

Laurasian ancestors and “Gondwanan” descendants of Rotoitidae (Hymenoptera: Chalcidoidea): What a review of Late Cretaceous *Baeomorpha* revealed



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ABSTRACT

Baeomorphinae Yoshimoto, 1975, based on *Baeomorpha* Brues, 1937, is transferred from Tetracampidae Förster, 1856 and recognized as a junior synonym of Rotoitidae Bouček and Noyes, 1987 (Hymenoptera: Chalcidoidea) **syn. nov.** following ICZN (1999) article 35.5. Inclusions in Taimyr amber (84–100 Ma) assigned to *Baeomorpha* are reviewed and the following eleven new species, all of Gumovsky, are described: *B. avamica* **sp. nov.**, *B. baikurensis* **sp. nov.**, *B. bianellus* **sp. nov.**, *B. caeleps* **sp. nov.**, *B. gracilis* **sp. nov.**, *B. ingens* **sp. nov.**, *B. quattorduo* **sp. nov.**, *B. quattoruno* **sp. nov.**, *B. popovi* **sp. nov.**, *B. yantardakh* **sp. nov.**, and *B. zherikhini* **sp. nov.** The recognized species are differentiated in separate keys to females and males and illustrated through microphotography. Two of four previously described *Baeomorpha* species from Campanian Canadian amber are synonymized: *B. distincta* Yoshimoto and *B. elongata* Yoshimoto under *B. ovata* Yoshimoto (**syn. nov.**). One enigmatic rotoitid inclusion, which differs from *Baeomorpha* species in the possession of very short stigmal vein, is described as *Taimyromorpha pusilla* Gumovsky **gen. et sp. nov.** Inclusions containing specimens identified as *Baeomorpha* and *Taimyromorpha* are found in amber from Taimyr and Canada that originated from Laurasia, not Gondwana. Two Realms are newly proposed to recognize different Cretaceous faunal elements, a more northern *Baeomorpha* Realm that is characterized by a temperate or warm temperate climate and very abundant aphid fossils, and the Isoptera Realm, an opposing southward territory with a warmer climate and common termite but rare aphid fossils. The newly described fossils indicate the southern hemisphere distribution of extant Rotoitidae is relictual with the pattern observed being formed at least in part by extinction events, though distributions of the only two extant rotoitid genera, *Rotoita* Bouček and Noyes, 1987 (New Zealand) and *Chiloe* Gibson and Huber, 2000 (small area in the southern Chile) may have been more extensive in the past. Both of known regions of extant Rotoitidae have highly suppressed ant faunas, which may suggest that their survival there depended on low biocenotic pressure by ants, perhaps as low as is hypothesized for the Late Cretaceous. The Canadian amber genera *Distylopus* Yoshimoto, 1975 (Distylopinae) and *Boucekytus* Yoshimoto, 1975 (Boucekytinae) are excluded from Tetracampidae and regarded as Chalcidoidea *incertae sedis*.

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1. Introduction

Brues (1937) described *Baeomorpha* Brues, 1937 with a single species, *B. dubitata* Brues, 1937 within the family Scelionidae (currently the family Platygasteridae: Murphy et al., 2007; but see

McKellar and Engel, 2012) from Upper Cretaceous Canadian amber. The genus was later transferred to Tetracampidae (as the type of the Baeomorphinae Yoshimoto, 1975) by Yoshimoto (1975), who also described three new *Baeomorpha* species and two other fossil tetracampid genera: *Distylopus* Yoshimoto, 1975 (in the subfamily Distylopinae) and *Boucekytus* Yoshimoto, 1975 (in the subfamily Boucekytinae).

The placement of *Baeomorpha* in Tetracampidae was not properly substantiated, but largely based on the concept that

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“Tetracampidae are intermediate between Eulophidae and Pteromalidae” (Yoshimoto, 1975) and that the legs of males of *Baeomorpha* were recorded as having 4-segmented tarsi like males of tetracampines. Gumovsky and Perkovsky (2005) suggested that placement of *Baeomorpha* in Tetracampidae was doubtful as part of discussion of the structure of the family.

The initial purpose of this paper was to review Taimyr amber inclusions (Russia, Siberia, Taimyr Peninsula: Upper Cretaceous, 84–100 Ma) that were preliminary identified as representatives of *Baeomorpha*. However, when study revealed that *Baeomorpha* is a member of Rotoitidae rather than Tetracampidae we undertook a more comprehensive review. Prior to our discovery of the proper relationships of *Baeomorpha*, Rotoitidae consisted of just two extant genera, *Rotoita* Bouček and Noyes (1987) from New Zealand and *Chiloe* Gibson and Huber, 2000 mostly from Chiloe Island (Chile), which suggested a Gondwanan origin for the family.

2. Material and methods

The Taimyr amber pieces reported in this paper were collected during expeditions of the Paleontological Institute of the Russian Academy of Sciences (Moscow, PIN) in 1970–1977 and 2012, and are deposited in the collection of this institution. Comparative analyses of hymenopteran assemblages of Taimyr and Canadian ambers were provided earlier in corresponding reviews by Rasnitsyn et al. (2016) and McKellar and Engel (2012), respectively. Stratigraphical data for examined amberiferous localities (Fig. 1) are listed in Table 1. Comparative material of Canadian amber

hymenopterans (from Cedar Lake in Manitoba and Medicine Hat in Alberta), in particular the specimens studied and described by Carl Yoshimoto, were obtained from the Canadian National Collection of Insects, Arachnids and Nematodes (CNC, Ottawa, ON). Data on the other Canadian amber specimens described by C. Yoshimoto were obtained from the Royal Ontario Museum (ROM, Toronto, ON) and the Museum of Comparative Zoology, Harvard University (MCZ, Cambridge, MA, USA). The pictures of MCZ specimens were taken with a Leica MZ16 stereomicroscope and with an Olympus BH-2 microscope by Ricardo Perez de la Fuente, and kindly provided for the authors because personal examination of the specimens was not possible.

Scanning electron microscopy (SEM) of extant Rotoitidae was carried out in the Mineralogy Department of the Natural History Museum (BMNH, London, UK) using ISI ABT-55 low-vacuum and LEO 1455VP microscopes, which allow imaging of uncoated specimens. Imaging with light microscopy was conducted in the Schmalhausen Institute of Zoology NAS of Ukraine (Kiev, Ukraine, SIZK) using an upright microscope Olympus CX-41, with the images stacked using Helicon Focus Pro software. If the surface of a piece of amber was uneven, the piece was put under water to fill the gaps with water as a medium and covered with cover slip before imaging.

Morphological terminology largely follows that of Gibson et al. (1997) and Heraty et al. (2013). The “funicle” is considered as that part of the flagellum between the anellus or anelli (the proximal most ring-like or distinctly smaller flagellar segments) and the clava (Gibson et al., 1997). The following abbreviations are used:

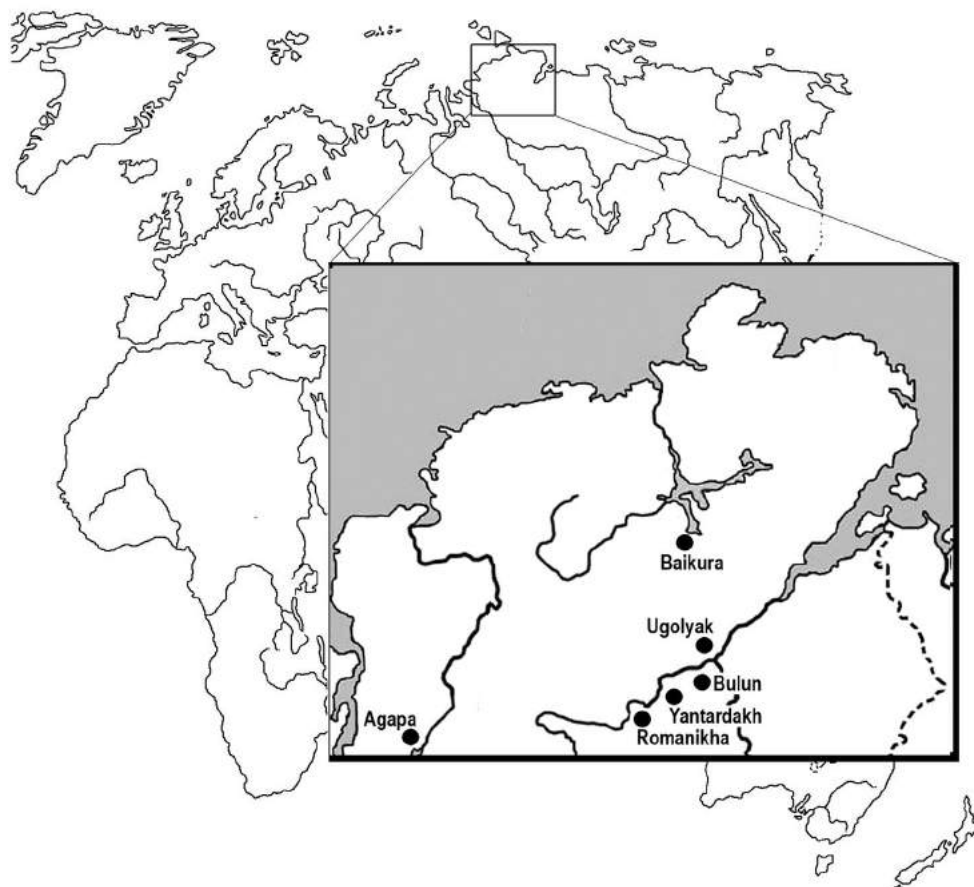


Fig. 1. Yantardakh, Baikura, Agapa, Romanikha, Ugolyak, Bulun localities (Russian Federation, Taimyr), the origin sites of amber inclusions discussed below, marked on the map.

Table 1
Localities with amber rotoitids.

Origin/Name	Locality	Horizon, formation	Stage	References
Canada	Cedar Lake (Manitoba), Medicine Hat (Alberta)	Upper Cretaceous, Foremost Formation	Campanian	Rasnitsyn et al. (2016)
Baikura (Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: Taimyr Peninsula: south bank of the Taimyr Lake, near southern tip of the Baikura-Neru Bay	middle Cretaceous, ? Ognivka Formation	upper Albian –? lower Cenomanian	Saks et al. (1959); Perkovsky and Wegierek (2017a)
Yantardakh (Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: Taimyr Peninsula: right bank of the Maimecha River 3 km upstream of its confluence with the Kheta River (a left source of the Khatanga River), Yantardakh Hill	Upper Cretaceous, Kheta Formation	upper Santonian	Rasnitsyn et al. (2016)
Romanikha (Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: Taimyr Peninsula, the right bank of the river Romanikha, 10 km above its mouth	Upper Cretaceous, Kheta Formation	upper Santonian	Rasnitsyn et al. (2016)
Nizhnaya Agapa (Agapa, Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: Taimyr Peninsula, Ust'-Enisei Region, right bank of the Nizhnaya Agapa River, 40 km downstream of its source (Ladannakh Lake), Agapa elevation	Upper Cretaceous, Dolgan Formation	? upper Cenomanian	Rasnitsyn et al. (2016)
Ugolyak (Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: Taimyr Peninsula, left bank of the Severny Ugolyak River, 9.5 km upstream from its mouth (Ugolyak locality), a tributary of the Ugolyak River	Upper Cretaceous, Kheta Formation	upper Santonian	Rasnitsyn et al. (2016)
Bulun (Fig. 1)	Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District: middle current of the Bulun river (right-hand tributary of the Kheta River), 18 km south from the trading post Novaya	Upper Cretaceous, Kheta Formation	upper Santonian	Rasnitsyn et al. (2016)

F1–F6, funicular segments; CL1–6, claval segments; OOL, oculo-ocellar distance; POL, post-ocellar distance; fore wing veins: BV, basal; MV, marginal; PMV, postmarginal; STV, stigmal. The abbreviation PSM is used for the distance between the junction point of the stigmal vein with the marginal vein and that of the basal vein with the submarginal vein (Fig. 2). The term “mesosoma” is a

complex of the thorax and propodeum, and “metasoma” is a complex of the petiole and gaster (Gibson et al., 1997; Heraty et al., 2013). The term “body” means head, meso- and metasoma combined.

Species concepts proposed below are based on estimated similar measurements among specimens and assumed range of

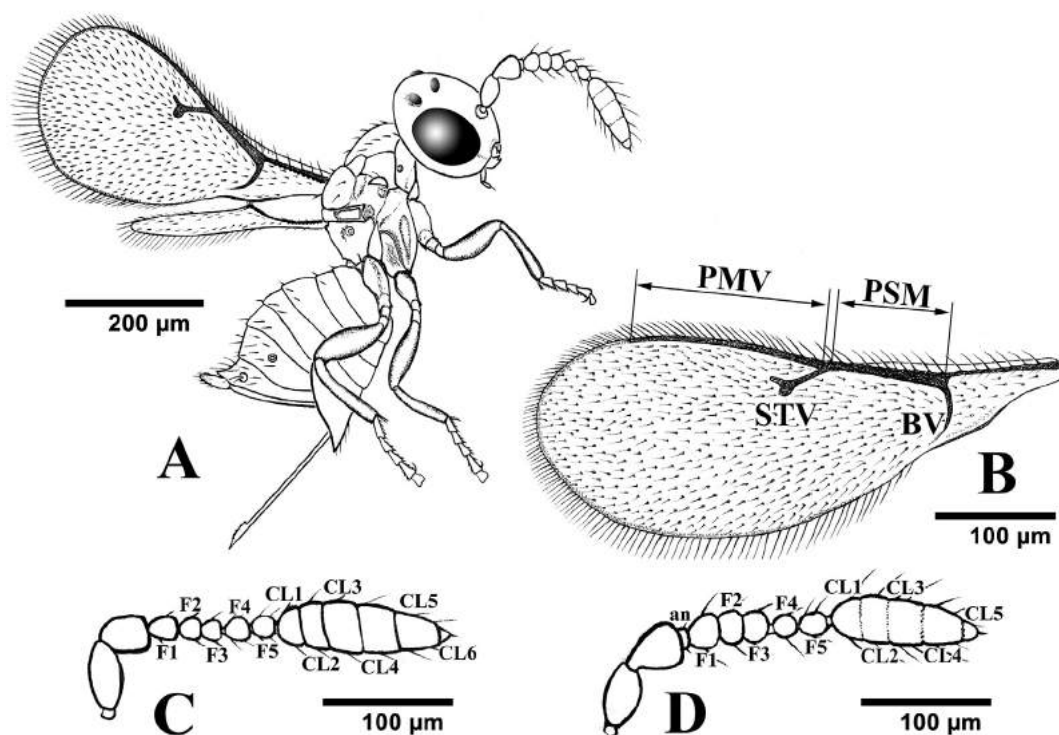


Fig. 2. Line drawings of *Baeomorpha*. (A) General habitus (combined from appearance of different species). (B) Fore wing with labeled veins. (C, D) Different types of antennal structure: (C) without anelli, with all funicular free and 6-segmented clava; (D) with 1 anellus, F1–F3 more closely attached than F4 and F5 and 5-segmented clava. Abbreviations: see ‘Materials and methods’ section.

morphological variation. The possible impact of preservation of specimens within fossil resins that affect morphology of the specimens was also taken into consideration. Since not all features can be seen in all fossil inclusions, certain parts of description were omitted if corresponding body parts were not seen in actual specimens.

Assigning inclusions to species was challenging because their state of preservation varies, specimens display different orientations, and they originate from different even though close localities. Therefore, we formally describe species and provide names only for specimens with most body parts discernible in order to facilitate future association of new finds with the species described herein. The amber inclusions that are characterized by rather poor

preservation and condition are listed with their registration numbers, and discussed separately in Table 2.

All taxonomic acts established in the present work have been registered in ZooBank LSID (see below), together with the electronic publication urn:lsid:zoobank.org:pub:C1F2B22C-76DD-4BB7-B9F3-D59F6E5012D1.

3. Results. Systematic palaeontology

The morphological characters of *Baeomorpha* (Fig. 2) as well as *Taimyromorpha* Gumovsky gen. nov., described below, demonstrate these are representatives of Rotoitidae, not Tetracampidae (see discussion below). *Baeomorpha* and *Rotoita* (Fig. 3) have a

Table 2

Unassigned inclusions of *Baeomorpha* in Taimyr amber.

Sex, PIN number	Condition	Origin	Comment
Male, PIN 3311/3334	Relatively well-preserved, but fore wings are partly cut off, and also a crack and air bubble surround it	Yantardakh, collected during 2012 PIN expedition	Details of morphology are problematic to elucidate. The specimen looks similar to <i>B. zherikhini</i> , but because it originates from Yantardakh deposit (not Baikura, as in <i>B. zherikhini</i>), we defer its specific affiliation.
Female, PIN 3311/2429	Well-preserved, but incomplete: half of the body is lost, only head, fore legs and anterior part of mesosoma remain	Yantardakh, collected during 2012 PIN expedition	The specimen looks similar to <i>B. zherikhini</i> , but antennal funicle is longer than in this species. Also, it originates from Yantardakh deposit (not Baikura, as in <i>B. zherikhini</i>), so we defer its specific affiliation.
Female, PIN 3311/99	Relatively well-preserved, but rather transparent	Yantardakh, collected during 1971 PIN expedition	Antennal funicle 5-segmented with F1–F3 more close attached than F4–F5, and indiscernible anellus. This antennal structure looks similar to <i>B. gracilis</i> (except for missing anellus), but other characters are difficult to observe due to the specimen's condition.
Female, PIN 3311/89	Complete, but rather transparent	Yantardakh, collected during 1971 PIN expedition	The antennal funicle appears 5-segmented with F1–F3 more close attached than F4–F5, which is similar to <i>B. gracilis</i> . However, more precise identification is problematic due to the specimen's condition.
2 males, PIN 3130/37 and PIN 3130/38	Complete, but considerably transparent	Yantardakh, collected during 1970 PIN expedition	The antennal funicle appears 5-segmented with F1–F3 more closely attached than F4–F5, which is similar to <i>B. gracilis</i> . However, more precise identification is problematic due to the condition of the specimens.
Male, PIN 3311/82	Relatively well-preserved, but situated on a split in the amber	Yantardakh, 1971 PIN expedition	Funicular segments appear separate similar to <i>B. popovi</i> , but part of antennae and entire head are situated on a split, so more accurate treatment is problematic.
Male, PIN 3311/83	Complete, but partly oxydated and partly transparent	Yantardakh, 1971 PIN expedition	Flagellum is relatively short, F1–F3 appear closely attached, which may suggest affinity with <i>B. yantardakh</i> and <i>B. gracilis</i> . However, more accurate treatment is problematic at the moment.
Sex undetermined, likely female, PIN 3311/92	Partly cut and oxydated, partly transparent	Yantardakh, 1971 PIN expedition	Flagellum is relatively short, F1–F3 appear closely attached, which may suggest affinity with <i>B. yantardakh</i> and <i>B. gracilis</i> . However, more accurate treatment is problematic due to the condition of the specimen.
Male, PIN 3426/260	Relatively well-preserved, but somewhat shriveled	Nizhnyaya Agapa, 1973 PIN expedition	The antennae are coiled in this specimen, which prevents its proper taxonomic placement at the moment.
Male, PIN 3130/202	Relatively well-preserved specimen in a cracked amber piece immersed in a cracked mass of Canada Balsam on a slide	Yantardakh, 1970 PIN expedition	Very likely <i>B. gracilis</i> , but the specimen is situated under a crack what prevents proper taxonomic placement at the moment.
Female, PIN 3312/19	Body situated in a crack, part of dorsum scratched	Yantardakh?, "Isaevsky?", 1971 PIN expedition	Possibly <i>B. gracilis</i> , but poor condition prevents proper taxonomic placement at the moment.
Sex undetermined, PIN 3730/36	Very swollen (likely artifact)	Baikura, 1976 PIN expedition	The body shape of the specimen is very damaged and modified, what prevents its further identification.
Sex undetermined, PIN 3311/96	Very transparent	Yantardakh, 1971 PIN expedition	The specimen's condition prevents its proper identification.
Sex undetermined (likely male), PIN 3963/5	Very transparent and partly damaged	Bulun, 1976 PIN expedition	The specimen's condition prevents its proper identification.
Sex undetermined, PIN 3311/668	Oxidized and partly scratched specimen	Yantardakh, 1971 PIN expedition	The specimen's condition prevents its proper identification.

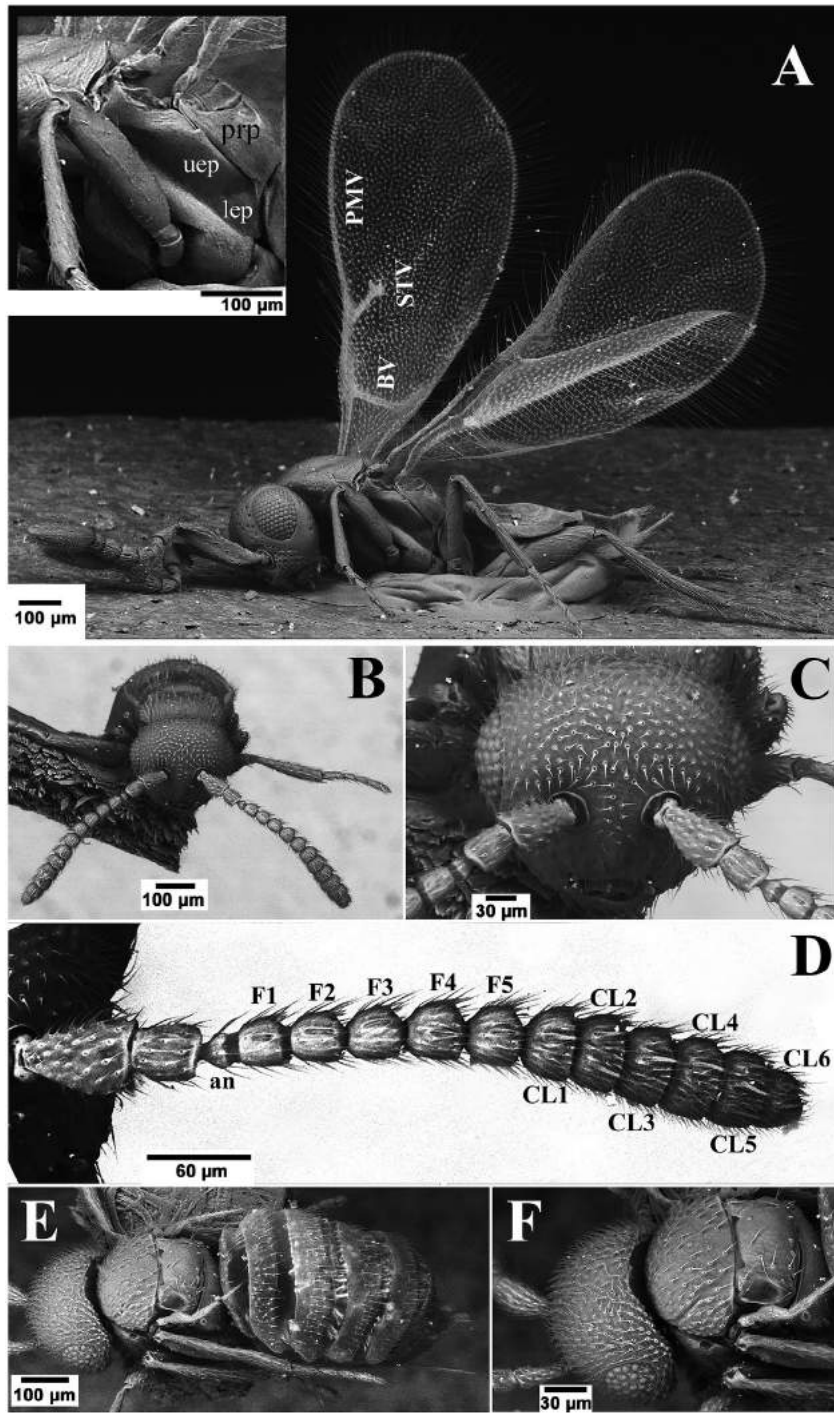


Fig. 3. SEM micrographs showing morphological details of extant Rotoitidae. (A) *Rotoita* sp. female and (B–F) *Chilo micropteron* female (BMNH collection): (A) Habitus in lateral view and enlarged part of mesosoma in inset; (B, C) Head in frontal view. (D) Antenna. (E) Habitus in dorsal view. (F) Head and mesosoma enlarged.

characteristic fore wing venation, in particular a sclerotized tubular basal vein, 4-segmented tarsi with a short, bifid fore tibial spur (calcar), and do not have an externally discernible prepectus. Consequently, an amended diagnosis of this family is proposed below.

Rotoitidae Bouček and Noyes, 1987

Rotoitidae Bouček and Noyes, 1987: 407–408; Rotoitidae; Gibson, 1993: 651 (Fig. 227); Gibson and Huber, 2000: 2300.

Baeomorphinae Yoshimoto, 1975: 519, **syn. nov.**

Diagnosis (after Bouček and Noyes, 1987 and Gibson and Huber, 2000, with amendments).

