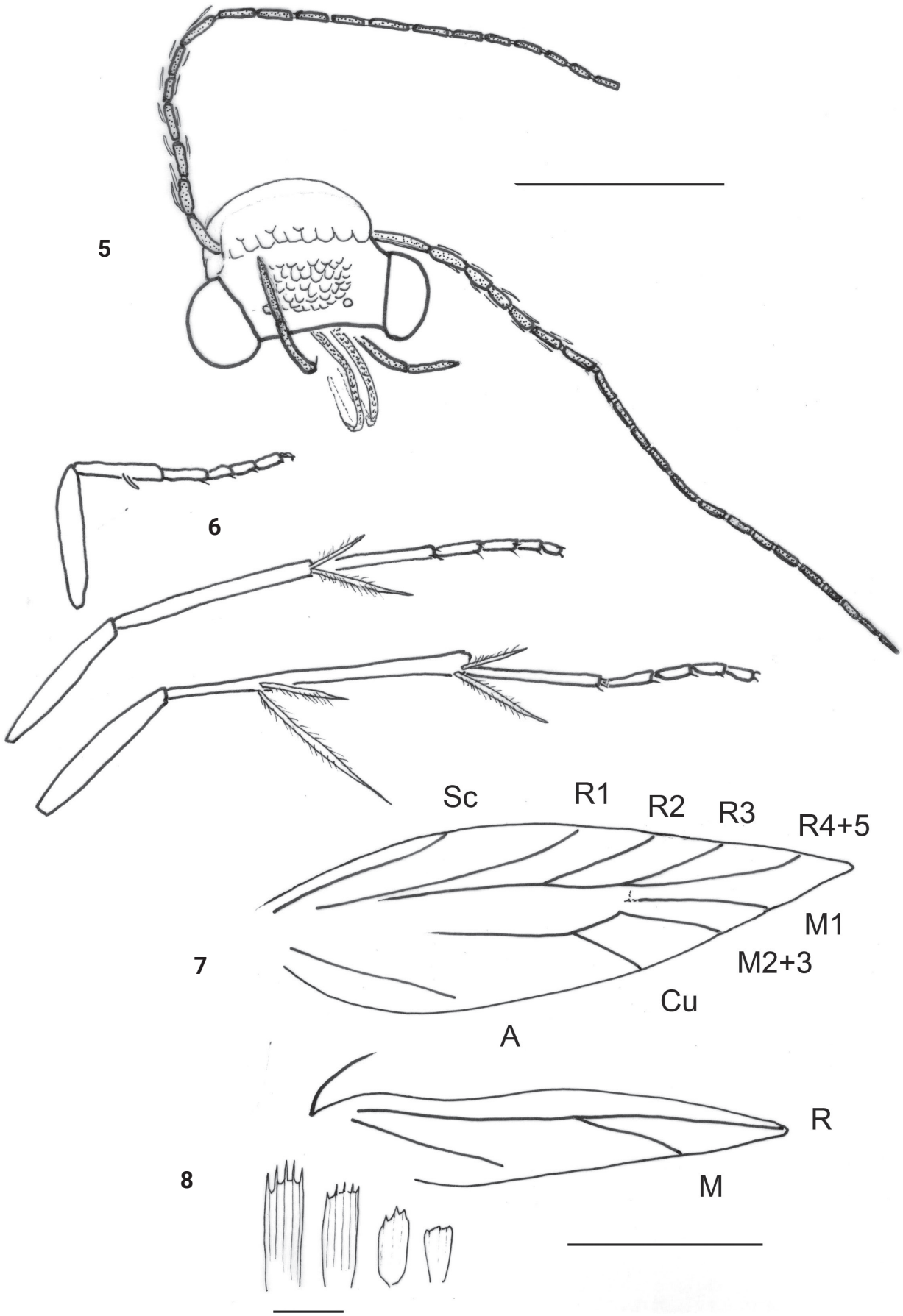
Krutzschius gen. nov.

https://zoobank.org/D6D61536-1F84-43E0-A7E1-8834A5BEF9C0

Gender. Masculine.