Antenna of extant rotoitids 14-segmented in female and 13-segmented in male (*Rotoita*: male unknown), but extinct representatives with variable number of segments (10–14, Fig. 2C, D); one or two proximal flagellomeres often anelliform with funicle and clava both 6-segmented in females in groundplan, but reductions to 3-segmented funicle and 4-segmented clava occur in

extinct forms; flagellum, including clava, with multiporous plate sensilla (MPS) having apical one-half to one-third free (Fig. 3D). Clypeus inflected in extant and extinct forms (at least appears as such in *Baeomorpha*, despite difficulties in observation). Tarsi 4-segmented in both sexes. Prepectus rather small, not visible externally because concealed under posterolateral margin of pronotum. Pronotum reduced medially (Figs. 2A, 3E). Mesothoracic spiracle situated between pronotum and external edge of mesoscutum, within pronotal emargination (Fig. 3F). Notauli distinctly and fully channeled in extinct forms (Fig. 2A), but absent or incomplete in extant forms. Axillae strongly advanced and distinctly delimited in extinct forms (Fig. 2A), whereas entire transscutal articulation (including the axillar internal borders) reduced in extant genus *Rotoita*. Mesopleuron without distinctly differentiated episternum and epimeron in extant forms (Fig. 3A), but distinctly separated in extinct forms (Fig. 2A). Fore wing (if fully developed) in both extinct and extant forms with undifferentiated setation extending to base (Fig. 3A), without speculum, and with characteristic pattern of venation: long PMV; and either long, petiolate STV (*Rotoita* and *Baeomorpha*) or sessile STV (*Taimyromorpha*); relatively short MV; 'broken' SMV and sclerotized tubular BV (Fig. 3A). Protibial spur (calcar) short, straight, and bifid; basitarsal comb consisting of 3–5 short spatulate setae that are at least somewhat obliquely orientated in both extinct and extant forms.

Distribution. Extant: New Zealand (*Rotoita*) and southern Chile (*Chiloe*); extinct: Late Cretaceous Canadian (*Baeomorpha*) and Taimyr amber (*Baeomorpha*, *Taimyromorpha*).

Remarks. Yoshimoto (1975) proposed Baeomorphinae as a subfamily in Tetracampidae to accommodate the genus *Baeomorpha*. The subfamily was characterized by a distinct BV and 4-segmented clava. However, a sclerotized BV is one of the diagnostic features of Rotoitidae (Fig. 3A), and segmentation of the clava varies within *Baeomorpha*. Other features that differentiate *Baeomorpha* and *Taimyromorpha* from extant rotoitids, namely complete notauli, distinctly delimited axillae, and others, are listed below and regarded as generic, since they also vary among genera of other families of Chalcidoidea (for instance within Eulophidae, Encyrtidae etc.).

Therefore, we believe that there is no support for keeping *Baeomorpha* in Tetracampidae or both *Baeomorpha* and *Taimyromorpha* as a separate subfamily within Rotoitidae and regard Baeomorphinae as a junior synonym of Rotoitidae (**syn. nov.**). Although both are family-group names, Rotoitidae has priority over Baeomorphinae because the latter has never been used as a family name (ICZN, 1999: Article 35.5).

Generic composition. Extant: New Zealand (*Rotoita*) and southern Chile (*Chiloe*); extinct: Upper Cretaceous Canadian and Taimyr ambers (*Baeomorpha* and *Taimyromorpha*).

Key to genera of Rotoitidae

1. Fore wing significantly reduced, dorsum densely setose, transscutal articulation present, ocelli absent, antenna non-geniculate.
Extant.....*Chiloe*
- Fully winged, dorsum with sparse setae, ocelli present, transscutal articulation variable, antennae geniculate.....2
2. Notauli reduced, axillae hardly visible, transscutal articulation reduced. Extant.....*Rotoita*
- Notauli complete, axillae distinctly delimited. Extinct.....3
3. STV of fore wing with long petiole.....*Baeomorpha*
- STV of fore wing short.....*Taimyromorpha* Gumovsky, gen. nov.

***Baeomorpha* Brues, 1937**

(Fig. 2)

Baeomorpha Brues, 1937: 580. Type species *Baeomorpha dubitata* Brues, 1937.

Baeomorpha Brues: Yoshimoto 1975: 519.

Remarks. The description provided by Yoshimoto (1975) is insufficient in view of new morphological features observed in the species described below. It also contained some misinterpreted features (e.g., described 5-segmented tarsi of females) so a re-description of the genus is warranted.

Diagnosis. Occipital carina absent, vertex smoothly transitioning into occiput; ocelli distinct; head in frontal view subcircular. Female antenna with short, ovate scape and wide pedicel; flagellum usually with 6 funiculars (only 3 are recognizable in *B. caeleps*), of which first (usually) or both proximal flagellomeres (*B. bianellus*) often, but not always, anelliform; antennal clava generally wider than funicle, with 4–6 distinct clavomeres in both sexes and small terminal spine; most funiculars and clavomeres with MPS, which are fused with flagellomeres over their proximal one-half to two-thirds (Fig. 2A, C, D). Face without facial grooves; clypeus depressed, broadly crescentic, often delimited by depressed sculpture.

Pronotum short, transverse. Vertex, pronotum and mesoscutum with sparse short setae (Fig. 2A). Mesoscutum generally distinctly longer than mesoscutellum, with complete, sutured notauli ending posteriorly at anterior margin of distinctly advanced axillae (Fig. 2A); mesoscutellum with 2 (rarely 3, *B. zherikhini*) pairs of bristles (when discernible); dorsellum (metascutellum) in shape of narrow bar. Prepectus not evident even in specimens with lateral mesosoma discernible. Mesopleuron well-sculptured; with distinct trans-epimeral suture separating slightly convex lower mesepimeron, and with large mesepisternum bearing shallow femoral depression; metapleuron separated from propodeal callus by distinct suture.

Propodeum relatively long (only slightly shorter than mesoscutellum); spiracle situated close to anterior propodeal margin (Fig. 2A).

Fore wing as for the family (Fig. 2B). STV with long petiole, small stigma and distinct uncus. Hind wing without anal lobe; hamuli represented by 3 setae, 2 of which distinctly hooked.

Legs with 4-segmented tarsi in both sexes; trochanters subdivided; fore tibia with short, nearly straight, bifid calcar. Basitarsal comb (when discernible) present as three prominent spatulate setae (well visible in the male of *B. zherikhini*, PIN 3730/162).

Metasomal petiole short, transverse in all known species (as may be concluded from the nearly sessile gaster). Gaster short, oval (most species) to elongate (*B. ovata*) in females; epipygium not produced; hypopygium short, not extending to tip of gaster and without sharp mucro; VI gastral tergum with pair of spiracles. Ovipositor sheaths robust and pointed, but not strongly produced; ovipositor of typical form for Chalcidoidea (when discernible), robust (only slightly narrower than mid tibia in the holotype of *B. yantardakh*, PIN 3311/1918). Male genitalia with robust parameres and digital sclerites bearing two blunt spines (when discernible: for instance, the paratype of *B. popovi*, PIN 3311/1395).

Comparative notes. The representatives of *Baeomorpha* are reminiscent in habitus (Fig. 2A) of species of the extant genus *Rotoita* (Fig. 3A) because of a similar antennal structure, general habitus and fore wing venation. However, species of *Baeomorpha* differ in having complete, sutured notauli connected with distinctly delimited advanced axillae (notauli and transscutal articulation are reduced in *Rotoita*), antennae inserted near middle of face (at lower margin of eye, close to mouth opening in *Rotoita*), metapleuron separated from propodeum, and mesopleuron with distinct trans-epimeral suture and femoral depression (the separation between the sclerites is indistinct in *Rotoita*). Also, species of *Baeomorpha* have a variable number of funicular and claval segments, though

the number of clavomeres is known only in a single extant species of *Rotoita*.

Biology. Not known (see Section 4).

Fossil deposition. Canadian and Taimyr ambers (mostly Upper Cretaceous, 78–100 Ma).

Key to species of *Baeomorpha* Females

1. Flagellum without differentiated anelli, with 5-segmented funicle and 6-segmented clava; funiculars slightly longer than broad.....*B. baikurensis* **Gumovsky sp. nov.**
 - Flagellum with 1 or 2 anelli differentiated from funiculars; funiculars variable.....2
2. Flagellum with 2 anelli.....*B. bianellus* **Gumovsky sp. nov.**
 - Flagellum with 1 anellus.....3
3. Funicle 5-segmented.....7
 - Funicle 3- or 4-segmented.....4
4. Funicle 3-segmented.....*B. caeleps* **Gumovsky sp. nov.**
 - Funicle 4-segmented.....5
5. Funicle with F1–F4 of about same width; mesosoma longer than metasoma.....*B. dubitata* Brues
 - Funicle either with only F1 or with F1 and F2 larger than rest of funiculars; mesosoma as long as or shorter than metasoma...6
6. Funicle with F1 larger than rest and all funiculars similarly closely attached.....*B. quattoruno* **Gumovsky sp. nov.**
 - Funicle with F1 and F2 larger than and more closely attached than rest of funiculars.....*B. quattorduo* **Gumovsky sp. nov.**
7. Funicle with F1–F3 more broadly and closely attached than F4 and F5.....9
 - Funicle with all funiculars similarly closely attached.....8
8. Funicle with F1–F5 uniform, slightly longer than broad; fore wing longer than body; POL slightly longer than OOL (about 1.1×); posterior ocellus separated from eye margin by a distance about 1.8× its larger diameter.....*B. ingens* **Gumovsky sp. nov.**
 - Funicle with F1 slightly larger than F2–F5, which are nearly subcircular; fore wing short, only 0.7× as long as body; POL about 4.7× OOL; posterior ocellus separated from eye margin by about its own diameter.....*B. popovi* **Gumovsky sp. nov.**
9. Pedicel about as wide as F1; F1–F3 distinctly thicker than F4 and F5; combined length of pedicel plus flagellum about as long as width of head.....*B. yantardakh* **Gumovsky sp. nov.**
 - Pedicel at most 1.8× as wide as F1; other features variable.....10
10. Scape short, as long as pedicel; clava about as long as funicle; mesoscutellum with 3 pairs of setae.....*B. zherikhini* **Gumovsky sp. nov.**
 - Scape long, at least about 1.3× as long as pedicel; clava variable; mesoscutellum with 2 pairs of setae (when observable).....11
11. Metasoma at most as long as mesosoma; combined length of pedicel plus flagellum about as long as head width; scape about 1.3× as long as pedicel and about 1.8–2.0× as long as broad; clava about as long as funicle; F1–F3 slightly wider or as wide as the following funiculars.....*B. gracilis* **Gumovsky sp. nov.**
 - Metasoma elongate, longer than mesosoma; combined length of pedicel plus flagellum about 1.2–1.3× as long as head width; scape about 1.6–1.7× as long as pedicel and 3.0× as long as broad; clava at least slightly longer than funicle; F1–F3 distinctly wider than following funiculars.....*B. ovata* Yoshimoto

Males (male of *B. dubitata* not included)

1. Flagellum with 2 anelli; antenna inserted above middle of face.....*B. bianellus* **Gumovsky sp. nov.**
 - Flagellum with only 1 anellus; level of insertion of antennae variable.....2

2. Flagellum with 5 funiculars.....6
 - Flagellum with 3 or 4 funiculars.....3
3. Funicle 3-segmented.....*B. caeleps* **Gumovsky sp. nov.**
 - Funicle 4-segmented.....4
4. Funicle with F1–F3 similarly small with F1 not much larger than anellus, but F4 distinctly larger than preceding funiculars; lower face with distinct tentorial pits above clypeus.....*B. avamica* **Gumovsky sp. nov.**
 - Funicle either with F1, or both F1 and F2 larger than F3 and F4; lower face variable.....5
5. Funicle with F1 as wide as or only slightly wider than F2–F4.....*B. quattoruno* **Gumovsky sp. nov.**
 - Funicle with F1 and F2 distinctly wider than F4 and F5.....*B. quattorduo* **Gumovsky sp. nov.**
6. Funicular segments similarly closely attached and F1 somewhat larger than rest; head in dorsal view nearly 2.0× as broad as long; axillar suture faded posteriorly; fore wing short, only 0.7× as long as body, slightly less than 2.0× as long as broad; PSM about as long as STV.....*B. popovi* **Gumovsky sp. nov.**
 - Funicle with F1–F3 more closely attached, F4 and F5 free; other features variable.....7
7. Combined length of pedicel plus flagellum 1.6× head width; PSM nearly 2.0× as long as STV; marginal fringe long, its longest seta about 8.0× as long as width of MV in its widest part.....*B. ovata* Yoshimoto
 - Combined length of pedicel plus flagellum at most 1.3× head width; PSM nearly 1.3–1.5× as long as STV; marginal fringe shorter, its longest seta 2.0–3.0× as long as width of MV in its widest part.....8
8. Scape as long as pedicel; combined length of pedicel plus flagellum slightly longer than (about 1.1×) head width; PMV about 4.0× STV; Baikura.....*B. zherikhini* **Gumovsky sp. nov.**
 - Scape slightly longer than pedicel; combined length of pedicel plus flagellum about 1.3× head width; PMV about 3.2× STV; Yantardakh.....*B. gracilis* **Gumovsky sp. nov.**

Canadian amber, *B. dubitata* Brues and *B. ovata* Yoshimoto (Fig. 4)

Based on examination of comprehensive material from CNC we conclude that the four hitherto described species of *Baeomorpha* from Canadian amber represent just two species. The type specimens of *B. distincta* Yoshimoto, *B. ovata* Yoshimoto and *B. elongata* Yoshimoto share critical morphological characteristics and appear to belong to the same species, whereas the specimen identified by C. Yoshimoto as *B. dubitata* Brues represents another species. Also, as mentioned above, there are many misinterpretations of morphology in the descriptions of Yoshimoto (1975). Apart from lapses in the descriptions, Yoshimoto (1975) occasionally reported the studied specimens incorrectly. We propose some morphological clarifications and nomenclatural changes below; however, further studies are needed to figure out taxonomic diversity of *Baeomorpha* in the Canadian amber deposits.

Baeomorpha dubitata Brues, 1937

Baeomorpha dubitata Brues, 1937: 41.

(Fig. 4A)

Remarks. The concept of this species proposed below is based on a single non-type specimen identified by C. Yoshimoto as *Baeomorpha dubitata*. However, given the inaccuracies discovered in Yoshimoto (1975) it is possible that this specimen was identified incorrectly (discussed below). Further studies are needed to clarify the identity of *B. dubitata*, but the specimen remains the only present source of information on the species.



Fig. 4. Photographs of species of *Baeomorpha* in the Canadian amber: (A) female of *B. dubitata* Brues (ID by C. Yoshimoto), CNC CAS 321 (antennae are shown in inset). (B–F) *B. ovatata* Yoshimoto: (B) male paratype of *B. distincta*, CNC CAS 770. (C, D) the box CNC CAS-77 with three amber pieces, one of which is supposed to be the holotype of *B. ovatata* Yoshimoto: two amber pieces contain the inclusions shown in (E) and (F): (E) female specimen, with another view in inset; (F) male specimen, assumed to be the holotype (see text for details).

Diagnosis. Female (Fig. 4A). Antenna with small anellus and 4 funiculars; F1–F4 of same size; club $3.4\times$ as long as broad, $1.3\text{--}1.4\times$ as long as funicle. Mesosoma longer than metasoma. Fore wing nearly ($0.9\times$) as long as head plus meso- and metasoma and about $2.0\times$ as long as broad; PMV about $2.0\times$ STV; PSM about $1.6\text{--}1.7\times$ as long as STV; marginal fringe about $2.0\times$ as long as width of PMV in its widest part. Mid and hind leg spurs about $2.0\times$ as long as width of respective tibiae.

Comparative notes. *Baeomorpha dubitata* is rather unique within the genus in having a flagellum with 1 anellus and 4 equally-sized funiculars (Fig. 4A, inset). The same size of the funiculars differentiates *B. dubitata* from the two other species described below from Siberian Taimyr amber with 4 funiculars and 1 anellus, *B. quattoruno* and *B. quattorduo*, which have at least F1 enlarged. The statement of Yoshimoto (1975) that this species is characterized by 5-segmented tarsi is erroneous and, if the identification of this specimen as *B. dubitata* by Yoshimoto is correct, so is the original statement of Brues (1937) that the female has 5 funiculars.

Material studied. Female, CAS 321 (Fig. 4A), Canada, Alberta, near Medicine Hat, 8–11 June 1971, J.F. McAlpine; identified by C. Yoshimoto (1975: Fig. 33) (CNC).

Remarks. The holotype of *B. dubitata* is supposed to be stored in the Royal Ontario Museum (Toronto, Canada), but could not be located (Peter Ferton, pers. comm.) at the time of writing of this paper.

Baeomorpha ovata Yoshimoto, 1975

Baeomorpha ovata Yoshimoto, 1975: 522.

Baeomorpha distincta Yoshimoto, 1975: 520, **syn. n.**

Baeomorpha elongata Yoshimoto, 1975: 521, **syn. n.**

(Fig. 4B–F)

Diagnosis. Female (Fig. 4E): antenna with small anellus and 5 funiculars; F1–F3 more broadly and closely attached than F4 and F5; clava at least slightly longer than funicle (Fig. 4E); scape $3.0\times$ as long as broad and $1.6\text{--}1.7\times$ as long as pedicel; pedicel about $1.3\text{--}1.4\times$ as long as broad; combined length of pedicel plus flagellum about $1.2\text{--}1.3\times$ as long as head width; metasoma longer than mesosoma. **Male** (Fig. 4B, F): antennal structure similar to female; head slightly more than $2.0\times$ as broad as long; combined length of pedicel plus flagellum $1.6\times$ head width; fore wing about as long as body and slightly more than $2.0\times$ as long as broad; PMV about $5.0\times$ STV; PSM nearly $2.0\times$ as long as STV; marginal fringe long, its longest seta about $8.0\times$ as long as width of MV in its widest part.

Comparative notes. *B. distincta* Yoshimoto, *B. ovata* Yoshimoto and *B. elongata* Yoshimoto are characterized by the antenna having a small anellus and the first three funiculars wider and more closely attached than the remaining two. Yoshimoto (1975) reported different degrees of closeness of attachment between the funiculars in these three species, but this is not true. We consider *B. elongata* Yoshimoto and *B. distincta* Yoshimoto as junior subjective synonyms of *B. ovata* Yoshimoto (**syn. n.**). Unlike in *B. ovata*, the anelliform first flagellomere is followed by four short, equally sized and shaped, evenly attached funiculars in the studied specimen of *B. dubitata* identified by C. Yoshimoto (CNC-321, Fig. 4A).

The identity of the holotype of *B. ovata* Yoshimoto is problematical. The original description of Yoshimoto (1975) states: “Holotype, female, Cedar Lake, Manitoba, VII-1950, CNC-77a, W.J. Brown & R. Bird Coll. (CNC No. 13548)”. The material obtained from the CNC consisted of a small box with three amber pieces referred to as “77a”, “77b” and “77c” on the lid (Fig. 4C, D), but these numbers were not associated with the particular pieces. The representation of the inclusions is as follows: one piece contained a small arthropod (non-*Baeomorpha*), one piece contained a male of

Baeomorpha (Fig. 4F), and another piece contained a female of *Baeomorpha* (Fig. 4E). The photo of the latter inclusion was provided by Yoshimoto (1975: Figs. 35–36) and stated in his legends to as “*Baeomorpha dubitata* Brues: ... 35–36, male, lateral and ventral views of body (CNC-77a)”. This inclusion (being the female, but recorded as a male by Yoshimoto, 1975) is very similar to the MCZ female of *B. elongata* illustrated by Yoshimoto (1975: Figs. 41, 42). The “Type” section of the description of *B. ovata* in the same paper reported the female holotype (males were not described for the species) as “77a”. Because Yoshimoto (1975) treated the female inclusion illustrated by him as a representative (male) of *B. dubitata* (but never mentioned it among the studied materials of this species), he stated unambiguous opinion about this inclusion being neither a representative of *B. ovata*, nor, correspondingly, its type specimen. Therefore, we presume that the male inclusion (Fig. 4F) in one of the three amber pieces (Fig. 4C) is the true holotype of *B. ovata*, despite the confused sex. Otherwise, it is hardly possible to trace the initial attribution of “a, b, c” numbers to any of the three pieces numbered as “77” (Fig. 4C). Also, the paratype female CAS-698 may be non-conspecific with the holotype (in its current concept). This damaged specimen (head and antennae are partly cut) appears to have a shorter gaster and somewhat longer PSM. However, the damage of the specimen prevents further clarification.

Material studied. *B. distincta* Yoshimoto: male paratype, CAS-770 (Fig. 4B), Alberta, Medicine Hat, May 1973, McAlpine & Teskey (CNC); *B. ovata* Yoshimoto, “77”: male holotype (not female) (Fig. 4F), CAS-77a, b, c, “Cedar Lake, Manitoba, August, 1950, Brown & Bird” [according to the original description: VII-1950, CNC-77a, W.J. Brown & R. Bird Coll., CNC No. 13548]; female (referred as male of *B. dubitata* Brues, see above, Fig. 4E), “Cedar Lake, Manitoba, August, 1950, Brown & Bird” (not listed among type specimens, but illustrated in Yoshimoto, 1975) (CNC); female paratype (part of head and major part of antenna cut off), CAS-698, Alberta, Medicine Hat, May 1973, McAlpine and Teskey (CNC); *B. elongata* Yoshimoto: male paratype (allotype), CAS-856, Medicine Hat, May 1973, McAlpine and Teskey (CNC).

Taimyr amber

The available inclusions of Taimyr amber that are sufficiently well preserved are keyed above and described below as representatives of 11 species of *Baeomorpha*. Sixteen other inclusions were problematic for reliable identification to species and these are treated and discussed below as “unassigned” (Table 2).

Baeomorpha avamica Gumovsky sp. nov.

urn:lsid:zoobank.org:act:61056AA0-41C6-47DA-9A88-E115386FAF9

(Fig. 5)

Diagnosis. Male (Fig. 5): antennal torulus situated above middle of face; scape about $2.2\times$ as long as broad; pedicel teardrop-shaped, slightly longer than broad and $0.7\text{--}0.8\times$ as long as scape, about $2.5\times$ as broad as F1; flagellum with 1 anellus and 4 funiculars, of which F1–F3 are of similar size, but F4 nearly $2.0\times$ wider than any of them, nearly as wide as CL1; clava 6-segmented; combined length of pedicel plus flagellum about $1.3\times$ as long as head width. Head in dorsal view about $2.2\text{--}2.3\times$ as broad as long; POL about $2.5\times$ OOL; posterior ocellus separated from eye margin by about its major diameter. Mesoscutum nearly $2.0\times$ as long as mesoscutellum. Fore wing slightly shorter than body; PSM about $2.3\times$ as long as STV; STV appearing relatively short, but with distinct petiole about $3.5\times$ as long as diameter of stigma and uncus about as long as stigmal diameter.

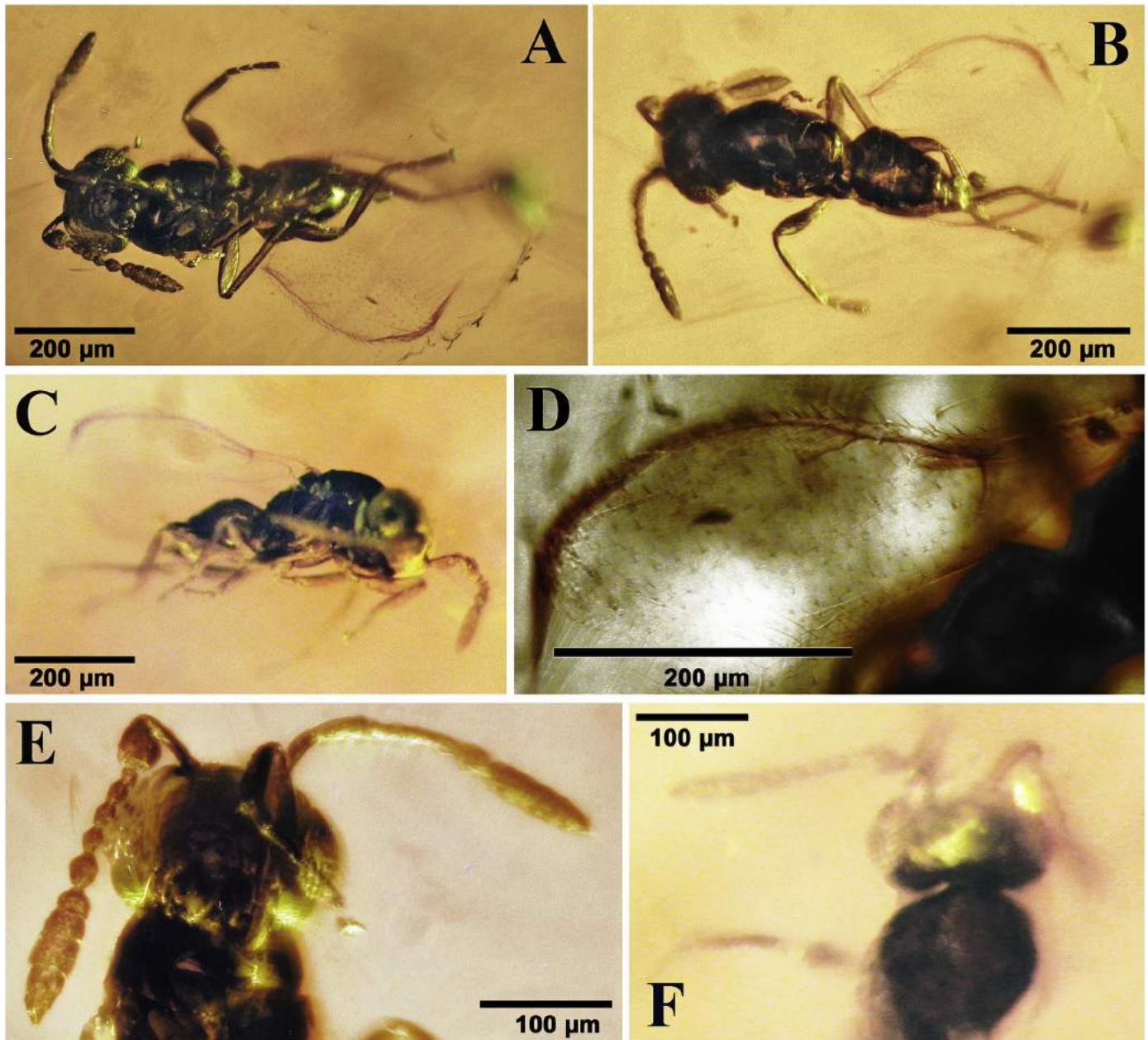


Fig. 5. Photographs and morphological details of *Baeomorpha avamica* Gumovsky *sp. nov.*, holotype, PIN 3311/95, Taimyr amber. (A–C) Habitus: (A) Ventral view; (B) Dorsal view; (C) Lateral view. (D) Fore wing. (E, F) Head and anterior part of mesosoma: (E) Fronto-ventral view; (F) Dorsal view.

Description. Male. Body length about 0.5 mm. Body (Fig. 5A–C) brownish with green tint in reflected light. Scape dark. Head light reticulate, slightly wider than mesosoma in dorsal view.

Head in dorsal view about $2.2\text{--}2.3\times$ as broad as long; POL about $2.5\times$ OOL; posterior ocellus separated from eye margin by a distance of about its larger diameter. Head in frontal view about $1.6\times$ as broad as high; antennal torulus situated above middle of face and middle of eye height; anterior margin of clypeus distinctly concave, with two distinct tentorial pits above. Antenna with scape about $2.2\times$ as long as broad; pedicel teardrop-shaped, slightly longer than broad and $0.7\text{--}0.8\times$ as long as scape, about $2.5\times$ as broad as F1. Flagellum with 1 anellus (though relatively large and just slightly smaller than F1–F3) and four funiculars, of which F1–F3 are of similar size, but F4 nearly $2.0\times$ larger than any of them; clava 6-segmented (so, likely F6 joined with clava), $4.3\times$ as

long as broad, slightly longer than funicle, CL3 (widest of funicle) about $1.5\times$ as wide as F5 and as wide as $2.5\times$ of F2–F4. Combined length of pedicel plus flagellum about $1.3\times$ as long as head width.

Mesosoma slightly longer than metasoma; dorsum light reticulate. Mesoscutum nearly $2.0\times$ as long as mesoscutellum. Fore tibia about $6.0\times$ as long as broad and nearly $1.2\times$ as long as fore femur, about $1.2\times$ as long as fore tarsus; mid femur nearly $4.0\times$ as long as broad; mid tibia about $10.0\times$ as long as broad, $1.4\times$ as long as mid femur; hind tibia about $1.3\times$ as long as hind femur, $1.2\text{--}1.3\times$ as long as hind tarsus. Fore wing (Fig. 5D) somewhat bent in holotype, slightly shorter ($0.9\times$) than body; PSM about $2.3\times$ as long as STV, which with distinct petiole about $3.5\times$ as long as diameter of stigma, and uncus about as long as stigmal diameter.

Gaster short, slightly longer than broad.

Female. Unknown.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taymyr Peninsula; Yantardakh Hill, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype male (Fig. 5), PIN 3311/95, Yantardakh, 1971 PIN expedition, well-preserved specimen.

Comparative notes. This species is rather recognizable in having the flagellomeres gradually enlarged in size such that the terminal funicular is nearly as wide as the clava (Fig. 5E). This condition is similar to *Taimyromorpha pusilla*, gen. sp. nov., described below, to a certain extent, in which the female terminal funiculars are larger than the proximal funiculars. However, the funicle is 6-segmented and the STV is distinctly shorter, nearly sessile in *Taimyromorpha*.

Etymology. The species is named after the Nganasans, Samoyedic people inhabiting Taymyr Peninsula, which used to refer to themselves as “Avam people”.

***Baeomorpha baikurensis* Gumovsky sp. nov.**

urn:lsid:zoobank.org:act:213D0A27-6783-48D5-A609-FD3C81CB4773
(Fig. 6)

Diagnosis. Female (Fig. 6): antenna with scape as long as pedicel, somewhat widened apically, about 1.5× as long as broad; pedicel ovate, about 1.5–1.6× as long as broad; flagellum without distinct anellus, with 5-segmented funicle and 6-segmented clava (CL1

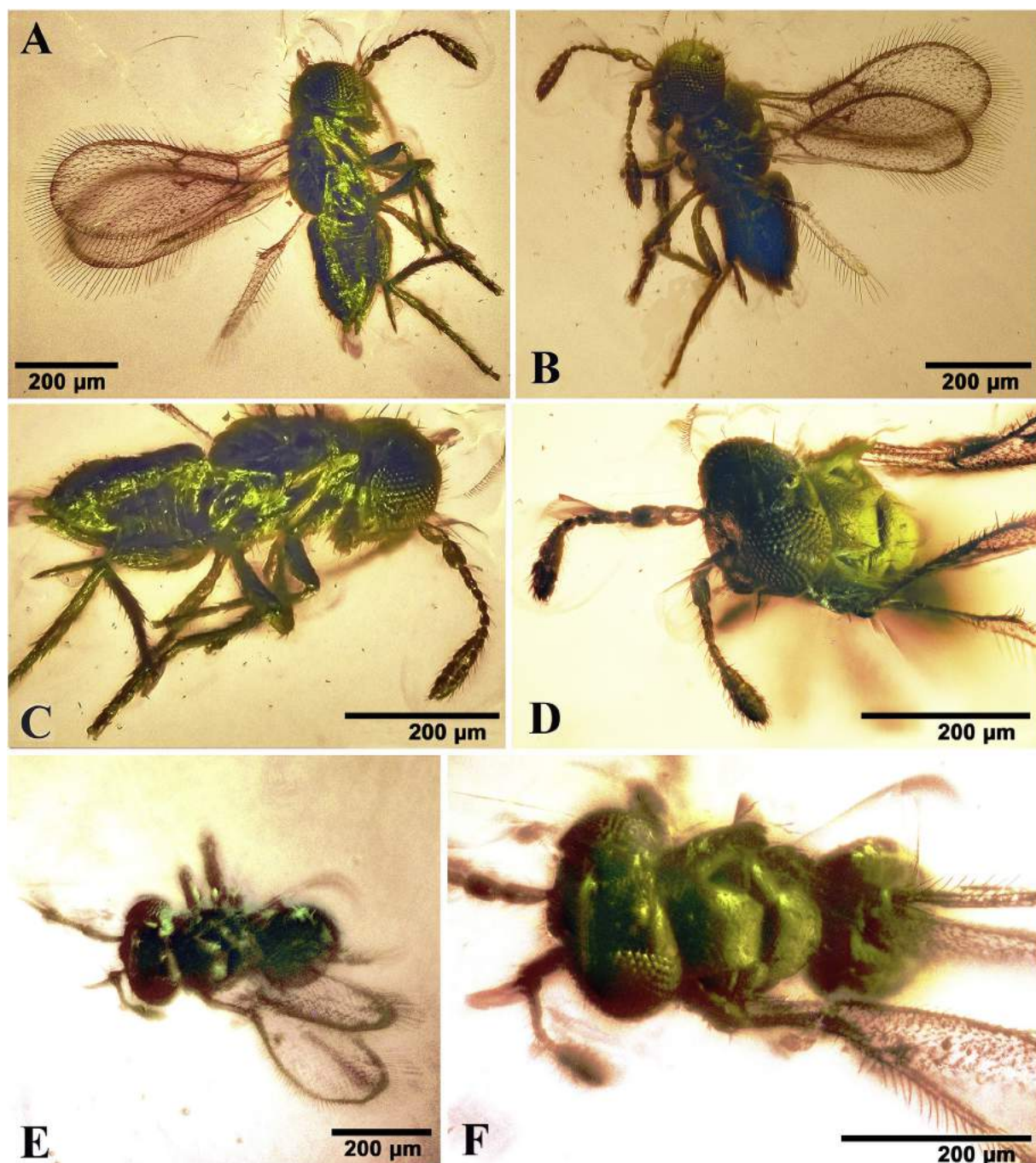


Fig. 6. Photographs and morphological details of *Baeomorpha baikurensis* Gumovsky sp. nov., holotype specimen, PIN 3730/34, Taymyr amber. (A–F) Habitus under different angles.

likely represents the terminal funicular fused with the clava); funiculars slightly longer than broad with F1–F3 somewhat more closely and broadly attached than F4 and F5, but just a little wider than F4 and F5; CL1 slightly wider than F5 and distinctly smaller than other clavomeres; funiculars and CL1 without MPS, but CL2–CL6 with MPS; combined length of pedicel plus flagellum about as long as head width. Head in dorsal view about $2.4\times$ as broad as long; POL about $1.3\times$ OOL; lateral ocellus separated from eye margin by about $2.0\times$ its own diameter. Axillar suture distinct throughout. Mesoscutellum with 2 pairs of setae. Propodeum smooth or finely reticulate. Fore wing slightly shorter than body, about $2.4\times$ as long as broad; STV with thin petiole and distinct uncus; PSM about $2.6\times$ as long as STV; marginal fringe nearly $5.0\times$ as long as width of PSM in its widest part.

Description. Female. Body (Fig. 6A–C) length about 0.5 mm. Body with golden-green tint in reflected light (artefact, original color apparently lost, but likely dark, perhaps metallic). Scape transparent, so apparently originally pale.

Head with frontal surface slightly convex, finely reticulate; vertex and frons with many setae. Antennal torulus situated in middle of face at middle of eye height. Eye in lateral view rounded, about as high as wide. Head in dorsal view (Fig. 6D) about $2.4\times$ as broad as long, with minimum distance between inner orbits about $0.4\times$ head width; POL about $1.3\times$ OOL; lateral ocellus separated from eye margin by about $2.0\times$ its own diameter. Antenna (Fig. 6C, D) with scape somewhat widened apically, about $1.5\times$ as long as broad; pedicel ovate, about 1.5 – $1.6\times$ as long as broad, as long as scape; flagellum without distinct anellus, with 5-segmented funicle and 6-segmented clava (terminal funicular likely joined with clava); funiculars slightly longer than broad; F1–F3 somewhat more closely and broadly attached than F4 and F5, but as wide as or just slightly wider (depending on angle of view) than F4 and F5; CL1 slightly larger than F5 and distinctly smaller than other clavomeres; no MPS are visible at funiculars and CL1, but CL2–CL6 with MPS. Combined length of pedicel plus flagellum about as long as head width.

Mesosoma short, robust, slightly narrower than head (Fig. 6D–F); dorsum finely reticulate. Mesoscutum with about 6 pairs of setae and distinct notauli, each notaulus ending posteriorly in center of anterior margin of axilla. Axilla with 1 seta and delimited throughout by a distinct axillar suture. Mesoscutellum with 2 pairs of setae. Fore femur $4.0\times$ as long as broad; fore tibia about $6.7\times$ as long as broad; fore tarsus slightly shorter than tibia; hind tibia about $8.0\times$ as long as broad; hind tarsus 0.7 – $0.8\times$ as long as tibia.

Fore wing slightly shorter than body, about $2.4\times$ as long as broad; PMV about $4.8\times$ STV; PSM about $2.6\times$ as long as STV; STV with thin petiole about $1.5\times$ as long as major diameter of stigma and uncus slightly longer than this diameter; marginal fringe nearly $5.0\times$ as long as width of PSM in its widest part. Propodeum appearing smooth or finely reticulate.

Metasoma as long as mesosoma; petiole reduced in size, not visible. Ovipositor short, robust, extending along major part of gaster. **Male.** Unknown.

Locality and horizon. Russia: Krasnoyarsk Krai: Taymyrsky Dolgano-Nenetsky District, Taymyr Peninsula; Lake Taymyr, Baikura-Neru Bay, ?Ognevka Formation, upper Albian –?lower Cenomanian, middle Cretaceous.

Type material. Holotype: female (Fig. 6), PIN 3730/34, Baikura-2, collected during 1976 PIN expedition, well-preserved, complete specimen.

Comparative notes. This species is similar in habitus to *Taimyromorpha pusilla* (described below), but differs from the latter mostly in having a longer STV and 6-segmented clava.

Etymology. The species epithet is derived from the name of locality.

***Baeomorpha bianellus* Gumovsky sp. nov.**

urn:lsid:zoobank.org:act:4CE28E91-E30A-4237-A35F-911CC8507DB1
(Fig. 7)

Diagnosis. Male (Fig. 7A–E): antenna with scape nearly $2.0\times$ as long as broad; pedicel teardrop-shaped, about $1.5\times$ as long as broad and about $0.75\times$ as long as scape; flagellum with 2 anelli and 4 evenly attached funiculars, with F1 slightly smaller than nearly same sized F2–F4 or F4 just slightly larger; combined length of pedicel plus flagellum about 1.3 – $1.5\times$ as long as head width in male, and about as long as head width in female (non-type specimen). Head in dorsal view about $2.8\times$ as broad as long; POL about $2.7\times$ OOL; posterior ocellus separated from eye margin by about its major diameter. Axillar suture distinct throughout. Fore wing only slightly shorter than body in male, about $2.1\times$ as long as broad; PSM approximately $2.0\times$ (not clear) as long as STV; STV with petiole about $3.0\times$ as long as diameter of stigma and uncus distinct, about as long as stigmal diameter. **Female** (Fig. 7F): similar to male in having antenna with two anelli.

Description. Male (Fig. 7). Body length about 0.5 mm. Body brownish with golden tint in reflected light. Scape dark. Head and mesosoma with alutaceous sculpture.

Head about $2.8\times$ as broad as long and about $1.2\times$ as wide as mesosoma in dorsal view; POL about $2.7\times$ OOL; posterior ocellus separated from eye margin by about its own major diameter. Head in frontal view (partly seen in PIN 3311/1200) slightly ($1.1\times$) wider than high. Anterior margin of clypeus evidently emarginate. Antennal torulus situated above middle of face and middle of eye height (Fig. 7A, B). Head in lateral view with vertex smoothly rounded into occiput and with sparse setae. Eye in lateral view about $1.3\times$ as high as wide. Antenna with scape nearly $2.0\times$ as long as broad; pedicel teardrop-shaped, about $1.5\times$ as long as broad and about $0.75\times$ as long as scape; flagellum with 2 anelli and 4 sub-circular, free, slightly pedunculate funiculars (Fig. 7E); F1 slightly narrower than nearly same sized F2–F4 or F4 just slightly larger; clava 5-segmented, 3.4 – $3.5\times$ as long as broad, 1.2 – $1.3\times$ longer than funicle, with widest clavomeres about $1.3\times$ as wide as F4–F6. Combined length of pedicel plus flagellum about 1.3 – $1.5\times$ as long as width of head.

Mesosoma slightly longer than (about $1.1\times$ as long as) metasoma, about 1.2 – $1.3\times$ as long as broad. Mesoscutum 1.5 – $1.6\times$ as long as mesoscutellum, $1.8\times$ as broad as long, with distinct notauli. Axilla with anterior margin somewhat emarginated in place of contact with notaulus, and delineated by distinct axillar suture; no setae visible in available specimens. Mesoscutellum about $1.2\times$ as broad as long, with 2 pairs of setae. Propodeum with rugose sculpture. Fore tibia with robust calcar; hind tibia slightly longer than hind tarsus. Fore wing only slightly shorter than body, about $2.1\times$ as long as broad; PMV at least $3.4\times$ and likely $4.0\times$ STV (not clear), PSM likely $2.0\times$ (not clear) as long as STV; STV with petiole about $3.0\times$ as long as diameter of stigma. Marginal fringe long, its longest seta about $3.3\times$ as long as MV in its widest part.

Metasoma about $0.5\times$ as long as head plus mesosoma; petiole reduced, not visible. Gaster short, about $1.3\times$ as long as broad.

Female (based on the non-type specimen, Fig. 7F). Similar to male in antennal structure (flagellum with 2 anelli). Head about 1.3 – $1.4\times$ as broad as high in frontal view; eye height about $0.6\times$ head height. Combined length of pedicel plus flagellum about as long as head width. Fore wing about $2.3\times$ as long as broad.

Type material. Holotype male (Fig. 7A–C), PIN 3311/1200, Yantardakh, collected during 2012 PIN expedition, well-preserved specimen, but situated in a crack (visible if filled by a medium). Paratypes: 2 males (Fig. 7D, E), PIN 3311/1866–1867, Yantardakh, collected during 2012 PIN expedition, well-preserved specimens.

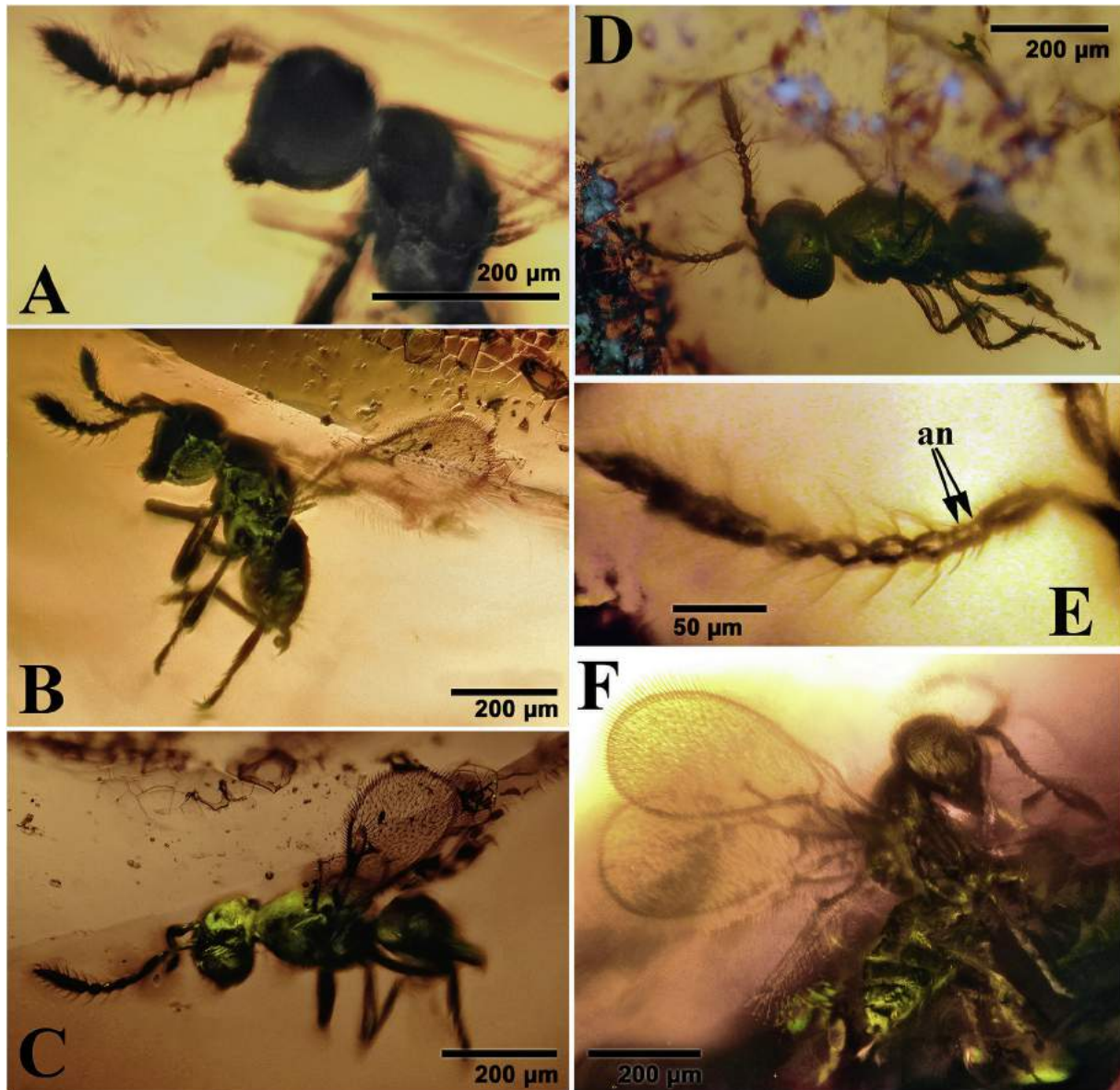


Fig. 7. Photographs and morphological details of *Baeomorpha bianellus* Gumovsky **sp. nov.**, Taimyr amber. (A–C) Holotype PIN 3311/1200: (A) head and anterior part of mesosoma; (B, C) habitus; (D, E) One of paratype males of PIN 3311/1866, 1867: (D) habitus; (E) antenna with 2 anelli arrowed. (F) Non-type female, PIN 3313/55, habitus in lateral view.

Non-type material. Male, PIN 3311/2425, Yantardakh, 2012 PIN expedition, relatively well-preserved specimen, but situated on a crack, so antennae and wings are not clearly visible; female (Fig. 7F), PIN 3313/55, Romanikha, 1977 PIN expedition (with dipteran syninclusion PIN 3313/56), relatively well-preserved specimen, but surrounded by splits.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh and Romanikha localities, Kheta Formation, upper Santonian, Upper Cretaceous.

Comparative notes. This species is very peculiar in having two anelli and in having the antennae inserted above the middle of the face. It also differs from other species as described in the diagnosis and in the key. The female PIN 3313/55 (Fig. 7F) from Romanikha shows a general similarity with males from the Yantardakh, but the combined length of the pedicel plus flagellum is as long as the width of the head, whereas it is about 1.3–1.5× in the males. This ratio is generally the same for both sexes of other studied species of the genus, but might be a result of sexual dimorphism.

Etymology. The specific epithet is based on the two anelli and latinized as an adjective.

Baeomorpha caeleps* Gumovsky **sp. nov.*

urn:lsid:zoobank.org:act:FE2F40EC-A8CC-4688-B7FF-9A4BDFBDB3DC
(Figs. 8, 9)

Diagnosis. Male (Figs. 8B–E, 9B–F): antenna with scape about 1.8× as long as broad; pedicel teardrop-shaped, slightly longer than broad and slightly shorter than scape; flagellum with 1 anellus and 3 evenly attached funiculars; clava 4-segmented (plus terminal spine), about as long as funicle and slightly longer than width of head. Head in dorsal view about 2.3–2.4× as broad as long; POL about 4.0× OOL; posterior ocellus separated from eye margin by about its major diameter. Axillar suture distinct throughout. Fore wing only slightly shorter than body in male, about 2.5× as long as broad; PSM about 1.5× as long as STV, petiole of which about 3.0×

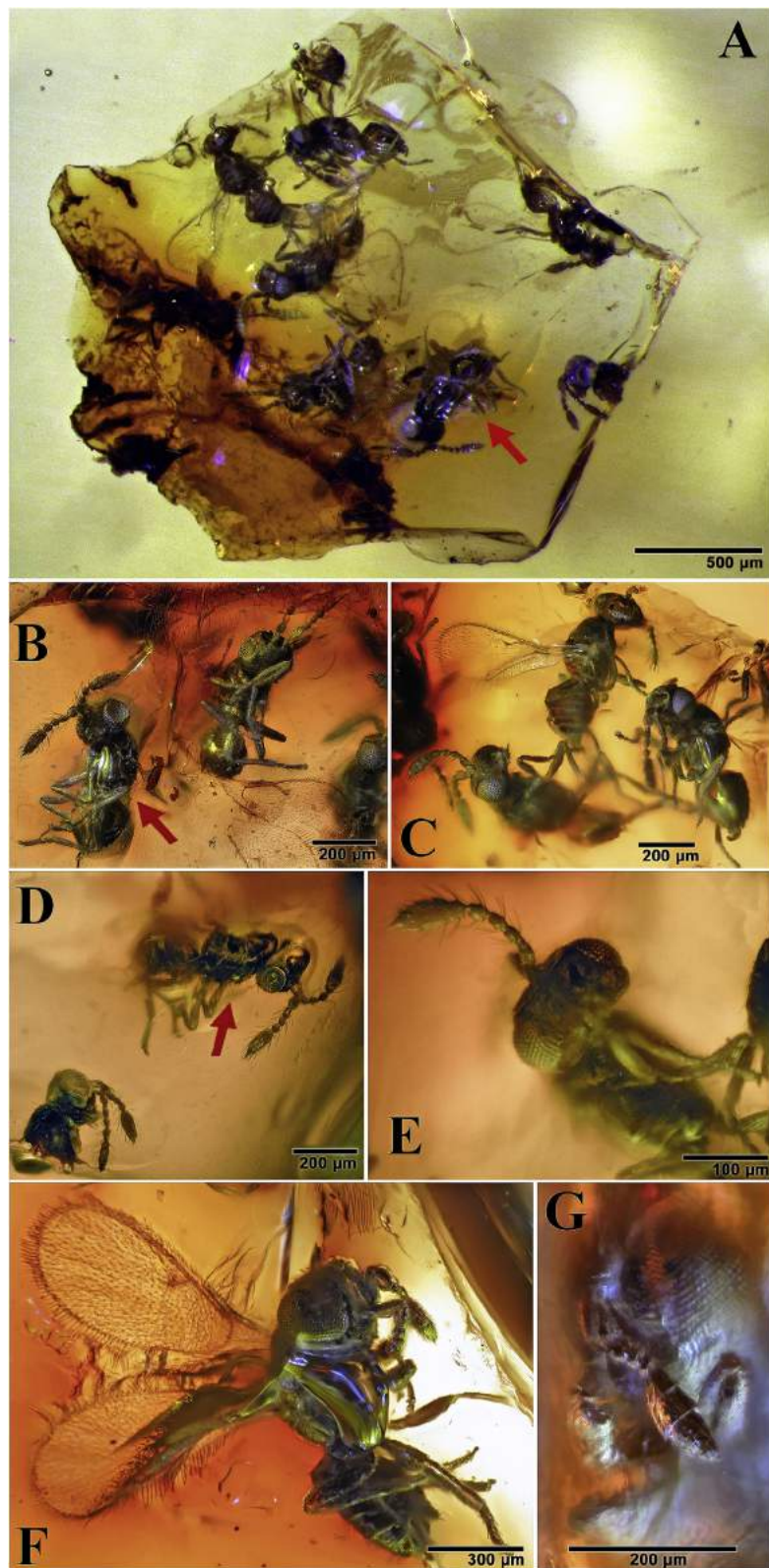


Fig. 8. Photographs and morphological details of *Baeomorpha caeleps* Gumovsky **sp. nov.**, Taimyr amber. (A–E) amber piece PIN 3311/2341–2350 with holotype arrowed: (A) general view; (B–E) male inclusions, different views. (F, G) Non-type female, PIN 3311/3338.