Type species. *K. nanarius* sp. nov.

Etymology. The name is dedicated to the memory of Prof. Wilfried Krutzsch, esteemed colleague, palaeo-palynologist



Figures 5–8. *Barthelius pumilus* gen. et sp. nov.: **5.** Head, frontal view (scale: 0.5 mm); **6.** Legs; **7.** Fore- and hindwing venation (scale: 0.5 mm); **8.** Forewing scales.

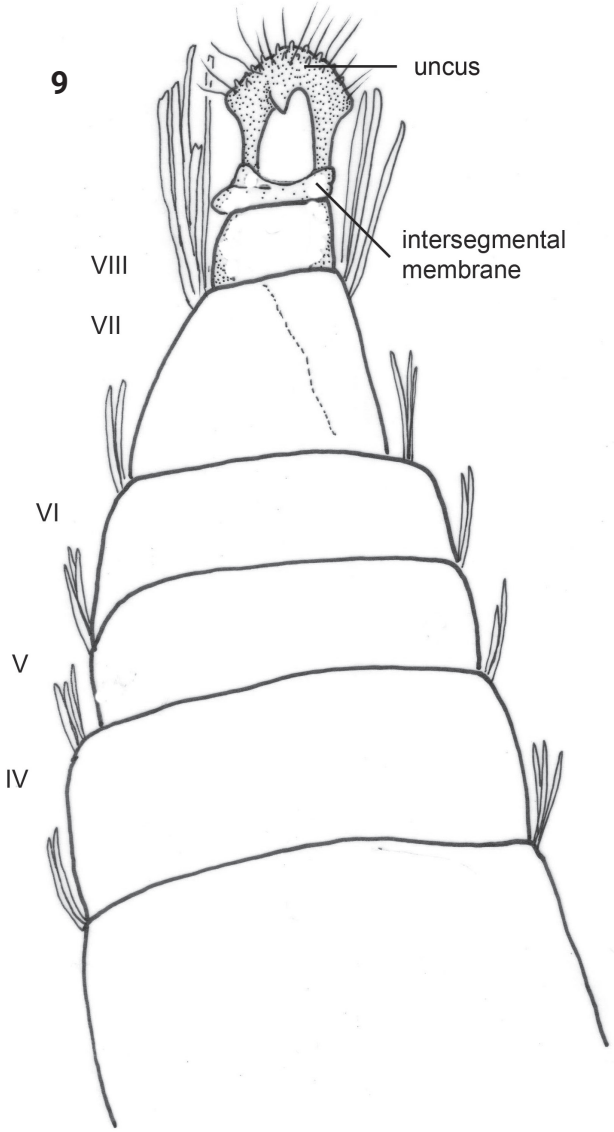


Figure 9. *Barthelius pumilus* gen. et sp. nov., male genitalia, ventral view.

and one of the first professional researchers examining Bitterfeld amber (see Daber et al. 1993).

Diagnosis. The assignment of *Krutzschius* gen. nov. to Gelechioidea is based on (1) the heteroneurous wing venation, (2) up-curved labial palpi, (3) absent maxillary palpi and (4) scaled proboscis. In a first attempt to assign the new genus to one of the gelechioid families, the Autostichidae were identified as possible candidate, based on the visible parts of the male genitalia with elongate valvae, spine-like sacculus with dorsally curved apex, and paw-like tip of uncus. This character pattern occurs in many species of extant genera of Autostichidae (see Gozmány 2008: figs 71–74, 89–91, 132–139, 178, 194). However, the wings of these genera differ in shape and some venational aspects from *Krutzschius* gen. nov. The wings of *K. nanarius* sp. nov. are more lanceolate than in most genera of the family, but the wing venation with four R and three M veins in the forewing and with the apical fork formed by R+RS and M1 in the hindwing agree with many genera of Autostichidae.