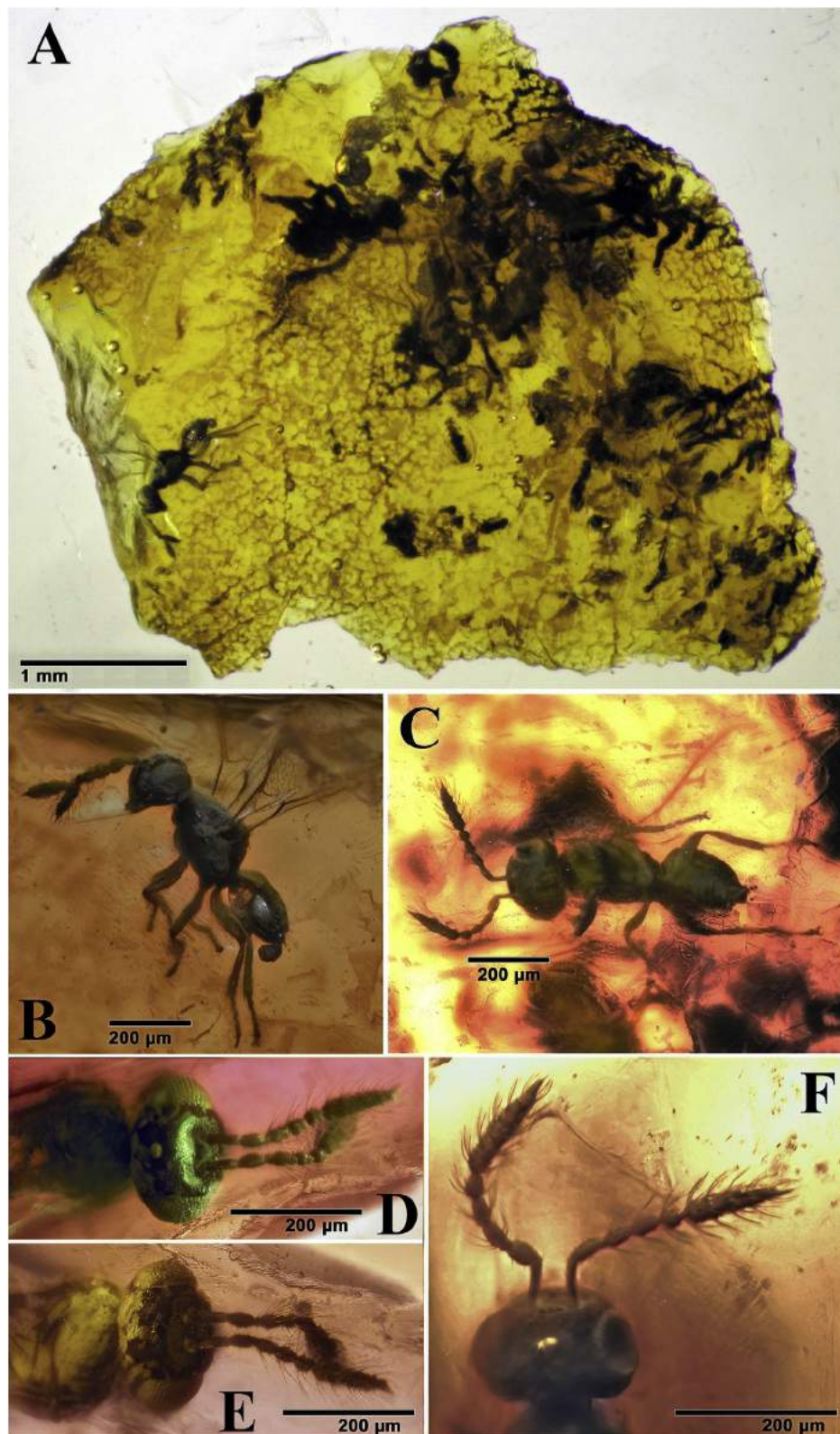


Fig. 9. Photographs and morphological details of *Baeomorpha caeleps* Gumovsky **sp. nov.**, PIN 3311/2317–2323, Taimyr amber. (A) General view. (B, C) Habitus of male paratypes. (D–F) Head and anterior part of mesosoma: (D, E) of the male shown in (B); (F) of the male shown in (C).

as long as diameter of stigma and uncus of stigma distinct, about as long as stigmal diameter. **Female** (Fig. 8F, G): flagellum with 1 anellus and 3 evenly attached funiculars.

Description. Male. Body length about 0.5 mm. Body dark brown, scape dark.

Head light reticulate, 1.3–1.4× wider than mesosoma in dorsal view (Fig. 8A–E). Head in dorsal view about 2.3–2.4× as broad as long; POL about 4.0× OOL; posterior ocellus separated from eye margin by about its major diameter. Head in lateral view with vertex smoothly rounded into occiput and with sparse setae. Eye in lateral view about 1.3× as high as wide. Face either with median cavity delimited by a weak carina along eye orbits and below antennal toruli (likely artifact in some specimens), or evenly rounded frontally. Antennal torulus situated in middle of face and in middle of eye height.

Antenna (Fig. 8E) with scape about 1.8× as long as broad; pedicel teardrop-shaped, slightly longer than broad and slightly shorter than scape; flagellum with 1 anellus and 3-segmented funicle; F1–F3 of same size, free, as long as or slightly longer than broad; clava 2.5–3.5× as long as broad (depending on degree of lateral compression), as long as funicle, 4-segmented with tiny terminal spine, with mean width about 2.0× mean width of F1–F3. Combined length of pedicel plus flagellum slightly longer than width of head.

Mesosoma about as long as metasoma (Fig. 8C, D); dorsum very finely reticulate. Mesoscutum with 5 pairs of setae and distinct notauli, about 2.0× as long as mesoscutellum. Axilla with anterior margin somewhat emarginate in place of contact with notaulus, with 1 seta, and with axillar suture distinct throughout. Mesoscutellum with 2 pairs of setae. Propodeum finely reticulate, with posterior depressions. Fore and mid femora about 4.0× as long as broad; fore and mid tibiae about 6.0× as long as broad, about as long as respective femora; fore tarsus slightly shorter than fore tibia and mid tarsus nearly as long as mid tibia; hind femur 3.0× as long as broad; hind tibia about 8.0× as long as broad, slightly longer than hind femur and hind tarsus. Fore wing only slightly shorter than body, about 2.5× as long as broad; PMV about 4.0× as long as STV; PSM about 1.5× as long as STV; STV with petiole about 3.0× as long as diameter of stigma and uncus distinct, about as long as stigmal diameter. Marginal fringe long, its longest seta about 4.0–5.0× as long as MV in its widest part.

Gaster short, ovate. Genitalia with aedeagus protruding from phalobase bearing parameres.

Female (based on non-type, Fig. 8F, G). Similar to male in having 3-segmented funicle; clava appears 3-segmented; anellus indistinct (flagella curved in the only available female specimen).

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh and Romanikha localities, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype male (arrowed, Fig. 8A, B, D), PIN 3311/2341–2350, Yantardakh, 2012 PIN expedition. Paratypes (all – Yantardakh, collected during 2012 PIN expedition, 30 males): 9 males, same amber piece (Fig. 8A) with holotype, mostly in good condition; 4 males (in good condition), PIN 3311/2154–2175 (plus about 7 other, non-type specimens, damaged to different extent); 3 males (in good condition), PIN 3311/2324–2337 (plus 4 males, non-type, damaged to different extent, represented by body parts only); 2 males, PIN 3311/2317–2323 (Fig. 9) (plus about 5 males, non-type, represented by separate body parts only); 6 males, PIN 3311/2217–2225 (plus 2 non-type, damaged males); 4 males, PIN 3311/2206–2215 (plus 3 non-type, damaged males); 2 males, PIN 3311/2184–2185 (plus remnants of some other specimens, mostly wings).

Non-type material. 3 males (2 of them are nearly scratched), PIN 3313/1–3, Romanikha, 1971 PIN expedition; female (Fig. 8F, G), PIN 3311/3338, Yantardakh, 2012 PIN expedition, well-preserved

specimen, but antennae are somewhat bent and a part of mesosoma is covered by an air bulb and background is patterned; body parts of supposedly 3 male specimens in the same piece as holotype and 9 paratypes, non-types, PIN 3311/2351–2353.

Comparative notes. This species is very distinctive in having 1 anellus and a 3-segmented funicle with free, equally sized funiculars.

Etymology. The species epithet means “bachelor” in Latin and refers to the aggregations of males of this species in amber pieces.

Baeomorpha gracilis Gumovsky sp. nov.

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(Figs. 10–12)

Diagnosis. Female (Figs. 10, 11): antenna with scape elongate, nearly 3.0× as long as broad, up to 1.3–1.4× as long as pedicel; pedicel teardrop-shaped, up to 1.2× longer than broad; flagellum with 1 anellus and 5-segmented funicle; F1–F3 closely attached, as wide as or only slightly wider than F4 and F5; CL1 slightly narrower than other clavomeres; combined length of pedicel plus flagellum about as long as head width. Head in dorsal view about 2.8× as broad as long; POL about 3.0× OOL; posterior ocellus separated from eye margin by a distance about 1.8× its larger diameter. Axillar suture distinct throughout. Mesoscutellum with 2 pairs of setae. Propodeum with weak depressions on sides anteriorly. Fore wing slightly shorter than body, about 2.2× as long as broad; PSM nearly 2.0× as long as STV; STV with petiole about 4.0–5.0× as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe slightly more than 5.0× as long as PSM in its widest part. **Male** (Fig. 12): flagellum with 1 anellus, 5-segmented funicle and 5-segmented clava, which nearly as long as funicle, F1–F3 closely attached and as wide as or slightly wider than F4 and F5.

Description. Female. Body length about 0.5 mm. Body (Figs. 10, 11) with golden-green tint, original color apparently metallic with antennae dark and legs paler.

Head (Fig. 10B) convex, light reticulate; vertex and frons with at least 4 pairs of setae. Head in frontal view about 1.3× as broad as high. Antennal torulus situated in about middle of face (Fig. 10E) and slightly below middle of eye height, but distinctly above lower margin of eye. Head in lateral view with blunt occipital margin. Eye in lateral view about 1.2–1.3× as high as wide. Head about 1.3× wider than mesosoma (Fig. 10F). Head in dorsal view about 2.8× as broad as long, with minimum distance between inner orbits about 0.8× head width; POL about 3.0× OOL; posterior ocellus separated from eye margin by a distance about 1.8× its larger diameter. Antenna with elongate scape, nearly 3.0× as long as broad, up to 1.3–1.4× as long as pedicel; pedicel teardrop-shaped, up to 1.2× as long as broad, 2.2–2.3× wider than F1; first flagellomere anelliiform; funicle 5-segmented, with F1–F3 more closely attached than F4 and F5, but only slightly wider than the latter funiculars; clava slightly more than 2.0× wider than funicle, about 1.4× longer than funicle, appearing 4-segmented (but segmentation not clear), about 3.0× as long as broad. Combined length of pedicel plus flagellum about as long as width of head (Fig. 11A–D).

Mesosoma almost 1.3× as long as metasoma; dorsum finely reticulate or alutaceous (Fig. 11C). Mesoscutum with distinct notauli and 5 or 6 pairs of setae. Mesoscutellum with 2 pairs of setae and relatively convex. Axillae distinctly advanced and delimited throughout by distinct axillar suture. Fore femur about 3.0× as long as broad; fore tibia about 5.5× as long as broad; fore tarsus as long as fore tibia; hind tibia about 1.4× as long as hind tibia. Fore wing about 0.9× as long as body, about 2.2× as long as broad; PMV about 4.5× STV; PSM nearly 2.0× as long as STV,

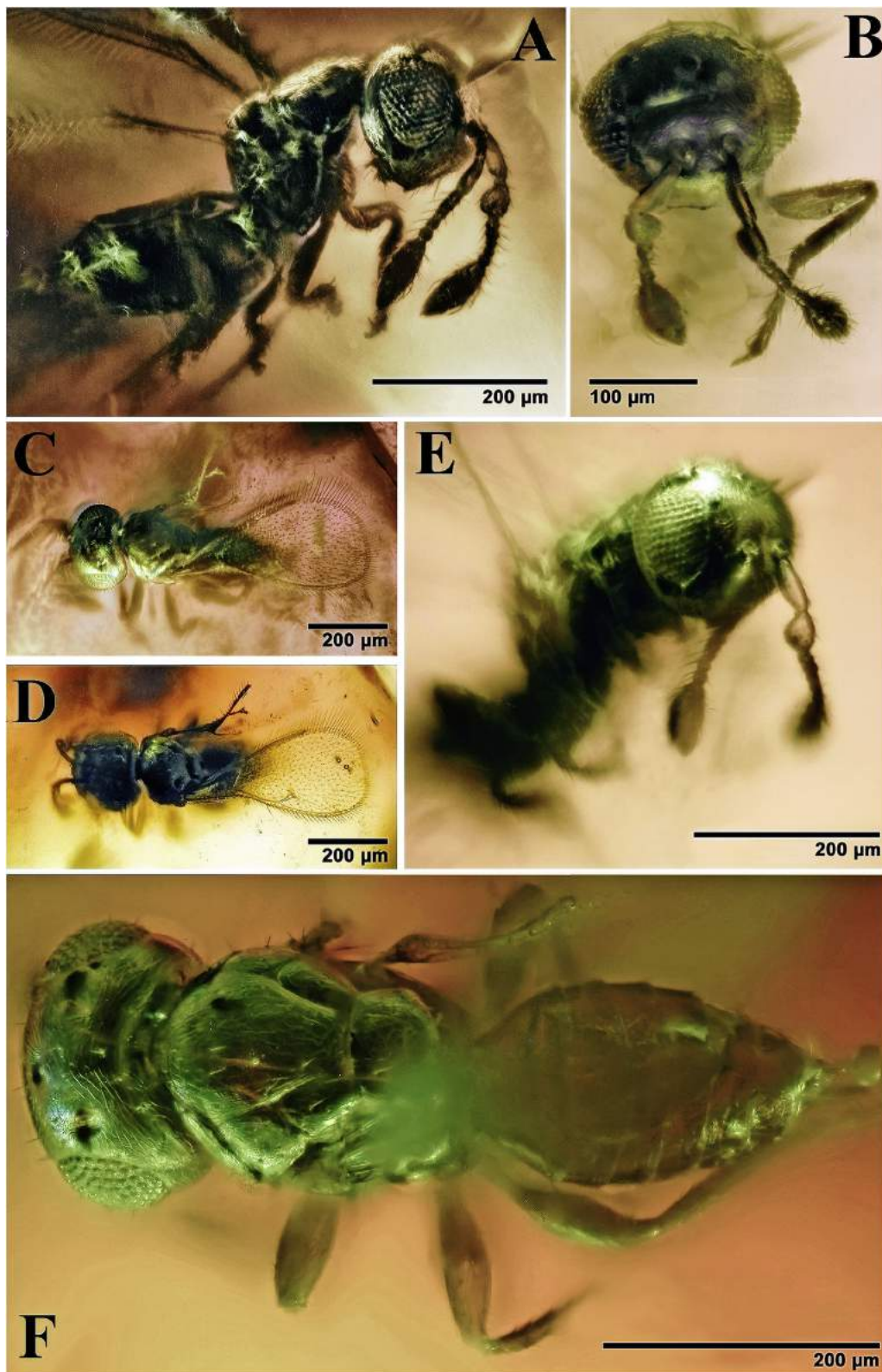


Fig. 10. Photographs and morphological details of *Baeomorpha gracilis* Gumovsky **sp. nov.**, holotype, PIN 3311/2005, Taimyr amber. (A, C, D, F) Habitus: (A) Lateral view; (C, D, F) Dorsal view. (B, E) Head views.

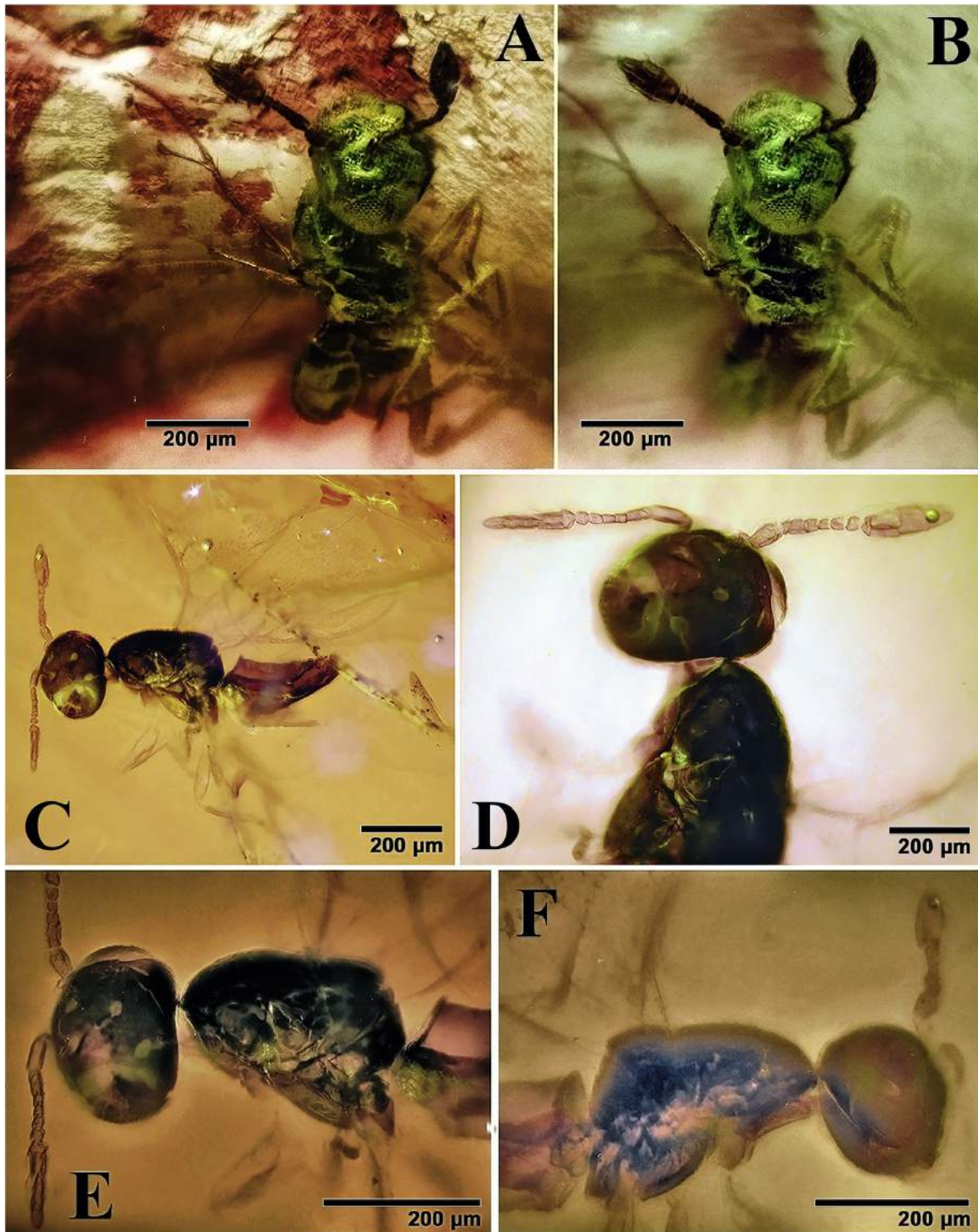


Fig. 11. Photographs and morphological details of *Baeomorpha gracilis* Gumovsky *sp. nov.*, female paratypes in Taimyr amber. (A, B) PIN 3311/721, habitus with different views of background. (C–F) PIN 3311/87: (C) habitus in lateral view; (D–F) head and mesosoma, different views.

petiole of which about $4.0\text{--}5.0\times$ as long as diameter of stigma, uncus of STV about as long as diameter of stigma; marginal fringe slightly more than $5.0\times$ as long as PSM in its widest part. Propodeum finely reticulate, its submedian areas delimited by weak depressions on sides.

Male (Fig. 12). Similar to female: antenna with pedicel about $1.5\times$ as long as F1; flagellum with 1 anellus; F1–F3 closely attached, as wide as or slightly wider than F4 and F5, which are more pedunculate; clava appearing 5-segmented, $0.8\text{--}0.9\times$ as long as funicle; head about $2.3\times$ as broad as long; combined length of

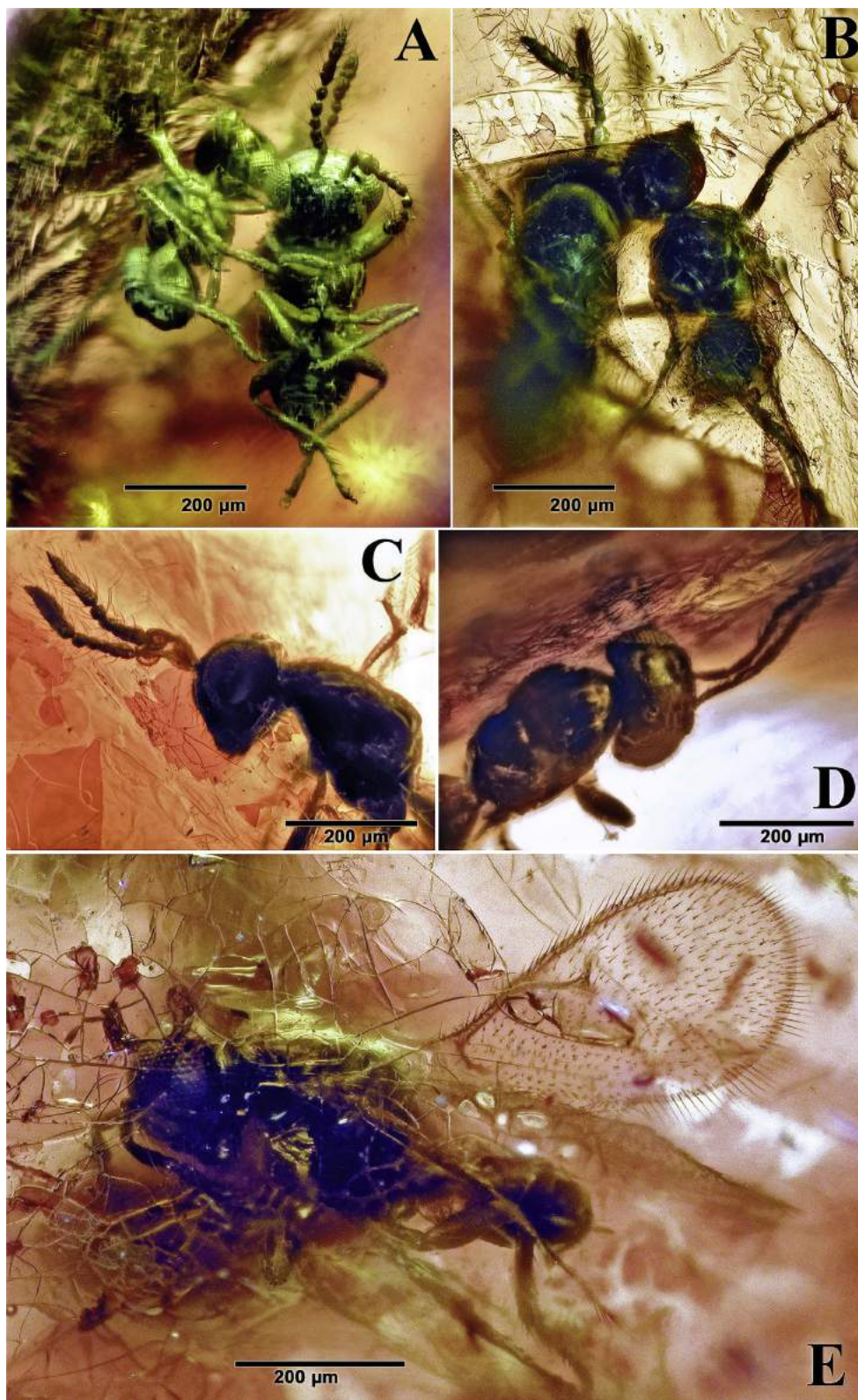


Fig. 12. Photographs and morphological details of *Baeomorpha gracilis* Gumovsky **sp. nov.**, male paratypes in Taimyr amber. (A, B) PIN 3311/2508, 2509: (A) ventral view; (B) dorsal view. (C–E) PIN 3311/2285–2287: head and anterior mesosoma of one specimen in lateral (C) and dorsal (D) view, and habitus of another specimen in lateral view (E).

pedicel plus flagellum about $1.3\times$ head width; fore wing about as long as body, about $2.2\text{--}2.3\times$ as long as broad with PMV about $3.0\times$ STV, PSM about $1.3\times$ as long as STV, and marginal fringe long, its longest seta about $4.0\times$ as long as MV in its widest part (Fig. 12E). *Locality and horizon.* Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh Hill, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype female (Fig. 10), PIN 3311/2005, Yantardakh, 2012 PIN expedition, well-preserved, complete specimen, but wings slightly bent. Paratypes (4 females, 10 males): female (Fig. 11A, B), PIN 3311/721, Yantardakh, 2012 PIN expedition, well-preserved, complete specimen, but laying at granulate background; female (Fig. 11C–F), PIN 3311/87, Yantardakh, 1971 PIN expedition, partially transparent specimen; 2 males (Fig. 12A, B), PIN 3311/2508, 2509, Yantardakh, 2012 PIN expedition, well-preserved, complete specimens, but dorsal parts and wings are difficult to observe due to non-transparent background; 3 males (Fig. 12C–E), PIN 3311/2285–2287, Yantardakh, 2012 PIN expedition, 2 are well-preserved, complete specimens, in one male metasoma is missing, one flagellum is detached and part of mesosoma is cut off; female, 5 males, PIN 3311/837, Yantardakh, 2012 PIN expedition, relatively well-preserved specimens in a large, partly transparent piece of amber; female, PIN 3130/203, Yantardakh, 1970 PIN expedition, well-preserved specimen immersed in Canada Balsam on a slide.