Krutzschius nanarius sp. nov.

https://zoobank.org/C4BED873-A879-4B73-BD19-0CEA4BECE221

Figs 10–17

Type. • Holotype ♂ and Paratype ♂, Bitterfeld amber, Goitsche, Serie 11, 1987, Museum für Naturkunde, Berlin, inventory number: MB.I. 17.489 und MB.I. 17.490 (paratype).

• 1 ♂ Paratype, Bitterfeld amber, Goitsche, Bernstein GmbH, inventory number: T-I-SM-39; 1 ♀ Paratype, same locality, Bernstein GmbH, inventory number: Rapp-SM 2.

Preservation. The holotype is completely preserved. The left wings are moderately separated and allow the study of venation. Right fore- and hindwings are overlapping. The male paratype held the wings overlapping with apical third of right forewing cut off. The small amber pieces with the inclusion are embedded each in a block of polyester resin, as well as the female paratype (Rapp-SM 2). The male paratype T-I-SM-39 is contained in a small, flat amber piece.

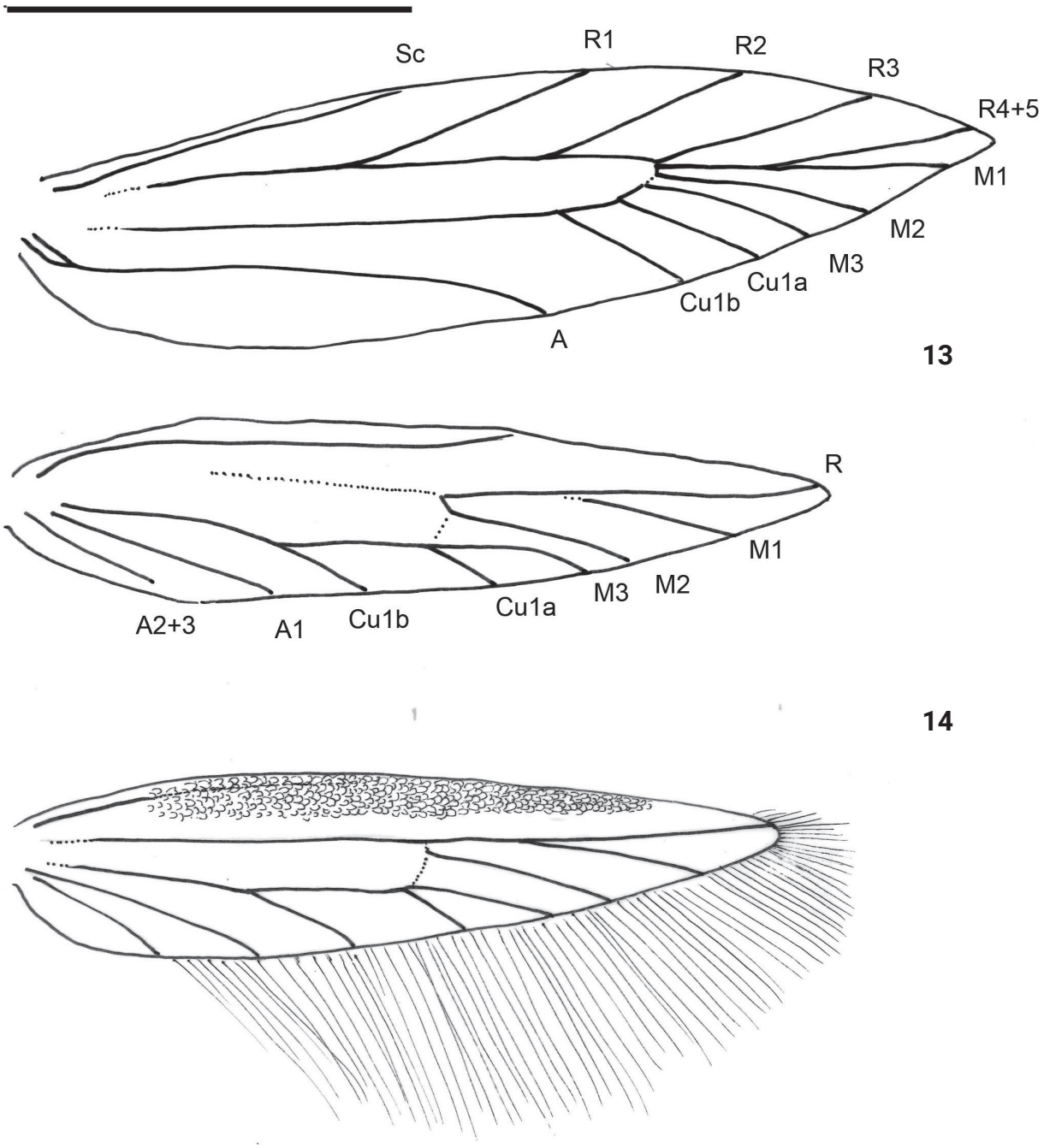
Description. (Holotype), male (Figs 10–12): Small adult moth with 2.2–2.4 mm wing length, and 2.1 mm body length, wing expanse approximately 5.2 mm. Forewings densely covered by scales not forming a pattern, hindwings with a coverage of scales in the subcostal area (Figs 13, 14). Head in frontal view (Fig. 15) with frons and vertex covered by appressed, laminate scales; eyes small, in ventro-lateral position, interocular index 0.3; ocelli and chaetosema absent; antenna filiform, nearly as long as the length of forewing, flagellomeres densely covered by whorls of scales, scape short, without pecten, pedicel as long as following segments, 31 flagellomeres present, becoming somewhat longer than wide towards tip; pilifers and maxillary palpi not visible (probably vestigial), proboscis long, scaled basally, labial palpi thin, not diverging and slightly up-curved (but embedded in drooping position), scaled, two segments visible, terminal segment shorter than preceding segment, pointed apically.

Thorax slightly wider than head, scaled; fore- and hindwings lanceolate, wing index 0.26 (forewing) and 0.22 (hindwing). Venation heteroneurous (Figs 13, 14): forewing with four radial veins, M1 connate with R4+5, Cu1a and Cu1b present, hindwing venation reduced, with one radial and three medial veins present; legs slender, small epiphysis beyond middle of foreleg present, two spurs on median tibia and four spurs on hind tibia, medial pair on hind tibia well before middle, inner spurs longer; length of basal tarsomere as long as remaining tarsal segments together, all tarsal segments with apical pair of short spines ventrally.

Male genitalia (Fig. 16): base of segment IX narrow, but partially covered by preceding segment, underside of paw-like tip of uncus visible between valvae, sacculus of valva as a broad spine, with apex acute and curved dorsad, valva elongate, truncate at apex.

Female genitalia (Fig. 17): segment VIII elongate, tubular; terminal part of oviscapt visible showing long papillae anales with short hairs.

Figures 10–12. *Krutzschius nanarius* sp. nov.: **10.** Dorsal view; **11.** Ventral view; **12.** Head, ventro-frontal view.



Figures 13, 14. *Krutzschius nanarius* sp. nov.: **13.** Venation (scale: 1 mm); **14.** Hindwing with scaled subcostal area.