Comparative notes. The species is very similar to *B. zherikhini* and *B. yantardakh*, but differs from both by the scape being longer than the pedicel, and from *B. zherikhini* also by the combined length of the pedicel plus flagellum being about as long as the width of the head (about $1.3\times$ as long as head width in *B. zherikhini*).

Etymology. The Latin word “*gracilis*”, meaning “slender”, and referring to the shape of scape and general habitus of the species.

***Baeomorpha ingens* Gumovsky sp. nov.**

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(Fig. 13)

Diagnosis. Female (Fig. 13): antenna with 1 anellus and 5-segmented funicle; pedicel $1.3\text{--}1.4\times$ as long as broad, as long as each of F1–F5, all of which are of same size, $1.3\text{--}1.4\times$ as long as broad; F1–F3 slightly more closely attached than F4 and F5; clava distinctly 6-segmented, as long as funicle, in widest part $1.4\times$ as wide as F5; clavomeres of same shape and length. Posterior ocellus separated from eye margin by a distance about $1.8\times$ its larger diameter. Mesoscutellum with 2 pairs of setae. Fore wing about $1.2\text{--}1.3\times$ as long as body, about $2.6\text{--}2.8\times$ as long as broad; PMV about $3.8\times$ STV; PSM about $1.8\times$ as long as STV; STV with petiole about $5.0\times$ as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe long, its longest seta about $7.0\times$ as long as MV in its mid part, and about $3.0\times$ in its widest part (in place of contact with BV).

Description. Female. Body (Fig. 13) length about 0.8 mm. Body dark, legs (except coxae) pale. Scape dark. Head nearly smooth, densely pubescent; POL slightly longer than OOL (about $1.1\times$); posterior ocellus separated from eye margin by distance about $1.8\times$ its larger diameter. Antenna (Fig. 13A, B) with first flagellomere anelliform; pedicel $1.3\text{--}1.4\times$ as long as broad, as long as either of F1–F5, all of which are of same size, $1.3\text{--}1.4\times$ as long as broad; F1–F3 slightly (but not very distinctly) more closely attached than F4 and F5; clava distinctly 6-segmented, as long as funicle, in widest part $1.4\times$ as wide as F5, with clavomeres of same shape and length.

Mesosoma as long as metasoma (Fig. 13A). Mesoscutellum with 2 pairs of setae. Fore femur about $5.0\times$ as long as broad; fore tibia about $10\times$ as long as broad, $1.3\text{--}1.4\times$ as long as fore femur; fore

tarsus about as long as fore tibia, calcar $1.4\times$ as long as width of fore tibia. Hind femur $4.0\times$ as long as broad; hind tibia $12.0\times$ as long as broad, about $1.5\times$ as long as its femur; hind tarsus about $0.7\times$ as long as its tibia. Fore wing (Fig. 13A) about $1.2\text{--}1.3\times$ as long as body, about $2.6\text{--}2.8\times$ as long as broad; PMV about $3.8\times$ STV; PSM about $1.8\times$ as long as STV; STV with petiole about $5.0\times$ as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe long, its longest seta about $7.0\times$ as long as MV in its mid part, and about $3.0\times$ in its widest part (in place of contact with BV).

Metasomal petiole short, robust. Gaster short, ovate, slightly longer than broad. Ovipositor short, extending along major part of gaster.

Male. Unknown.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh deposit, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype female (Fig. 13), PIN 3311/97, Yantardakh, 1971 PIN expedition, well-preserved, complete specimen, but some body parts are concealed by the crack in the amber piece.

Comparative notes. The species is very distinctive in having F1–F5 somewhat elongate and of the same size. Also, this is relatively large species with long fore wings (longer than body).

Etymology. The species epithet is from the Latin word *ingens*, which means “huge”, and referring to the comparatively large body and fore wings of the insect.

***Baeomorpha popovi* Gumovsky sp. nov.**

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(Fig. 14)

Diagnosis. Male (Fig. 14): antenna with scape about $1.7\text{--}1.8\times$ as long as broad; pedicel teardrop-shaped, slightly longer than broad, $0.8\times$ as long as scape, about $1.5\times$ as broad as F1; flagellum with 1 anellus and 5 funiculars; funicular segments uniformly attached, F1 somewhat larger than rest of funiculars in male, but more distinctly larger in female. Head in dorsal view slightly less than $2.0\times$ as broad as long; POL about $4.7\times$ OOL; posterior ocellus separated from eye margin by about half of its own diameter. Axillar suture faded posteriorly. Fore wing short, only $0.7\times$ as long as body, slightly less than twice (about $1.8\text{--}1.9\times$) as long as broad; SMV break very distinct; PSM about as long as STV, petiole of which about $5.0\times$ as long as diameter of stigma, and uncus slightly shorter than diameter of stigma; propodeum with sublateral grooves. **Female:** POL slightly more than $4.0\times$ as long as OOL, flagellum similar to male, but flagellomeres shorter and sub-circular, F1 nearly $2.0\times$ wider than F2–F5.

Description. Male. Body length about 0.8–0.9 mm. Body (Fig. 14A–C) with bright golden-green tint in reflected light. Scape dark.

Head light reticulate, slightly wider than mesosoma in dorsal view. Head in dorsal view about $1.8\times$ as broad as long; POL about $4.7\times$ OOL; posterior ocellus separated from eye margin by about half of its own diameter (Fig. 14A). Face convex, evenly rounded frontally (Fig. 14D, E). Clypeus distinctly delimited as a convex plate with anterior margin emarginate (Fig. 14D). Antennal torulus situated above middle of face and above middle of eye height (Fig. 14D). Head in lateral view with vertex evenly rounded into occiput and with numerous sparse setae. Eye in lateral view slightly higher than wide, about $0.7\times$ as high as head height in frontal view. Head in frontal view about $1.3\times$ as wide as high, mouth opening about $2.0\times$ as long as malar space (visible in PIN 3311/1398). Mandibles bidentate. Antenna (Fig. 14A, D, E) with scape about $1.7\text{--}1.8\times$ as long as broad; pedicel teardrop-shaped, slightly longer than broad, $0.8\times$ as long as scape, about $1.5\times$ as broad as F1;

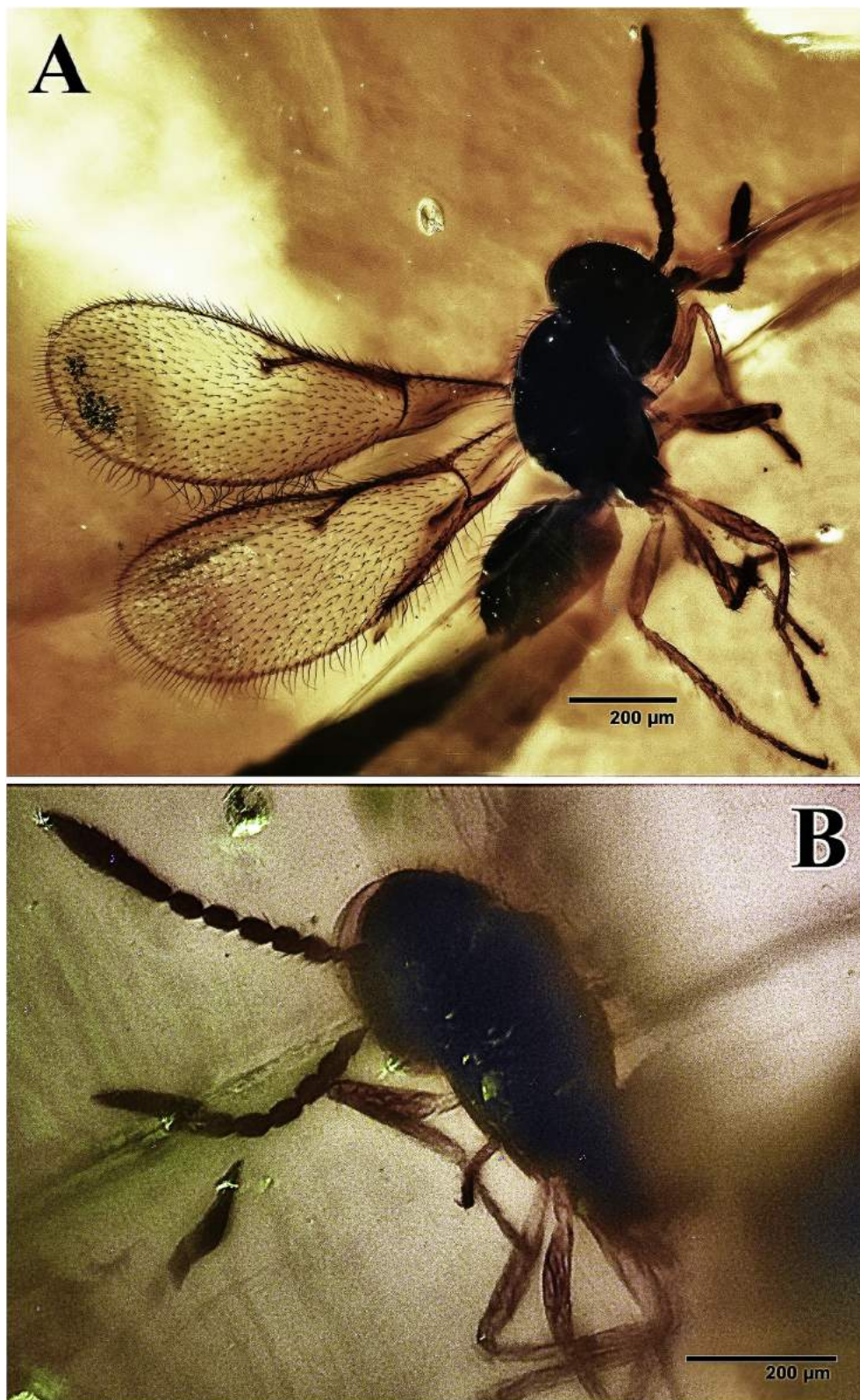


Fig. 13. Photographs of *Baeomorpha ingens* Gumovsky **sp. nov.**, female holotype in Taimyr amber, PIN 3311/97. (A) Habitus. (B) Head and anterior part of mesosoma.

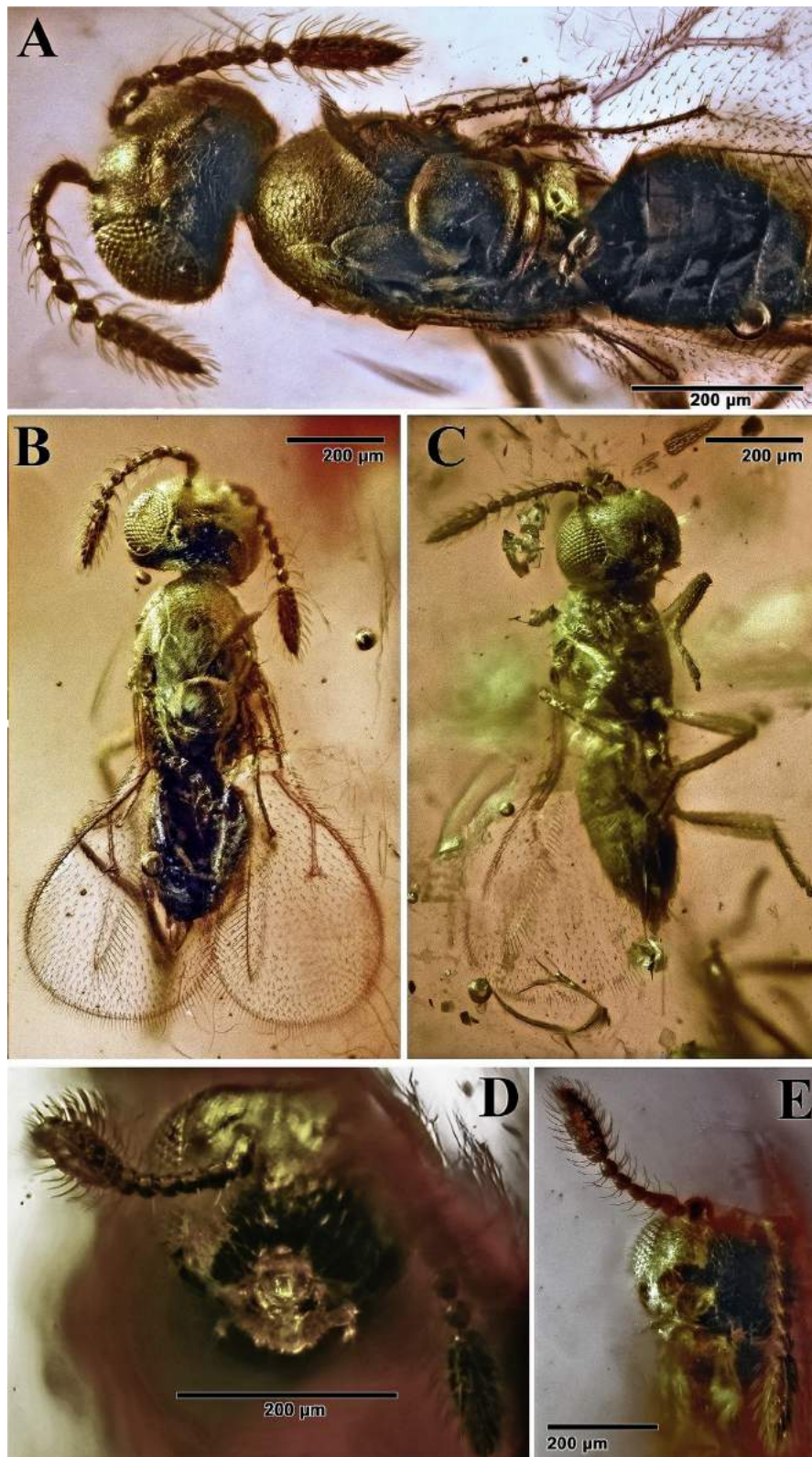


Fig. 14. Photographs and morphological details of *Baeomorpha popovi* Gumovsky **sp. nov.**, Taimyr amber. (A–C) Holotype, PIN 3311/1386: (A) Body in dorsal view; (B, C) Habitus in dorsal (B) and lateral (C) views. (D, E) PIN 3311/1398, head in frontal view.

flagellum with 1 anellus and 5 funiculars; F1–F3 of same size, slightly longer than broad, only weakly more closely (or rather somewhat broader) attached, but not wider than F4 and F5, which are only slightly shorter and slightly pedunculate; clava about $3.0\times$ as long as broad, slightly shorter than funicle, 5-segmented, with separated small terminal clavomere, and mean width about $1.7\text{--}1.8\times$ of mean width of F1–F5. Combined length of pedicel plus flagellum about $1.4\times$ head width (Fig. 14A).

Mesosoma about as long as metasoma; dorsum light reticulate (Fig. 14B, C). Mesoscutum with several pairs of setae and distinct notauli, about $1.7\text{--}1.8\times$ as long as mesoscutellum (Fig. 14A); each notaulus present as weak suture ending posteriorly at small emargination of anterior margin of axilla. Axilla very advanced, with posterior margin of axillar suture poorly delimited, and with 1 seta proximally. Mesoscutellum with 2 pairs of setae. Propodeum finely reticulate, submedian areas with distinct grooves in holotype. Fore femur $3.2\times$ as long as broad; fore tibia about $8.0\times$ as long as broad, about as long as fore femur; fore tarsus slightly ($0.8\text{--}0.9\times$ as long as) shorter than fore tibia and calcar about as long as width of fore tibia, with basitarsal comb on fore basitarsus present as three setae; mid tibia about $1.2\times$ as long as mid femur, about $1.5\text{--}1.6\times$ as long as mid tarsus; hind tibia about $8.0\times$ as long as broad, about $1.3\times$ as long as hind femur and $1.6\times$ as long as hind tarsus. Fore wing only $0.7\times$ as long as body, slightly less than twice (about $1.8\text{--}1.9\times$) as long as broad; SMV distinctly broken (Fig. 14A, B); PMV about $2.2\text{--}2.4\times$ STV; PSM about as long as STV; STV with petiole about $5.0\times$ as long as diameter of stigma and uncus slightly shorter than diameter of stigma; marginal fringe moderate, its longest seta at most $3.0\times$ as long as MV in its widest part.

Metasomal petiole short, transverse. Gaster short, $1.4\times$ as long as broad. Genitalia with phallobase bearing protruding parameres and digiti with two poorly visible blunt spines.

Female (based on a non-type specimen). Similar to male in general antennal structure, long POL and short OOL. Differs from male in shorter and subcircular flagellomeres, among which F1 is nearly $2.0\times$ wider than F2–F5.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taymyr Peninsula; Yantardakh Hill, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype male (Fig. 14A–C), PIN 3311/1386, Yantardakh, 2012 PIN expedition; well-preserved, complete specimen. Paratypes (7 males): 2 males, PIN 3311/1389, Yantardakh, 2012 PIN expedition: one male is well-preserved, nearly complete specimen, just clava of one antenna is cutted off; another male has both antenna partly damaged; male, PIN 3311/1398, Yantardakh, 2012 PIN expedition: well-preserved, but partly damaged specimen with easily observable frontal projection of head, Fig. 14D, E; syninclusions: remnants of another male specimen (likely same species: only legs and metasoma remained) and part of a spider (as PIN 3311/1399); 3 males of total 7 (only 3 are in good condition, among the other 4 non-type specimens: three are present by meso- and metasoma only, and one is present just by a leg remnants), PIN 3311/1395, Yantardakh, 2012 PIN expedition; syninclusions: dipterans 1396 and 1397; male (in a good condition) of total 6, among the remaining 5 (non-type): 4 are oxidized and one is present by an antenna only, PIN 3311/1387, Yantardakh, 2012 PIN expedition.

Non-type material (apart from specimens mentioned above with the types). 3 oxidized males (presumably of this species, but problematic for observation), PIN 3311/1400, Yantardakh, 2012 PIN expedition; female, PIN 3311/90, Yantardakh, 1971 PIN expedition, complete specimen, but many body parts are turned transparent; with an aphid nymph syninclusion.

Comparative notes. This is a very distinctive species in having a long POL, short OOL, fore wing shorter than the body (at least in male)

and propodeum with sublateral grooves (at least in holotype, Fig. 14A). The female has a certain resemblance to *B. quattoruno* in having an enlarged F1, but the funicle is 4-segmented in the latter species and 5-segmented in *B. popovi*. The males may be confused with males of *B. gracilis* because they share a 5-segmented funicle with weakly widened proximal flagellomeres. However, *B. popovi* differs in having a shorter antennal scape, F1–F3 just weakly grouped together, and also by the diagnostic characters mentioned above and in the key.

Etymology. The species is named in memory of our friend, the prominent paleoentomologist Yuri Popov.

***Baeomorpha quattorduo* Gumovsky sp. nov.**

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(Fig. 15)

Diagnosis. Male (Fig. 15A–E): antenna with scape about $2.5\times$ as long as broad; pedicel teardrop-shaped, about $1.6\times$ as long as broad, slightly shorter than scape; flagellum with 1 anellus and 4-segmented funicle; F1 and F2 more broadly attached and wider than F3 and F4; clava appearing 5-segmented in male; combined length of pedicel plus flagellum about as long as width of head. Head in dorsal view about $3.2\times$ as broad as long; POL about $2.6\times$ OOL; posterior ocellus separated from eye margin by about its own diameter. Axillar suture distinct throughout. Fore wing about $0.8\times$ as long as body, about $2.0\times$ as long as broad; SMV break weak; PSM about $1.6\times$ as long as STV, petiole of which about $3.0\times$ as long as diameter of stigma and uncus slightly shorter than stigmal diameter. Propodeum smooth. **Female** (Fig. 15F): F1 and F2 widened, combined length of pedicel plus flagellum nearly as long as head width, metasoma as long as mesosoma.

Description. Male. Body (Fig. 15A–E) length about 0.6 mm. Body with bright golden-green tint in reflected light. Antennal scape dark.

Head light alutaceous, slightly wider than mesosoma in dorsal view. Antennal torulus situated slightly above middle of face and middle of eye height (Fig. 15C). Head in lateral view with vertex smoothly rounded into occiput. Eye in lateral view slightly higher than wide. Face convex, evenly rounded frontally. Head in dorsal view about $3.2\times$ as broad as long; POL about $2.6\times$ OOL; posterior ocellus separated from eye margin by about its own diameter. Antenna (Fig. 15G, H) with scape about $2.5\times$ as long as broad; pedicel teardrop-shaped, about $1.6\times$ as long as broad, slightly shorter than scape; flagellum with 1 anellus and 4 funiculars, each about $1.4\times$ as long as broad, of about same size, but F1 and F2 closely and broadly attached and slightly wider than free (narrowly attached) F4 and F5; clava appearing 5-segmented, about $3.8\times$ as long as broad, about as long as funicle, with mean width about $1.5\times$ mean width of F2–F5. Combined length of pedicel plus flagellum about as long as width of head.

Mesosoma about $1.4\times$ as long as metasoma (Fig. 15A–C, E), about $1.6\times$ as long as broad; dorsum with light alutaceous reticulation. Mesoscutum about nearly $2.0\times$ as long as mesoscutellum; mesoscutum with several pairs of setae and distinct notauli present as fine sutures ending posteriorly at anterior upmost margin of axilla, which is evenly delimited posteriorly. Axilla very advanced, with anterior margin somewhat emarginate at point of contact with notaulus, and with 1 seta proximally. Mesoscutellum with 2 pairs of setae. Propodeum appearing entirely smooth. Fore femur about $4.0\times$ as long as broad and slightly longer than fore tibia; fore tibia slightly longer than fore tarsus; mid femur $3.2\times$ as long as broad; mid tibia slightly more than $8.0\times$ as long as broad, about $0.7\text{--}0.8\times$ as long as mid femur and about $1.4\times$ as long as mid tarsus; hind femur nearly $4.0\times$ as

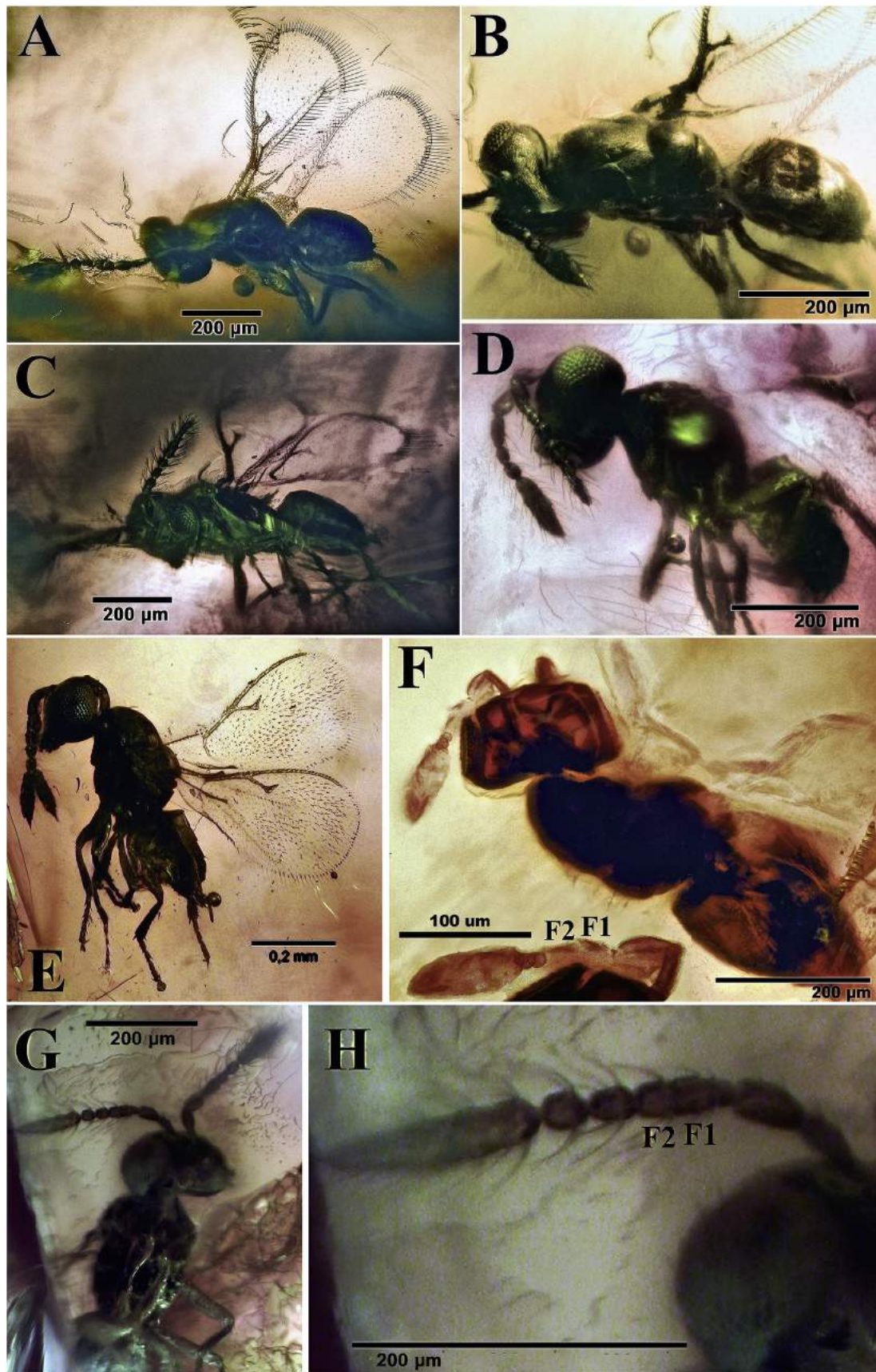


Fig. 15. Photographs and morphological details of *Baeomorpha quattorduo* Gumovsky **sp. nov.**, Taimyr amber: (A–C) Holotype male, PIN 3311/85, habitus under different angles. (D) Male paratype, PIN 3311/2668, body, lateral view. (E) Male paratype, PIN 3311/1392. (F) Female paratype, PIN 3311/84, body and antenna in inset. (G) male paratype, PIN 3311/2416, habitus. (H) Antenna enlarged. See text for abbreviations.

long as broad; hind tibia $7.0\times$ as long as broad, about $0.7\times$ as long as hind femur, about $1.5\times$ as long as hind tarsus. Fore wing (Fig. 15A) about $0.8\times$ as long as body, about $2.0\times$ as long as broad; PMV about $3.6\times$ STV; PSM about $1.6\times$ as long as STV; STV with petiole about $3.0\times$ as long as diameter of stigma, uncus of stigma slightly shorter than stigmal diameter; SMV weakly broken; marginal fringe with longest seta about $3.2\text{--}3.4\times$ as long as MV in its widest part.

Metasomal petiole short transverse. Gaster short, about $1.4\times$ as long as broad.

Female (Fig. 15F). Similar to male in general habitus: antenna with F1 and F2 more distinctly widened (perhaps artefacts of preservation, Fig. 15F, inset); combined length of pedicel plus flagellum nearly as long as head width; metasoma as long as mesosoma.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taymyr Peninsula; Yantardakh and Romanikha localities, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype male (Fig. 15A), PIN 3311/85, Yantardakh, 1971 PIN expedition, well-preserved specimen, but with slightly shriveled head and with a crack in the middle of the amber piece; with another damaged male syninclusion (non-type). Paratypes (4 males, 1 female): male (Fig. 15E), PIN 3311/1392, Yantardakh, 2012 PIN expedition, well-preserved specimen, most characters are visible in lateral view; male, PIN 3311/100, Yantardakh, 1971 PIN expedition, well-preserved specimen, but rather transparent; male (Fig. 15D), PIN 3311/2668, Yantardakh, 2012 PIN expedition, well-preserved specimen in amber piece with uneven surface; male (Fig. 15G), PIN 3311/2416, Yantardakh, 2012 PIN expedition, relatively well-preserved, but incomplete specimen, just head and mesosoma remained, rest is cut off; female (Fig. 15F), PIN 3311/84, Yantardakh, 1971 PIN expedition, well-preserved, but very transparent specimen, with mymarid syninclusion.

Non-type material. female, PIN 3313/4, Romanikha-2, 1971 PIN expedition, poorly visible specimen (mostly wings and partly antenna), with syninclusions labeled “Diptera, Heteroptera”; male, PIN 3311/85, Yantardakh, 1971 PIN expedition (synincluded with holotype).

Comparative notes. This species differs from *B. quattoruno* in having both F1 and F2 more broadly attached in the male and distinctly widened in the female (only F1 is widened in *B. quattoruno*).

Etymology. The species name is a combination of the Latin “quattor” (“four”) and “duo” (“two”), which refers to the four-segmented funicle with two enlarged proximal funiculars.

***Baeomorpha quattoruno* Gumovsky sp. nov.**

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(Fig. 16)

Diagnosis. Female (Fig. 16A–D): antenna with 1 anellus and 4-segmented funicle; F1 and F2 more broadly attached than F3 and F4; F1 somewhat larger than F2–F4 in female, only slightly larger or as broad as in male; clava appearing 4-segmented; combined length of pedicel plus flagellum about as long as or slightly longer than head width. Head in dorsal view about $2.2\text{--}2.3\times$ as broad as long; POL about $3.0\times$ OOL; posterior ocellus separated from eye margin by about its own diameter. Axillar suture slightly fading posteriorly. Fore wing moderately long, $0.8\text{--}0.9\times$ as long as body, about $2.2\text{--}2.3\times$ as long as broad; SMV break weak; PSM about $2.2\times$ as long as STV; STV petiole about $4.0\times$ as long as diameter of stigma and uncus short, about as long as stigmal diameter. Propodeum smooth. **Male** (Fig. 16E, F): flagellum with 1 anellus, 4-segmented funicle and 5-segmented clava, which about as long as funicle; F1–F4 of same size and width, about $1.3\text{--}1.4\times$ as long as broad.

Description. Female. Body length about $0.5\text{--}0.6$ mm. Body (Fig. 16A, C, D) with bright golden-green tint in reflected light. Head light alutaceous, slightly wider than mesosoma.

Head in dorsal view about $2.2\text{--}2.3\times$ as broad as long; POL about $3.0\times$ OOL; posterior ocellus separated from eye margin by about its own major diameter. Head in lateral view with vertex smoothly rounded into occiput and with sparse setae. Antennal torulus situated in middle of face at middle of eye height (Fig. 16B). Eye in lateral view about $1.2\text{--}1.3\times$ as high as wide. Face convex, evenly rounded frontally, densely setose below level of antennal insertion (Fig. 16B). Antenna (Fig. 16B) with scape about $2.6\times$ as long as broad; pedicel teardrop-shaped, about $1.5\times$ as long as broad, $0.5\text{--}0.7\times$ as long as scape; flagellum with 1 anellus and 4-segmented funicle; F1 and F2 more broadly attached than F3 and F4; F1 somewhat larger than subcircular F2–F4; clava appearing 4-segmented, $3.0\times$ as long as broad, $1.3\times$ as long as funicle, with mean width about $2.0\text{--}2.5\times$ of mean width of F2–F4. Combined length of pedicel plus flagellum about as long as or slightly longer than width of head (Fig. 16C).

Mesosoma about as long as metasoma (Fig. 16A, C), about $1.4\times$ as long as broad; dorsum with light alutaceous reticulation (Fig. 16C). Mesoscutum about $1.6\times$ as long as mesoscutellum, with several pairs of setae and distinct notauli, each notaulus present as weak suture ending posteriorly at anterior upmost margin of axillar suture. Axilla very advanced, posterior margin slightly emarginate at place of contact with notaulus; and with 1 seta proximally; posterior margin of axillar suture slightly fading in holotype. Mesoscutellum with 2 pairs of setae. Metanotum present as a narrow bar. Fore femur about $4.0\times$ as long as broad, about as long as fore tibia; fore tarsus about $0.7\text{--}0.8\times$ as long as fore tibia; mid tibia about $1.5\times$ as long as mid tarsus; hind femur about $3.0\times$ as long as broad; hind tibia about $7.0\times$ as long as broad, about $1.4\times$ as long as hind femur and about $1.8\times$ as long as hind tarsus. Fore wing only $0.8\text{--}0.9\times$ as long as body (Fig. 16A, C), about $2.2\text{--}2.3\times$ as long as broad; SMV slightly broken; PMV nearly $4.0\times$ STV ($3.8\times$ in holotype); PSM about $1.5\times$ as long as STV; STV with petiole about $4.0\times$ as long as diameter of stigma and uncus short, about as long as stigmal diameter. Marginal fringe moderate, its longest seta about $2.5\text{--}3.0\times$ as long as MV in its widest part. Propodeum appearing smooth or finely reticulate.

Metasomal petiole short, transverse; gaster short, $1.4\times$ as long as broad.

Male (Fig. 16E, F). Similar to female: flagellum with 1 anellus and 4-segmented funicle, but with 5-segmented clava; F1–F4 of same size and width, about $1.3\text{--}1.4\times$ as long as broad, occasionally with distinct whorls of setae (PIN 3311/101); funicle about as long as clava (Fig. 16F).

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taymyr Peninsula; Yantardakh and Ugolyak localities, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype female (Fig. 16A, B), PIN 3311/2808, Yantardakh, 2012 PIN expedition, well-preserved, complete specimen, but some parts are difficult to observe due to the debris on the background. Paratypes (4 females, 5 males): female, PIN 3130/39, Yantardakh, 1970 PIN expedition, body largely brown-transparent, fore wing partly damaged; female, PIN 3311/94, Yantardakh, 1971 PIN expedition, body mostly brown to transparent; female, PIN 3311/93, Yantardakh, 1971 PIN expedition, relatively well-preserved specimen, but antennae are mostly transparent; female (Fig. 16C), PIN 3311/2883, Yantardakh, 2012 PIN expedition, relatively well-preserved specimen, but with a “cloud” around preventing its proper observation; 3 males, PIN 3311/98, Yantardakh, 1971 PIN expedition, relatively well-preserved specimens, but partly transparent; male, PIN 3311/102, Yantardakh, 1971 PIN expedition, relatively well-preserved specimen, but partly

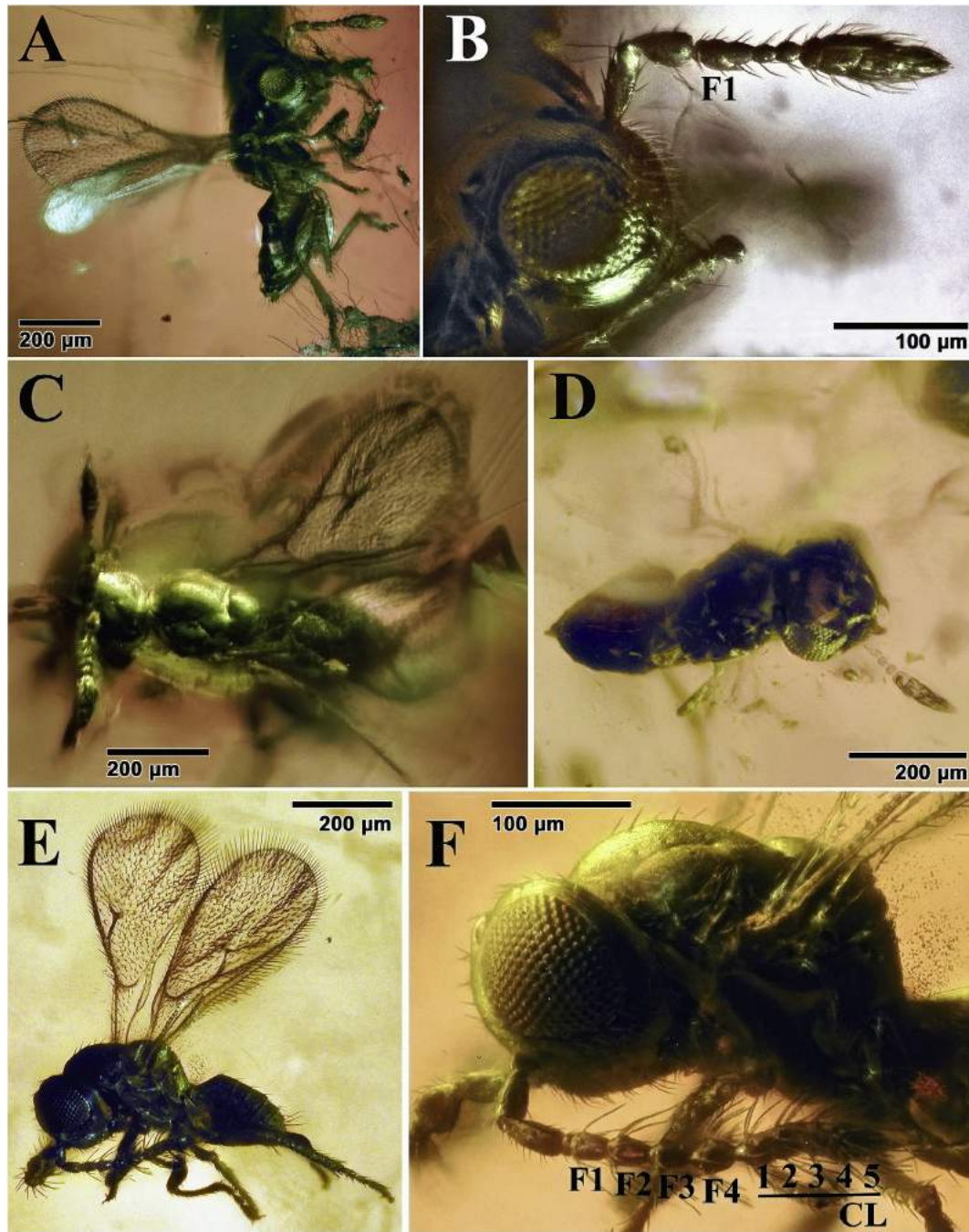


Fig. 16. Photographs and morphological details of *Baeomorpha quattoruno* Gumovsky **sp. nov.**, Taimyr amber. (A, B) Holotype PIN 3311/2808: (A) General view; (B) Head and antenna enlarged. (C) Female paratype, PIN 3311/2883. (D) Female paratype PIN 3311/93. (E, F) male paratype PIN 3311/101: (E) habitus in lateral view; (F) head, antenna and mesosoma enlarged. See text for abbreviations.

transparent; male (Fig. 16E, F), PIN 3311/101, Yantardakh, 1971 PIN expedition, well-preserved specimen.

Non-type material. female, PIN 3311/86, Yantardakh, 1971 PIN expedition, largely transparent specimen, wings hardly discernible; [sex undetermined] Yantardakh, PIN 3311/91, 1971 PIN expedition, relatively well-preserved specimen, but mostly transparent; [sex undetermined] PIN 3631/31, Ugolyak, 1977 PIN expedition, complete, but mostly transparent specimen.

Comparative notes. This species is similar to *B. quattorduo* in having a flagellum with 1 anellus and 4-segmented funicle, but differs by having F1 larger than F2 in the female and of nearly the same width in the male (both F1 and F2 are widened in *B. quattorduo*).

Etymology. The species name is a combination of the Latin “quattor” (“four”) and “uno” (“one”), which refers to the four-segmented funicle with just one enlarged proximal funicular.

Baeomorpha yantardakh* Gumovsky **sp. nov.*

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(Fig. 17)

Diagnosis. Female (Fig. 17): antenna with scape somewhat triangular, about 1.7× as long as broad, as long as pedicel; pedicel teardrop-shaped, about as long as broad; flagellum with 1 anellus,

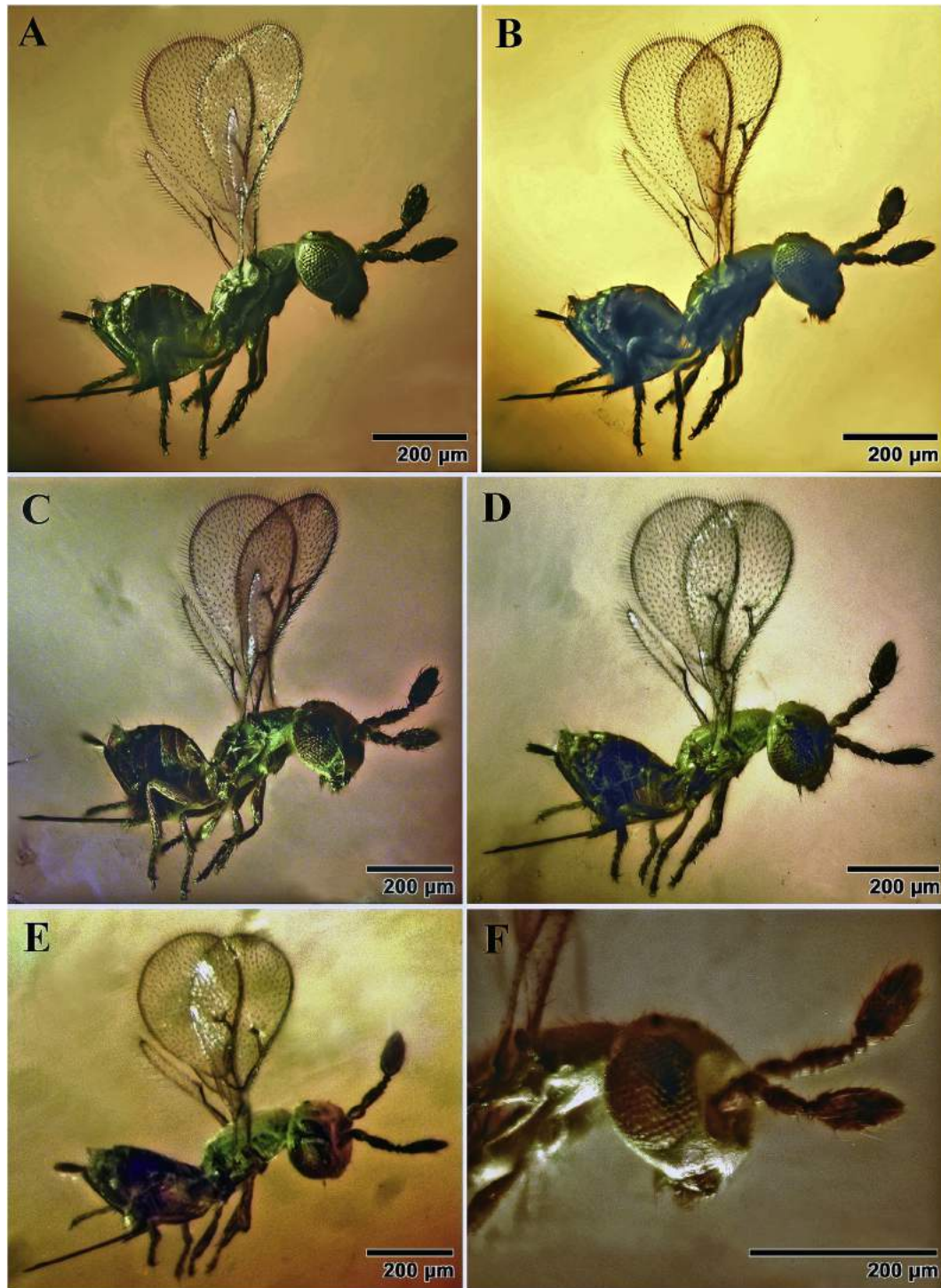


Fig. 17. Photographs and morphological details of *Baeomorpha yantardakh* Gumovsky **sp. nov.**, holotype, PIN 3311/1918, Taimyr amber. (A–E) Habitus under different angles. (F) Head and anterior mesosoma enlarged.

and 5-segmented funicle slightly shorter than (about $0.8\times$ as long as) clava; F1–F3 distinctly widened, transverse and closely attached, with nearly no constrictions between them, distinctly wider than free F4 and F5; at least F1–F3 and all clavomeres with MPS; CL1 nearly as wide as other clavomeres; combined length of pedicel plus flagellum about as long as width of head. Posterior ocellus separated from eye margin by distance at least $2.0\times$ its own diameter. Mesoscutellum with 2 pairs of setae. Propodeum finely reticulate. Fore wing about $0.8\times$ as long as body, about $2.2\times$ as long

as broad, PSM about $1.7\text{--}1.8\times$ as long as STV, petiole of which about $7.0\times$ as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe about $3.0\times$ as long as PSM in its widest part.

Description. Female. Body length about 0.7 mm. Body (Fig. 17A–E) with golden-green tint, original color apparently metallic. Scape dark.

Head finely sculptured; vertex and frons with sparse setae. Antennal torulus situated slightly below middle of face, below

middle of eye height; median area of face somewhat depressed in holotype (Fig. 17F). Head in lateral view with blunt occipital margin. Eye in lateral view about $1.2\text{--}1.3\times$ as high as wide. Head in dorsal view about $2.5\times$ as broad as long (not clearly visible), with minimum distance between inner orbits about $0.6\times$ head width; posterior ocellus separated from eye margin by distance at least $2.0\times$ its own diameter. Anterior margin of clypeus concave. Antenna (Fig. 17F) with scape somewhat triangular, about $1.7\times$ as long as broad, as long as pedicel; pedicel teardrop-shaped, about as long as broad; first flagellomere anelliform; F1–F3 wide, transverse, about $1.3\text{--}1.4\times$ wider than F4 and F5; F1 about $2.0\times$ as broad as long, F2 about $1.5\times$ as broad as long, F3 longer than F1 and F2, about $1.8\times$ as broad as long, F4 and F5 subcircular or slightly wider than long; clava about $2.0\times$ wider than funicle, about $1.2\times$ as long as funicle, number of its segments not easily discernible, but at least 4 clearly visible. Combined length of pedicel plus flagellum about as long as head width.

Mesoscutum with distinct notauli and at least 5 pairs of setae; dorsum very finely sculptured. Mesoscutellum with 2 pairs of setae. Hind tibia about $6.4\times$ as long as broad; hind tarsus $0.8\times$ as long as hind tibia. Fore wing about $0.8\times$ as long as body, about $2.2\times$ as long as broad; PMV about $3.0\times$ STV; PSM about $1.7\text{--}1.8\times$ as long as STV (Fig. 17A–E); STV with petiole about $7.0\times$ as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe about $3.0\times$ as long as PSM in its widest part. Propodeum very finely sculptured, without noticeable grooves.

Metasoma slightly longer than mesosoma. Ovipositor robust, extending along major part of gaster (Fig. 17A–E).

Male. Unknown.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh Hill, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype female (Fig. 17), PIN 3311/1918, Yantardakh, 2012 PIN expedition, well-preserved, complete specimen (with syninclusions PIN 3311/1919 (small hymenopteran) and PIN 3311/1920 (mite)). Paratype: female, PIN 3311/2088, Yantardakh, 2012 PIN expedition, relatively well-preserved, complete specimen, but laying with its dorsum on dark background (with dipteran syninclusions PIN 3311/2087, PIN 3311/2089).

Non-type material. Female, PIN 3426/277, Nizhnyaya Agapa, Dolgan Formation, 1973 PIN expedition. The specimen is incomplete with most of its meso- and metasoma damaged and the rest of the body significantly transparent. Its antennal structure suggests that it could be same as the type specimens.

Comparative notes. This species is very similar to *B. zherikhini* and *B. gracilis*, but differs as noted in the key, mostly by its short antennal flagellum and noticeably widened F1–F3.

Etymology. The species is named after its locality of origin.

***Baeomorpha zherikhini* Gumovsky sp. nov.**

urn:lsid:zoobank.org:act:32D57A6F-A6FC-4360-A5B3-52B89E4AB474 (Figs. 18, 19)

Diagnosis. Female (Fig. 18): antenna with scape slightly longer than pedicel, about $2.0\times$ as long as broad; pedicel teardrop-shaped, subtriangular, about $1.3\times$ as long as broad; flagellum with 1 anellus, 5-segmented funicle and 5-segmented clava; F1–F3 of about same size, closely attached, with nearly no constrictions between them, and distinctly wider than free F4 and F5; CL1 slightly smaller than other clavomeres; F2–F5 and all clavomeres with MPS; combined length of pedicel plus flagellum about $1.3\times$ as long as head width. Head in dorsal view about $2.4\text{--}2.5\times$ as broad as long; POL about $2.0\times$ OOL; posterior ocellus separated from eye margin by a distance slightly greater than its own diameter. Axillar suture

distinct throughout. Mesoscutellum with 3 pairs of setae. Propodeum finely reticulate. Fore wing slightly shorter than body, about $2.2\text{--}2.3\times$ as long as broad; PSM about $1.6\times$ as long as STV; STV with petiole about $8.0\times$ as long as diameter of stigma and uncus about as long as diameter of stigma; marginal fringe about $4.5\times$ as long as PSM in its widest part. **Male** (Fig. 19): antennal flagellum with 1 anellus, 5-segmented funicle with wider, closely attached F1–F3, and 5-segmented clava, which nearly as long as funicle; head about $2.3\times$ as broad as long; combined length of pedicel plus flagellum just slightly longer than head width; fore wing about as long as body, slightly more than $2.0\times$ as long as broad, PMV about $4.0\times$ STV, PSM about $1.5\times$ as long as STV, longest seta of marginal fringe about $3.3\times$ as long as PSM in its widest part.

Description. Female. Body (Fig. 18A, B) length about 0.8 mm. Body with gold or golden-green tint in reflected light. Scape dark.

Head (Fig. 18C) moderately convex, finely reticulate; vertex and frons with short sparse setae. Antennal torulus situated in middle of face at middle of eye height. Eye in lateral view slightly higher than wide. Head in dorsal view about $2.4\text{--}2.5\times$ as broad as long, with minimum distance between inner orbits about $0.6\times$ head width; POL about $2.0\times$ OOL, posterior ocellus separated from eye margin by a distance slightly greater than its own diameter. Antenna (Fig. 18D) with scape slightly widened apically, about $2.0\times$ as long as broad, slightly longer than pedicel; pedicel teardrop-shaped, subtriangular, about $1.3\text{--}1.4\times$ as long as broad; first flagellomere anelliform; F1–F3 of about same size, subquadrate or slightly longer than broad, closely attached, slightly (PIN 3730/35) or distinctly (others) wider than F4 and F5, the latter free and of same size or one slightly wider than another, F2–F5 with MPS (but not always discernible) (Fig. 18D); clava 5-segmented (appears 6-segmented in PIN 3426/258), about $2.0\times$ wider than and as long as funicle; CL1–CL4 with MPS. Combined length of pedicel plus flagellum about $1.3\times$ as long as head width (Fig. 18C).