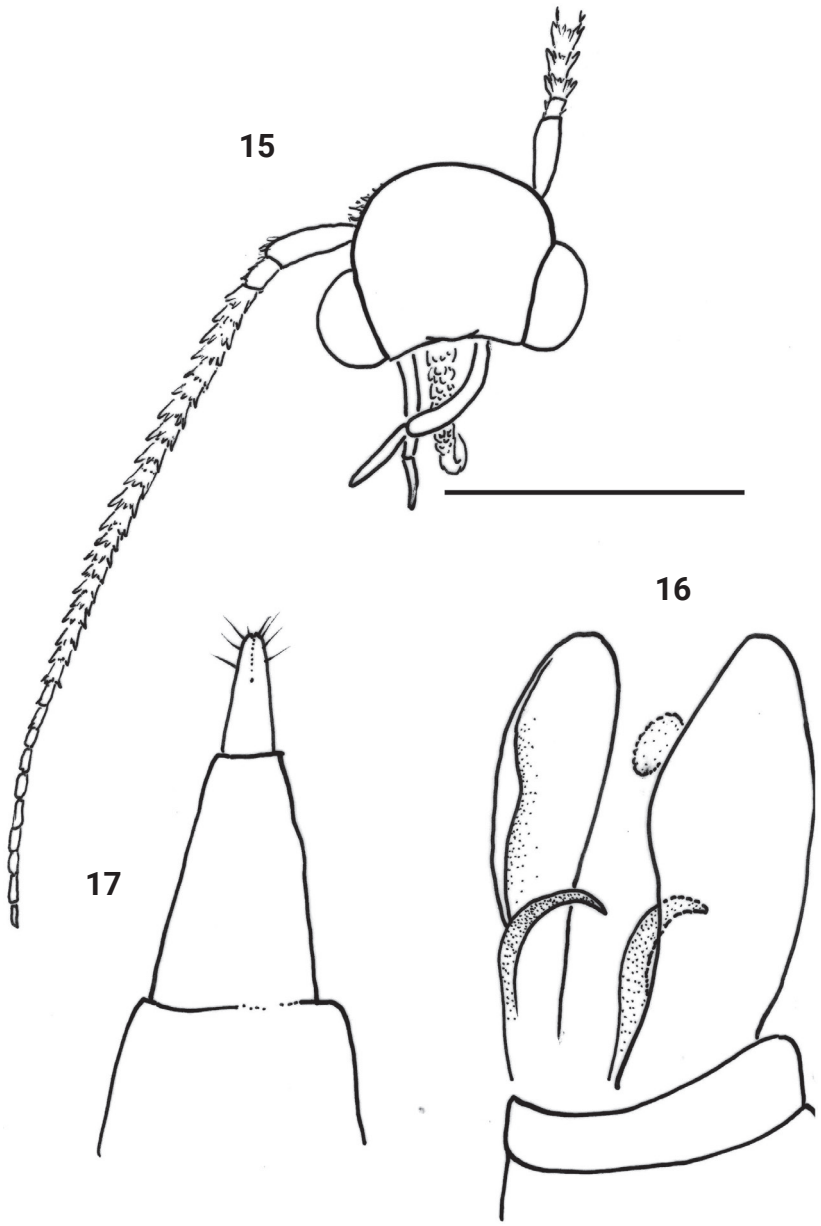
Remarks. The systematic position of *Krutzschius* gen. nov. within Gelechioidea remains unresolved, due to the absence of clear symplesiomorphies. Concerning male genitalia the new species resembles species of Autostichidae.

The family Autostichidae is known from Baltic amber via *Microsymmocites* Skalski, 1977 and the questionably included genera *Symmocites* Kusnezov, 1941 and *Oegoconites* Kusnezov, 1941. By comparing their original descriptions with the characters found in *Krutzschius* gen. nov., the new genus is clearly distinct from these named taxa. However, Skalski (1977: fig. 7) illustrated the wing venation of an unnamed species which he thought should belong to Heliodinidae. The species has remained undescribed. Interestingly, the venation is very similar to that of *Krutzschius* gen. nov., rather than to any species of Heliodinidae. Since no other morphological traits were communicated, the species cannot be identified even at the family level.

Baltic amber
Superfamily Gelechioidea
Autostichidae, Symmocinae
***Symmoca* Hübner, 1825**

***Symmoca hoffeinsorum* sp. nov.**
https://zoobank.org/DB31CD5B-597B-4170-99AB-02D1D7C9BC68
Figs 18–21

Material. • 1 ♂, Baltic amber, coll. C. & H. Hoffeins (Hamburg), Nr. 124/1.



Figures 15–17. *Krutzschius nanarius* sp. nov.: **15.** Head, ventro-frontal; **16.** Male genitalia, ventro-lateral; **17.** Female oviscapt, ventral.