Mesosoma short, robust; dorsum finely alutaceous. Mesoscutum with distinct notauli (Fig. 18B, E) and 4–5 pairs of setae. Mesoscutellum with 3 pairs of setae (distinctly visible in holotype, PIN 3730/37, Fig. 18B, and PIN 3426/258). Axillar suture not nicely visible, but looks distinct throughout. Axilla with 1 seta. Fore femur about $4.0\times$ as long as broad; fore tibia about $6.2\text{--}6.5\times$ as long as broad; fore tarsus about as long as fore tibia; mid tibia about $1.3\times$ as long as mid tarsus; hind tibia about $8.0\text{--}9.0\times$ as long as broad; hind tarsus $0.7\text{--}0.8\times$ as long as hind tibia. Fore wing about $0.8\times$ as long as body, about $2.2\text{--}2.3\times$ as long as broad (Fig. 18A); PMV about $3.5\text{--}4.0\times$ STV; PSM about $1.6\times$ as long as STV; STV with petiole about $8.0\times$ as long as diameter of stigma, and uncus about as long as diameter of stigma; marginal fringe about $4.5\times$ as long as PSM in its widest part. Propodeum finely reticulate, without distinct grooves or carinae.

Metasoma as long as mesosoma (Fig. 18E, F). Ovipositor short robust, extending along major part of gaster (Fig. 18F).

Male (Fig. 19). Similar to female in general habitus and antennal formula. Head about $2.3\times$ as broad as long; combined length of pedicel plus flagellum slightly longer (about $1.1\times$) than head width (Fig. 19A–D); funicular segments somewhat longer and hairier than for female; clava 5-segmented, nearly as long as funicle (Fig. 18E, F); fore wing (Fig. 19E) about as long as body, slightly more than $2.0\times$ as long as broad, with PMV about $4.0\times$ STV, PSM about $1.5\times$ as long as STV, and marginal fringe moderate, its longest seta about $3.3\times$ as long as PSM in its widest part.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Lake Taimyr, Baikura-Neru Bay, ?Ognevka Formation, upper Albian –?lower Cenomanian, middle Cretaceous.

Type material. Holotype: female (Fig. 18A–D), Baikura-2, PIN 3730/37, 1976 PIN expedition, well-preserved, complete specimen. Paratypes (4 females, 7 males): female (Fig. 18E), PIN 3730/93, Baikura, 1976 PIN expedition, well-preserved, complete specimen, but

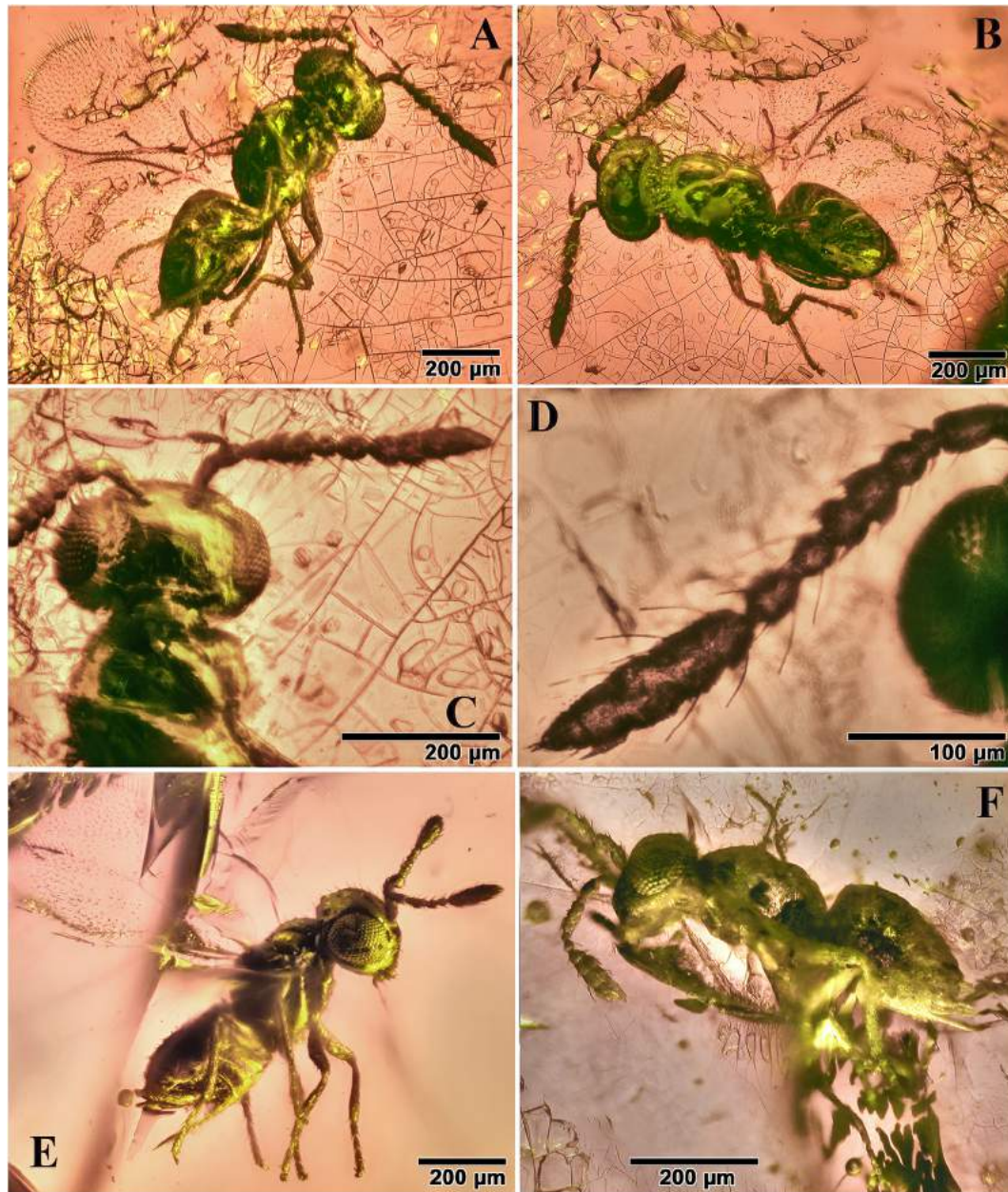


Fig. 18. Photographs and morphological details of *Baeomorpha zherikhini* Gumovsky *sp. nov.*, females in Taimyr amber. (A–D) holotype, PIN 3730/37: (A, B) Habitus. (C) Head and antenna. (D) Antenna. (E) PIN 3730/93, paratype habitus. (F) PIN 3730/43, paratype habitus.

wings are folded and hardly discernible; male, PIN 3730/143, Baikura-2, 1976 PIN expedition, mostly complete specimen with dorsal part of head and anterior part of mesosoma cutted off; male (Fig. 19A–D), PIN 3730/162, Baikura, 1976 PIN expedition, well-preserved, complete specimen; female, PIN 3730/35, Baikura-2, 1976 PIN expedition, moderately-well preserved, complete specimen, but some body parts are covered by debris; male (Fig. 19E), Baikura-2, PIN 3730/39, 1976 PIN expedition, well-preserved, complete specimen (but possesses notable constrictions between F2–F4, like in holotype); male, PIN 3730/41, Baikura-2, 1976 PIN expedition, complete specimen, but partly shriveled with bent wings; female, PIN 3730/42, Baikura-2, 1976 PIN expedition, moderately well preserved, complete specimen, partly shriveled; female (Fig. 18F), PIN 3730/43, Baikura-2, 1976 PIN expedition,

nearly complete specimen, but wings and parts of mesosoma are hardly discernible; 3 males (1 in good condition, Fig. 19F, 2 very oxidized: likely males, but not discernible), PIN 3730/44, 45, 46, Baikura-2, 1976 PIN expedition, good male: well-preserved, nearly complete specimen, but wings are hardly discernible (PIN).

Non-type material. Female, PIN 3426/258, Nizhnyaya Agapa-3, Dolgan Formation, 1973 PIN expedition, well-preserved, nearly complete specimen, but wings are hardly discernible, not included in the type series because of the appearance (? superficial) of a 6-segmented clava.

Comparative notes. This species is similar to *B. gracilis*, but differs mostly by the F1–F3 being wider, having a shorter distance between a posterior ocellus and eye margin, and also by several other features given in the “Diagnosis” and in the key above. This species

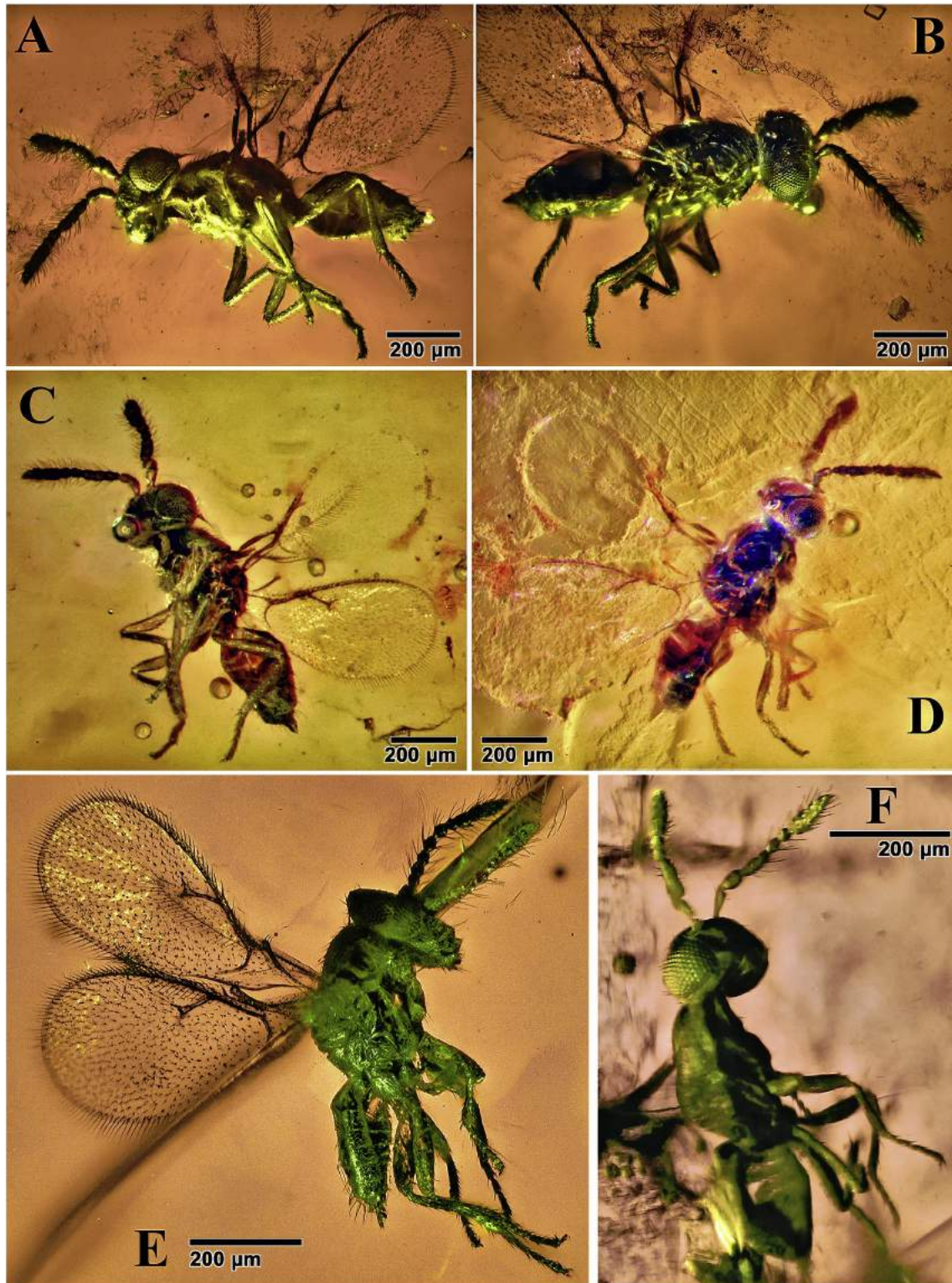


Fig. 19. Photographs and morphological details of *Baeomorpha zherikhini* Gumovsky **sp. nov.**, male paratypes in Taimyr amber, habitus: (A–D) PIN 3730/162; (E) PIN 3730/39; (F) PIN 3730/44.

also differs from all other species of the genus by the presence of 3 pairs of setae on the mesoscutellum.

Etymology. The species is named after famous paleoentomologist Vladimir Zherikhin.

***Taimyromorpha* Gumovsky, gen. nov.**

urn:lsid:zoobank.org:act:CD25E323-E1E4-4BC7-AADD-13F8F9C0BA8C
(Fig. 20)

Remarks. This monotypic new genus is proposed for enigmatic species represented so far by a single amber inclusion (Fig. 20A) of

an enigmatic rotoitid with wing venation being different from *Baeomorpha*.

Diagnosis. Female (Fig. 20). Occipital carina hardly discernible, vertex likely smooth; ocelli distinct. Antennal torulus situated above lower margin of eye, about near middle of face. Female antenna with short, ovate scape and similarly shaped pedicel; flagellum with 6 funiculars, neither of which anelliiform; antennal clava wider than funicle, with 5 distinct clavomeres (Fig. 20B), which bear discernible MPS being fused with flagellomeres over their proximal one-half to two-thirds. Face hardly visible in the available specimen.

Pronotum likely short, transverse (Fig. 20C). Mesoscutum with complete, sutured notauli ending posteriorly at anterior margin of distinctly advanced and delimited axillae, transscutal articulation distinct (Fig. 20D); mesoscutellum with 2 pairs of bristles (when

discernible). Prepectus not discernible. Propodeum in shape of narrow stipe.

Fore wing as for the family, but with short STV with petiole as wide as stigma (Fig. 20E, F). Hind wing hardly visible in the available specimen.

Legs with 4-segmented tarsi, fore tibia with short, nearly straight, bifid calcar. Basitarsal comb not discernible in the available specimen.

Metasomal petiole likely short, transverse, gaster short; epipygium not produced; hypopygium likely short, and ovipositor very short, extending along major part of gaster.

Comparative notes. This genus is close to *Baeomorpha* in having the mesosoma with complete, sutured notauli and distinctly delimited advanced axillae (notauli and axillae are reduced in *Rotoita*), and the antennae inserted near middle of face. The main and so far the

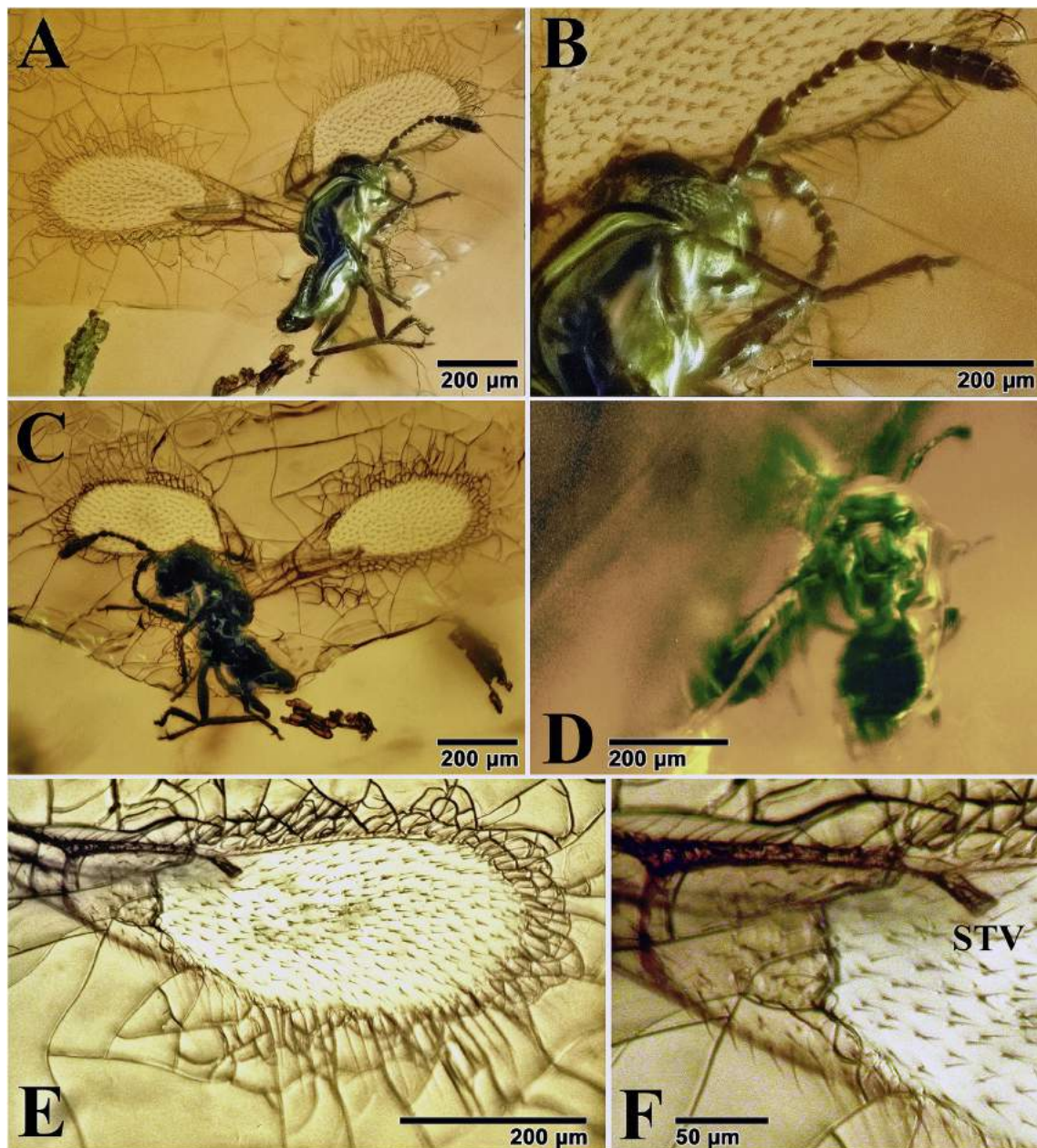


Fig. 20. Photographs and morphological details of *Taimyromorpha pusilla* Gumovsky **sp. nov.**, holotype, PIN 3311/3396, Taimyr amber. (A, C, D) Habitus: (A, C) Lateral view; (D) Dorsal view. (B) Head and anterior part of mesosoma. (E, F) Fore wing: (E) General view; (F) Proximal part with labeled stigmal vein (STV).

only morphological difference between the genera is the STV, which is relatively short, nearly sessile in *Taimyromorpha* and much longer, with long petiole in *Baeomorpha*. Forewing venation is one of most conservative characters used to discriminate genera in Chalcidoidea, therefore despite overall similarity with *Baeomorpha*, we propose a separate genus for the enigmatic Taimyr amber inclusion described below as *Taimyromorpha pusilla* sp. nov.

Biology. Not known.

Fossil deposition. Taimyr amber from Kheta Formation (Upper Cretaceous: upper Santonian, 84–86 Ma).

Etymology. The genus epithet is a combination of “Taimyr” (the deposition name) and “-morpha” (from *Baeomorpha*).

***Taimyromorpha pusilla* Gumovsky sp. nov.**

urn:lsid:zoobank.org:act:CC74B5AD-60AE-4736-BAD5-BD67B089105F
(Fig. 20)

Diagnosis. Female (Fig. 20): antennal scape and pedicel of the same shape and length, both about $1.5\times$ as long as broad; flagellum without distinct anellus, with 6 flagellomeres, of which F1–F4 small and subcircular, and free, and F5 and F6 subequal and larger than F1–F4; clava about $4.0\times$ as long as broad, slightly longer than funicle, distinctly 5-segmented; combined length of pedicel plus flagellum about as long as head width. Head in dorsal view appearing about $3.0\times$ as broad as long; posterior ocellus separated from eye margin by $1.7\times$ its major diameter. Propodeum finely reticulate. Fore wing about $1.2\text{--}1.3\times$ as long as body, about $3.0\times$ as long as broad; PSM about $4.5\text{--}5.0\times$ as long as short STV, which at most $1.5\times$ as long as diameter of stigma; PMV about $8.0\times$ STV; marginal fringe long, its longest seta about $8.0\times$ as long as PSM in its widest part.

Description. Female (Fig. 20). Body (Fig. 20A) length about 0.5 mm. Body with golden-green tint, original color apparently metallic. Scape dark.

Head (Fig. 20B) light reticulate, slightly wider than mesosoma in dorsal view. Eye in lateral view about $1.5\times$ as high as wide. Head in dorsal view about $3.0\times$ as broad as long (not clearly visible in holotype); POL about $2.0\times$ OOL (not clearly visible in holotype); posterior ocellus separated from eye margin by about $1.7\times$ its major diameter. Both antennal scape and pedicel about $1.5\times$ as long as broad; F1–F4 small but not anelliform, of same size, as long as broad, about $0.5\times$ as broad as pedicel; F5 and F6 wider than preceding funiculars and F6 slightly wider than F5; clava distinctly 5-segmented, about $4.0\times$ as long as broad, slightly longer than funicle, in widest part $1.6\times$ as wide as F5, $2.2\times$ as wide as F1, CL4 and CL5 with distinct MPS (Fig. 20B). Combined length of pedicel plus flagellum about as long as width of head.

Mesosoma as long as metasoma (Fig. 20C); dorsum and propodeum finely reticulate (Fig. 20D).

Fore tibia about $8.0\text{--}9.0\times$ as long as broad; fore tarsus about $0.7\text{--}0.8\times$ as long as fore tibia, calcar about $1.4\times$ as long as width of fore tibia; hind femur $4.0\times$ as long as broad; hind tibia about $9.0\times$ as long as broad, about $1.3\times$ as long as hind femur; hind tarsus $0.7\times$ as long as hind tibia.

Fore wing longer than (about $1.2\times$ as long as) body (Fig. 20E), about $3.0\times$ as long as broad; PMV about $8.0\times$ STV; PSM about $5.0\times$ as long as short STV (Fig. 20F), in which uncus reduced and petiole at most $1.5\times$ as long as diameter of stigma; marginal fringe long, its longest seta about $7.5\text{--}8.0\times$ as long as MV in its widest part.

Gaster short, ovate, about as long as broad.

Male. Unknown.

Locality and horizon. Taymyrsky Dolgano-Nenetsky District, Taimyr Peninsula; Yantardakh Hill, Kheta Formation, upper Santonian, Upper Cretaceous.

Type material. Holotype female (Fig. 20), PIN 3311/3396, Yantardakh, 2012 PIN expedition, well-preserved, complete specimen, but some dorsal body parts are concealed by air bubbles and background pattern.

Comparative notes. Since this is the only species of its genus, the comparative species diagnosis is not strictly applicable. However, the long fore wing (about $1.2\text{--}1.3\times$ as long as body and about $3.0\times$ as long as broad) and flagellum with small F1–F4 and larger F5 and F6 may be considered of specific value, if more *Taimyromorpha* species are found.

Etymology. The species epithet *pusillus* means “small” or “tiny” in Latin and refers to body size and habitus of the holotype.

4. Discussion

4.1. Baeomorpha and Taimyromorpha: ‘new old’ rotoitids

The above review of Cretaceous Taimyr and Canadian specimens allowed re-evaluation of the diagnostic features of *Baeomorpha*, clarification of its diagnosis, description of related genus *Taimyromorpha* and proposition of their affinity as members of Rotoitidae. Previous authors, Bouček and Noyes (1987) and Gibson and Huber (2000), also briefly suggested a similarity between rotoitids and fossil representatives of the family Tetracampidae, mainly described and diagnosed by Yoshimoto (1975). However, the confused and misinterpreted diagnostic features of these groups prevented further discussion of their relationships at that time. Gumovsky (2016) reviewed diagnostic features of the nominal subfamily Tetracampinae, among which the most diagnostic were a short, straight calcar, 4-segmented male tarsi, a complete occipital carina, a smooth and convex mesopleuron, and an X-shaped pattern of grooves on the face. The two other subfamilies of Tetracampidae, Platynocheilinae and Mongolocampinae, were shown as distantly related to Tetracampinae by Heraty et al. (2013), and both are characterized by 5-segmented tarsi for both sexes. Also, all groups classified currently as Tetracampidae have an exposed prepectus visible externally as a triangular plate more or less similar to other chalcidoids excluding rotoitids. Some features are shared by rotoitids and tetracampines: the presence of a basal vein (traceable as a weakly pigmented fold in some tetracampines), a concave anterior margin of the clypeus, a completely setose base of the fore wing without a speculum, a short bifid calcar, and a short, oblique basitarsal comb. Some of the features (e.g., the basal vein and a basally setose fore wing), however, likely are symplesiomorphies for Chalcidoidea, which supports the position of Rotoitidae and Tetracampinae (in some analyses: Heraty et al., 2013; Klopstein et al., 2013) as basal-most nodes of Chalcidoidea after Mymaridae.

Heraty et al. (2013) demonstrated that Chalcidoidea are monophyletic, with Mymaridae as the sister group of Rotoitidae plus the remaining Chalcidoidea. Rotoitidae is easily recognizable group and its monophyly is mainly supported by the possession of the tiny prepectus being concealed under the mesoscutum (Heraty et al., 2013). Our data demonstrate remarkable differences in morphology between extant and extinct rotoitids. Comparing to the extant rotoitids, *Baeomorpha* and *Taimyromorpha* have more chalcidoid ground-plan (symplesiomorphic) features than either *Rotoita* or *Chiloe*. The two latter genera are characterized by numerous reductions and other morphological derivations, such as reduced transscutal articulation, notauli (thus axillae are badly delimited) and metapleural suture in *Rotoita* (Fig. 3A), as well as brachyptery, reduction of ocelli (Fig. 3C, E, F), and modified ovipositor in *Chiloe*, etc. Also, the lateral surface of the mesosoma of *Baeomorpha* (hardly visible in *Taimyromorpha*) is morphologically less derived compared to *Rotoita* because the metapleuron is

separated from the lateral callus of the propodeum by a distinct suture, Fig. 2A (nearly fused in *Rotoita*, Fig. 3A) and the mesopleuron has a distinct transepimeral suture (Fig. 19E) subdividing the lower and the upper mesepimera (absent in *Rotoita*, Fig. 3A). The ovipositor of *Chiloe* with upper valve being uniformly convex basally but cleft apically also appears an apomorphic character state, since the ovipositor of extinct rotoitids (Fig. 17A–E) appears of symplesiomorphic chalcidoid structure, which presumes the longitudinally cleft asymmetrical upper valve. The latter character, however, cannot be estimated with certainty in amber inclusions.