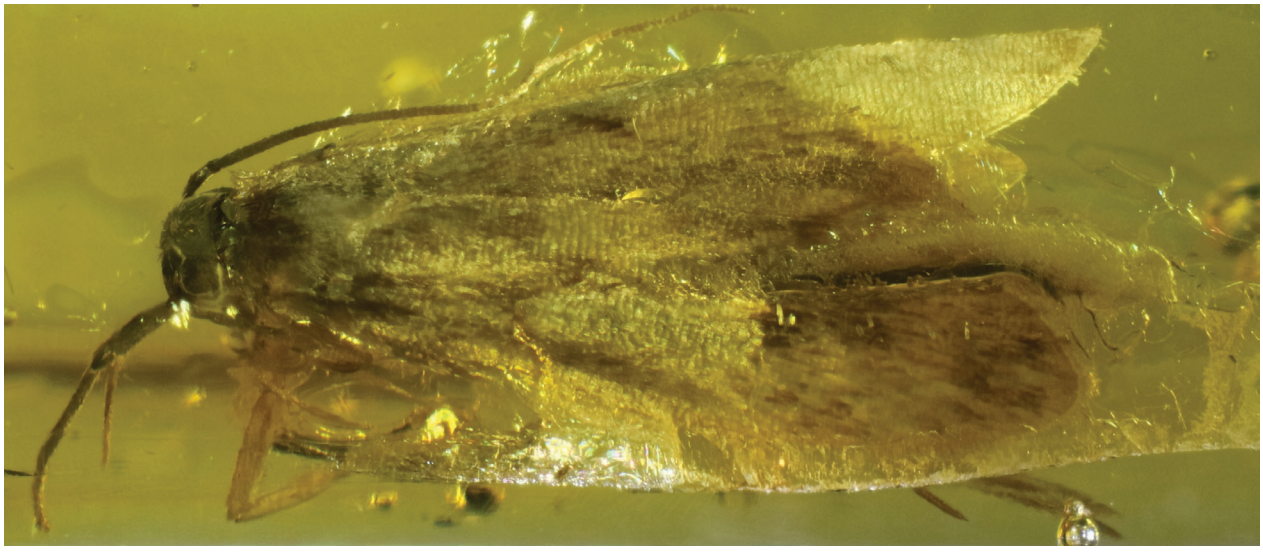


Figure 18. *Symmoca* spec., adult moth, dorsal.

Preservation. The holotype is completely preserved. The small amber piece with the inclusion is embedded in a block of polyester resin.

Etymology. The new species is named in honour of Christel and Hans Werner Hoffeins for their untiring interest, occupation and research of insects of Baltic amber.

Description. Male (Fig. 18): Small moth with 5.1 mm wing length. Labial palpi long and upcurved, terminal segment longer than second segment, acute at apex. Antenna more than half the length of the forewing, scape without pecten. Epiphysis present in middle of foreleg tibia, first tarsomere as long as remaining tarsal segments together, preapical spurs on hindleg in the middle of tibia, with short hairs on inner side, spur formula 0.2.4 (Fig. 19). Wing venation as in *Symmoca*, with R4 and R5 stalked in forewing, fork as long as its stalk, running to costal margin, three medial veins present (see Gozmány 2008).

Male genitalia (Figs 20, 21): Uncus with paw-like apex, gnathos hook-like, curved distad only in apical third. Valva elongate, tapering towards rounded apex, sacculus tightly attached to ventral margin of valva, appendix nearly parallel to valva, longer than half length of valva.

Remarks. This is the first documented individual of the family in Baltic amber, exhibiting clearly visible male genitalia, which are in agreement with many species of extant *Symmoca*, depicted in Gozmány (2008). The species it described and named, because comparisons with the original drawings of the fossil genus *Symmocites* Kusnezov, 1941 revealed substantial differences in wing venation. The forewings of *Symmoca* have five radial and three medial veins in contrast to *Symmocites*, with four radial and one medial vein only.

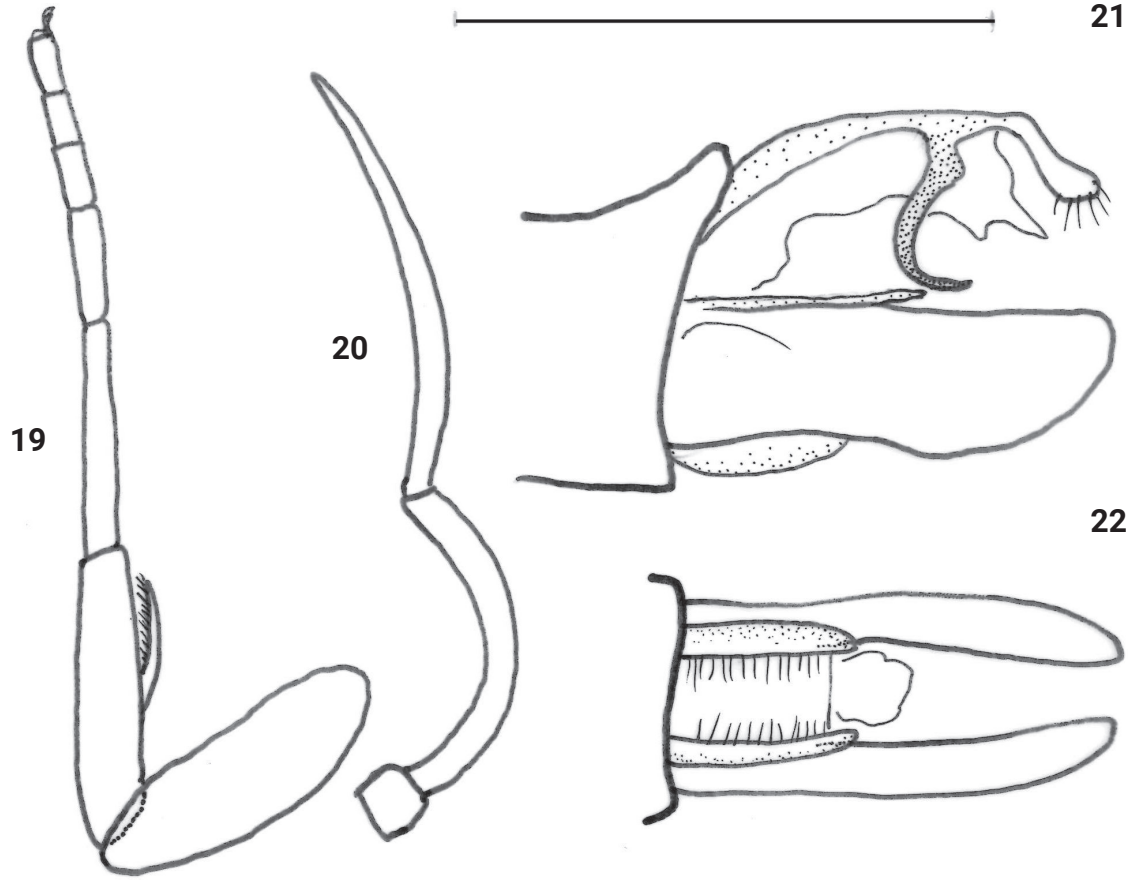
Oegoconites borisjaki Kusnetzov, 1941

Figs 22–24

Material. • 1 ♂, Baltic amber, coll. C. & H. Hoffeins (Hamburg), Nr. 1137/5.

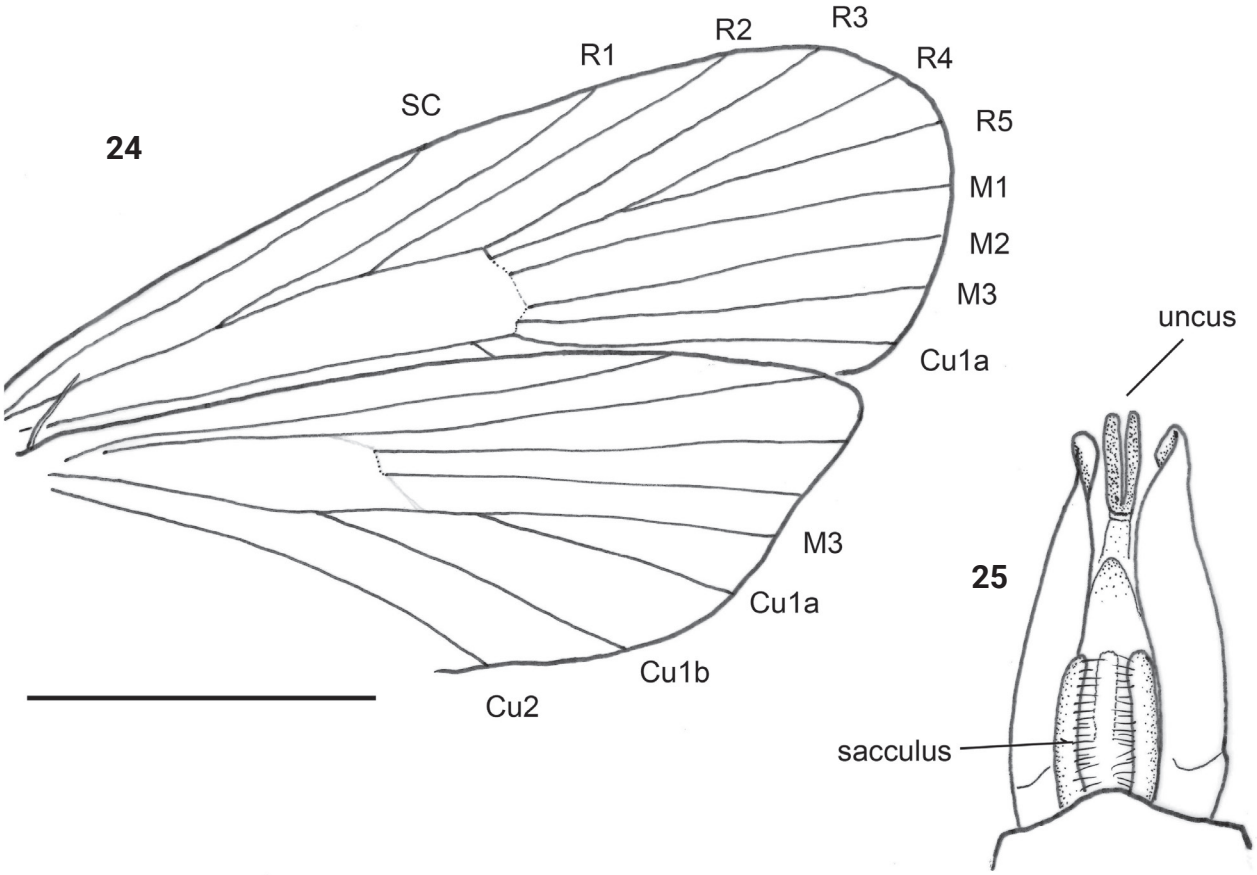
Preservation. The male individual is completely preserved. The right wings are somewhat spread. Only the ventral side of the moth is visible (Fig. 22).

Remarks. The individual is here associated with *O. borisjaki*, based on a comparison with the original drawings. However, originally included in the family Gelechiidae and later transferred to Oecophoridae, the current placement of the genus in Autostichidae (Sohn et al. 2012) is apparently incorrect, at least with respect to wing venation (Fig. 23). The genus belongs to the depressariine complex of taxa, which encompasses several families today. With the available characters at hand, it is not possible to determine the correct systematic position within this complex. For the time being, the genus is left in Autostichidae, until new material and new characters are found that would facilitate a formal transfer of *Oegoconites borisjaki* to another family.



Figures 19–22. *Symmoca* sp., **19.** Foreleg with epiphysis; **20.** Labial palpus; **21.** Male genitalia, lateral (scale: 0.5 mm); **22.** Male genitalia, ventral.

Figure 23. *Oegoconites borisjaki*, male, ventral view.



Figures 24, 25. *Oegoconites borisjaki*, venation (scale: 0.2 mm); **25.** Male genitalia, ventral view.

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