Therefore, the lack of number of morphological modifications in extinct rotoitids as opposed to the derived morphology of their extant representatives may suggest possible ancestor-descendant relationships between them, or at least that *Baeomorpha* and *Taimyromorpha* are very close to the common ancestor of Rotoitidae.

Also, *Baeomorpha* apparently demonstrates wider morphological intrageneric variation in antennal structure compared to many extant groups of chalcidoids, which made generic attribution of the amber inclusions described above somewhat challenging for the authors. The number of visible flagellomeres varies in *Baeomorpha* from 8 in *B. caeleps* (1 anellus, 3 funiculars and 4-segmented clava, Figs. 8D–E, 9D–F) to 11 in *B. baikurensis* (without distinct anellus, 5 funiculars and 6-segmented clava, Fig. 6A–D). However, these differences are gradual and additive in nature, and thus applying alternative generic grouping based on differences in flagellomere number would require an erection of a separate genus for nearly each species described above, what is not rational approach, at least for now.

The range of variation in size and setation of the proximal flagellomeres is distinctly large in *Baeomorpha* if compared to *Rotoita* and *Chiloe*. An anellus has been defined differently by different authors. In many works it is defined as a small, ring-like flagellomere that lacks MPS, whereas it is defined simply as a reduced first flagellomere in Heraty et al. (2013). Rotoitidae were characterized by the lack of anelli originally (Bouček and Noyes, 1987), despite the presence of one (*Chiloe*, Fig. 3D) or two (*Rotoita*, Fig. 39 of Gibson and Huber, 2000) proximal flagellomeres being distinctly smaller than the following ones and lacking MPS. The establishment of the presence or absence of MPS is often problematic for fossil specimens, but in most cases the small proximal segments appear not to bear MPS and thus are considered as anelli in the species diagnoses above. Also, occasionally there is a continuous transitional widening of flagellomeres, which makes distinguishing flagellomeres as anelli or funiculars difficult (for instance, in *Taimyromorpha pusilla*).

4.2. Cretaceous ‘Tetracampidae’

Heraty et al. (2013) suggested that the origin of most groups of Chalcidoidea took place in the Late Cretaceous or soon after, and Peters et al. (2017) estimated the beginning of the radiation of Chalcidoidea as by about Late Cretaceous (ca 120–130 Ma, judging from Fig. 1 of Peters et al., 2017). Cretaceous chalcidoids are considered the most ancient fossils of the superfamily, which are unambiguously represented by Mymaridae and Rotoitidae (Heraty et al., 2013; this study). The identity of chalcidoids from Jordanian amber (Kaddumi, 2005) requires a special study, but cannot be established with certainty at the moment.

As mentioned above, Yoshimoto (1975) described two Campanian genera and subfamilies in Tetracampidae: *Distylopus* Yoshimoto (and the subfamily Distylopinae) and *Bouceklytus* Yoshimoto (and the subfamily Bouceklytinae). Their placement in Tetracampidae was poorly supported, mainly due to the concept of Tetracampidae as “a group intermediate between Pteromalidae and Eulophidae” at that time (Yoshimoto, 1975). Such a broad concept allowed rather arbitrary interpretation of morphological features

and attribution of many unrelated chalcid taxa to Tetracampidae. Both, *Distylopus* and *Bouceklytus* are characterized by a long, curved calcar, which suggests a distant relationship with either Tetracampinae or the other two subfamilies of Tetracampidae, Platynocheilinae and Mongolocampinae. The two latter subfamilies, in their turn, were shown as non-sister to the Tetracampinae by Heraty et al. (2013). No other derived features of Tetracampinae (the nominal subfamily and likely the only ‘true’ representatives of Tetracampidae) can be found in either *Distylopus bisegmentus* Yoshimoto, 1975, or in *Bouceklytus arcuodes* Yoshimoto, 1975, following the description and figures provided by Yoshimoto (1975). The actual specimens (Fig. 21), the holotype of *D. bisegmentus*, PALE-5298, Fig. 21A–D, and the holotype of *B. arcuodes*, PALE-5287, Fig. 21E, F (MCZ), are in relatively poor condition and do not demonstrate any critical features mentioned above. Therefore, inclusion of *Distylopus* and *Bouceklytus* in Tetracampidae is unsupported and make the concept and history of this family artificial, and also misleads paleontological calibrations.

One of the diagnostic key features of *Distylopus* reported by Yoshimoto (1975) is a two-segmented petiole, which is also a diagnostic feature of Serphitidae Brues, 1937, a fossil family known from Cretaceous and the extant superfamily Mymarommatoidea, which is also well represented in fossil resins (Gibson et al., 1997; McKellar and Engel, 2012; Rasnitsyn et al., 2016). However, structures of the head, wings and mesosoma make mymarommatooids easily distinguishable from chalcidoids and none of the features are possessed by *D. bisegmentus*. The possible position of *Distylopus* in Serphitidae has been earlier suggested by Kozlov and Rasnitsyn (1979), and it even resembles to some extent the Cretaceous genus *Microserphites* Kozlov and Rasnitsyn, 1979. Gibson (1986) suggested however that the petiole is only one-segmented, and its proximal portion (reported as the ‘basal segment’ by Yoshimoto) is simply “a basally constricted, paler portion of the petiole that fits into the propodeal orifice” (Gibson, 1986: character 17). The structure of the petiole is rather difficult for observation in the type specimen, even if viewed under different angles (Fig. 21D). The wing venation, another crucial character for attribution of *Distylopus* to either Chalcidoidea, or Serphitoidea, is also hardly traceable in the holotype of *D. bisegmentus* (Fig. 21C). Also, unlike serphitids, *D. bisegmentus* has filiform male antenna (Fig. 21B), the pale areas on its flagellomeres appear similar to the MPS fused to the antennal surface but with free distal ends, and its pronotum appears (under certain angle) to have a tiny mesothoracic spiracle. The two latter characters are the synapomorphies of Chalcidoidea. Therefore, despite suppositions of an affinity of *Distylopus* with Serphitoidea, its position in this superfamily remains not properly supported, in part because of difficulties in morphological observations of its type species, *D. bisegmentus*. A relationship of *D. bisegmentus* with Chalcidoidea is likewise not strongly supported because interpretation of characters are subjective due to the extremely poorly visible morphological features. Because *Distylopus* is already classified in Chalcidoidea, keeping *D. bisegmentus* in that superfamily appears less assumptive for now.

Both *Distylopus bisegmentus* and *Bouceklytus arcuodes* have a long, curved fore tibial spur (calcar: Fig. 21F, arrowed), which is characteristics of many groups of Chalcidoidea, but not for Tetracampidae, as stated above. These morphological considerations allow us to propose that both *Distylopus bisegmentus* and *Bouceklytus arcuodes* are unplaced (“incertae sedis”) representatives of Chalcidoidea. Further studies are needed to establish true position of these groups in Hymenoptera; however, the main conclusion of this study is that none of the Upper Cretaceous records that have been attributed to Tetracampidae (Yoshimoto, 1975; McKellar and Engel, 2012; Rasnitsyn et al., 2016), belongs to this family.

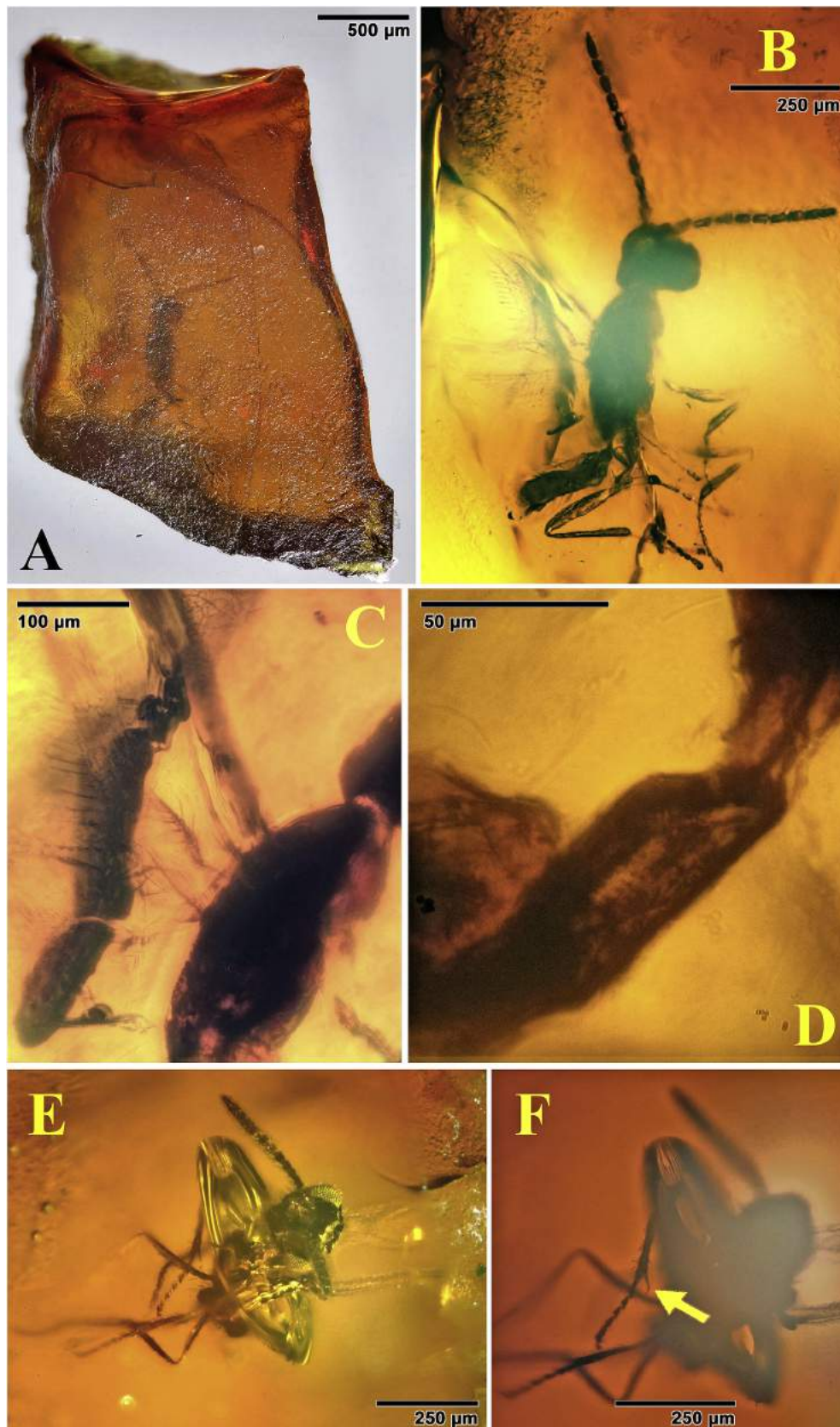


Fig. 21. Photographs and morphological details of Distylopinae and Bouceklytinae (Canadian amber). (A–D) *Distylopus bisegmentus* Yoshimoto, holotype: (A) amber piece PALE-5298 (MCZ); (B) Habitus. (C) Mesosoma with wings; (D) Petiole; (E, F) *Bouceklytus arcuodes* Yoshimoto, habitus: (E) Amber piece PALE-5287 (MCZ); (F) Legs enlarged, with calcar arrowed. ©President and Fellows of Harvard College.

4.3. Biological traits of fossil rotoitids

The biology of extinct insects is obviously obscure, although occasionally certain life-history traits may be hypothesized based on available material. Most available insect syninclusions in the Taimyr amber along with *Baeomorpha* are likely trapped occasionally in resins and cannot be assumed as the hosts of the *Baeomorpha* specimens found in the same amber pieces.

The presence of gregarious males in the same amber piece is an interesting feature of *Baeomorpha* inclusions and is recorded above for *B. caeleps*, *B. gracilis* and *B. popovi*. These aggregations might result from various traits, such as for example swarming (Nadel, 1987). The males might be attracted by an odor of the resin or another object on the tree, so they were trapped and accumulated. Another possible explanation is that the males may have emerged earlier than females, which is common among chalcidoids, and were trapped in fresh resin from a narrow mine in the bark of a resin-producing tree prior to females emerging. Females may have emerged later, individually or in smaller groups, but asynchronously, when the resin drop containing the trapped males was already hardened or fallen from the tree. The only available inclusion with a group of males and a single female of *B. gracilis* (PIN 3311/837) is likely a case when the drop with trapped males was still sticky enough to trap a newly emerged female. Nevertheless, only an occasional find of the parasitoid trapped in amber when emerging from its host, may shed light on true host association of *Baeomorpha* and support or disprove the hypotheses described above.

4.4. Laurasian versus Gondwanan origin of Rotoitidae

Gibson and Huber (2000) hypothesized a Gondwanan origin of Rotoitidae based on the distribution of extant forms: *Rotoita* in New Zealand and *Chiloe* in southern Chile. However, the recognition of *Baeomorpha* and *Taimyromorpha* as rotoitids is not supporting this hypothesis. The amber inclusions containing specimens identified as *Baeomorpha* are found in ambers from Canada and Siberia (Taimyr Peninsula), which originate from the north of the Laurasia supercontinent, not Gondwana. Generally, a seemingly Gondwanan distribution pattern of living taxa is fairly commonly falsified with abundant Laurasian records in the geological past (Eskov, 1987, 1992, 2002; Poinar, 2005; Archibald et al., 2006; Soriano, 2009; Eskov and Lukashevich, 2015; Skibińska, 2016; Fig. 2). The Australian relicts Peradeniidae and Austroniidae (Proctotrupoidea) were found in late Eocene of Europa (Johnson et al., 2001) and Cretaceous of Siberia (Aptian of Transbaikalia and Santonian of Taimyr; Rasnitsyn, 1980, 2002), respectively. Representatives of Mantophasmatodea were described from Baltic amber a bit earlier than the numerous and abundant African mantophasmatodeans (more than thirteen genera and eighteen species from western Southern Africa, Malawi and Tanzania) were recorded (Wipfler et al., 2012; Roth et al., 2014); otherwise they were supposed to supplement this list. The finding of the two extant species of the upper Albian Spanish amber atelestid genus *Alavesia* Waters and Arillo, 1999 in Brandberg Mountain (Namibia) (Sinclair and Kirk-Spriggs, 2010), is remarkable in that this is the same area where the first living examples of Mantophasmatodea were discovered (Wipfler et al., 2012). The family Monomachidae (Diaprioidea) being “likely determined by Gondwanan vicariance events” (Austin et al., 2004, p. 228), is expected to be the newest addition to the list based on western North American Ypresian fauna (Archibald et al., 2018). As such, Rotoitidae is evidently one more example of extant taxa showing an apparently Gondwanan distribution, but origin of the group actually being Laurasian.

The known distribution of *Baeomorpha* shows a meaningful pattern, corresponding to a higher latitude provenance and a younger age assemblages as defined by Rasnitsyn et al. (2016). If the age of Baikura amber is correctly identified as mid-Cretaceous or even older (Perkovsky and Wegierek, 2017a; Table 1), the above group of amber fossil assemblages appear as geographically and not geochronologically defined. As such, the respective territory deserves its own name which we propose as the *Baeomorpha* Realm. Characteristic of this realm (Fig. 22) is a temperate or warm temperate climate and abundant aphid fossils that differ strongly in composition of the aphid assemblages from other territories with known rich amber faunas (Heie and Wegierek, 2011; Perkovsky and Wegierek, 2017b); their hind wings are never reduced to stubs. In particular, eight Cretaceous aphid families consisting of four families of Tajmyraphidoidea (Tajmyraphididae, Khatangaphididae, Retinaphididae, Grassyaphididae) as well as Canadaphididae and Cretamyzidae (Aphidoidea), Shaposhnikovidae (Palaeoaphidoidea) and Mesozoicaphididae (Adelgoidea) are unknown in amber outside this realm in parallel to *Baeomorpha*. At least Khatangaphididae are known not only from Upper Cretaceous, but from Albian Begichevo Formation (Heie and Wegierek, 2011; Rasnitsyn et al., 2016) as well.

The opposed lower latitude group, as defined by Rasnitsyn et al. (2016), covers Europe, Levant and Burma and merits its own name, which we propose as the Isoptera Realm because of the well-known abundance of termite fossils in contrast to their extreme rarity in the *Baeomorpha* Realm (Engel and Delclos, 2010). There are no documented *Baeomorpha* fossils recorded from the Isoptera Realm thus far, and aphid fossils are absent or very rare there (see above); an overwhelming majority of aphids from Isoptera realm had hind wings reduced to stubs (Wegierek et al., 2017). The Raritan, or New Jersey assemblage has an intermediate position according to calculations by Rasnitsyn et al. (2016). However, it is similar to those in Isoptera Realm in displaying termites (Krishna and Grimaldi, 2000) and being free of *Baeomorpha* and poor in aphids (Heie and Wegierek, 2011; Perkovsky and Wegierek, 2017a,b), which makes it possible to add it to the Isoptera Realm.

Despite some unpublished records of fossil rotoitids in Burmese amber (J. Huber and G. Gibson, pers. comm., 2017), we have no documented *Baeomorpha* or *Taimyromorpha* fossils recorded farther southward to prove the existence of these genera there in the past. However, based on such expected findings and present distribution of *Chiloe* in Chile and *Rotoita* in New Zealand, we presume a former general worldwide distribution of the family some time in Cenozoic, which followed their southward expansion after their putative origin and documented diversification in Laurasia during the mid- and Late Cretaceous. Thus the present distribution of Rotoitidae is relictual with the pattern observed formed by extinction rather than origination events. This inference may be supported by the observation that both known areas of distribution of extant Rotoitidae are known to have highly suppressed ant faunas (Snelling and Hunt, 1975). This observation suggests that survival of Rotoitidae in southern Chile (Los Lagos; mostly Chiloe) and New Zealand might have resulted from a low biocenotic pressure by ants, perhaps as low as is hypothesized for the Late Cretaceous environments (LaPolla et al., 2013; Perkovsky and Wegierek, 2017b). It is worth noticing that most of the terrestrial New Zealand flora and fauna has clearly arrived in New Zealand much more recently than the postulated separation of New Zealand from Gondwana dated at 80 Ma (McDowall, 2008). A new explanation for this fact is a possible complete submersion of New Zealand between 22 and 85 Ma which implies that all present-day terrestrial animals and plants might have been evolved from ancestors that arrived during the past 22 Ma (Landis et al., 2008). So, we consider the low biocenotic pressure by ants in New Zealand as

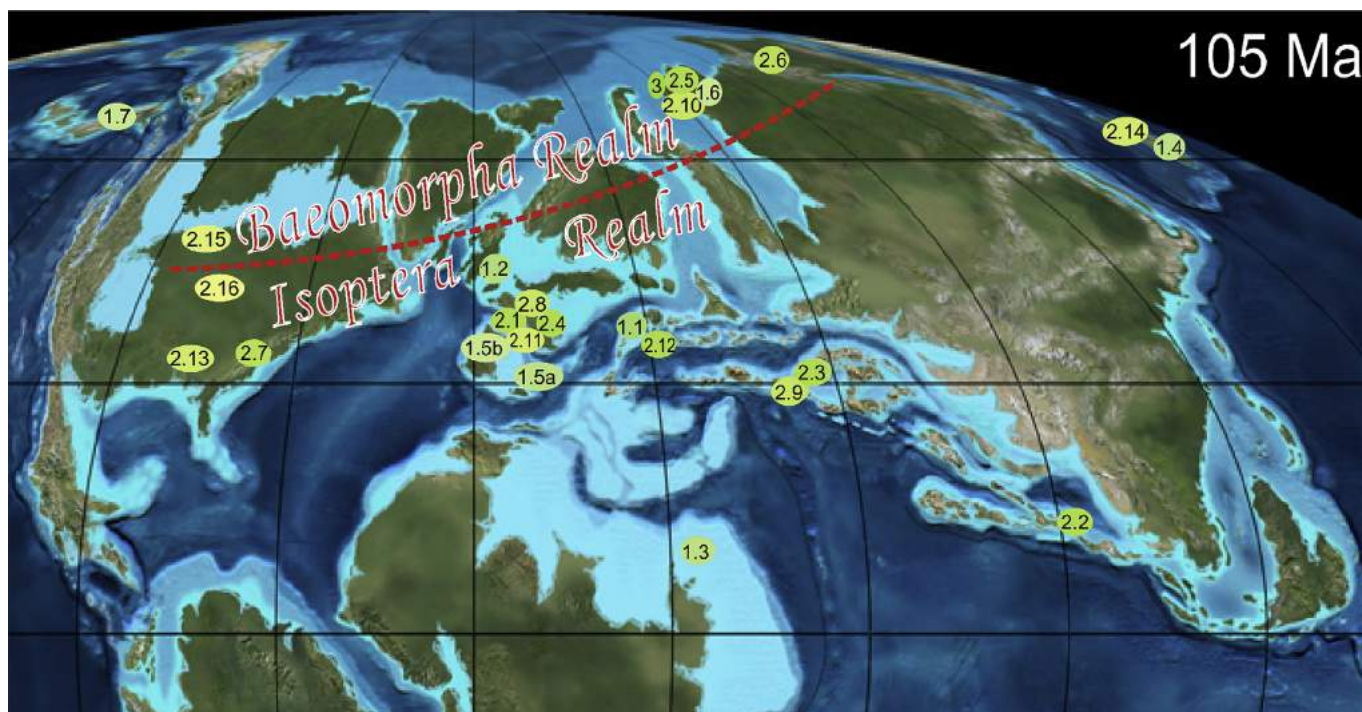


Fig. 22. A possible boundary between the *Baeomorpha* Realm and the *Isoptera* Realm (based on Rasnitsyn et al., 2016: Fig. 1). **1. Lower Cretaceous:** 1.1. Golling, Austria; 1.2. Wessex Fm., Isle of Wight, U.K.; 1.3. Levantine amber belt (Lebanon, Syria, Jordan, Israel); 1.4. Choshi, eastern Honshu Isl., Japan; 1.5.a mainly Escucha Fm. (San Just, Arroyo de la Pascueta, La Hoya), 1.5b mainly Utrillas Group (El Caleyú, El Soplaio, Peñacerrada, Salinillas de Buradón) – Albian, Spain; 1.6. Begichevo Fm. (Zhdanikha, Kresty) Taimyr Peninsula, Russia; 1.7. Arctic Coastal Plain, Alaska, U.S.A. **2. Upper Cretaceous:** 2.1. Charentese amber (Archingeay-Les Nouillers, île d'Aix, Cadeul, Puy-Puy, Fouras, etc.), Western France; location for part of 2.4 (middle Cenomanian Anjou amber) is the same; 2.2. Hukawng Valley, Myanmar; 2.3. Agdzhakend, Azerbaijan; 2.4. (part) Fourtou and Salignac, South-eastern France; 2.5. Agapa, Taimyr Peninsula, Russia; 2.6. Timmerdyakh, Yakutia, Russia; 2.7. Raritan Fm., New Jersey and Maryland, U.S.A.; 2.8. Vendée, Western France; 2.9. Shavarshavan, Armenia; 2.10. Kheta Fm. (Yantardakh, Romanikha, Ugolyak), Taimyr Peninsula, Russia; 2.11. Piolenc and Belcodène, Southern France; 2.12. Ajka, Csinger valley, Hungary; 2.13. Eutaw Fm. (Alabama – Santonian), Neuse River near Goldsboro (North Carolina – Campanian), U.S.A.; 2.14. Kuji group – Campanian and Futaba group – Santonian, northern Honshu Isl., Japan; 2.15. Grassy Lake, Alberta, and Cedar Lake, Manitoba, Canada; 2.16. Hell Creek Formation, South Dakota, U.S.A. **3. Controversially dated locality:** Baikura, ? Ognevka Formation, Taimyr Peninsula, Russia.

one of the crucial parameters that ensured local survival of the relictual groups of insects, which are absent now in Australia though; Valdivian temperate rainforest ensured survival of the relictual groups as well, with Chiloe Is. ant fauna being particularly impoverished (Snelling and Hunt, 1975). In other words, Rotoitidae has gone extinct everywhere where ant-homopteran symbiosis established successfully during the Cenozoic (Wilson and Hölldobler, 2005; Perkovsky and Wegierek, 2017b). We can only hypothesize the mechanism of rotoitid suppression by ants. Perhaps, it might affect in a way the (currently unknown) hosts of Rotoitidae.

5. Conclusions

The family Rotoitidae is represented by two extant and two extinct genera, one of latter (*Taimyromorpha*) is described in this paper. The extant genera have relictual distribution: *Rotoita* in New Zealand and *Chiloe* in southern Chile (Los Lagos; mostly Chiloe). The extinct genera *Baeomorpha* and *Taimyromorpha* are known from the Upper Cretaceous ambers of Laurasian origin. *Rotoita*, *Chiloe* and *Taimyromorpha* are monotypic, but *Baeomorpha* is comparatively diverse: 2 species are known from Canadian and 11 are described here from Taimyr ambers. The plesiomorphic morphology, species composition and distribution pattern of extinct Rotoitidae suggest their origin and diversification in north of Laurasia (“*Baeomorpha* realm”), further migration southward followed by hypothesized world-wide distribution and then global extinction everywhere, apart from relictual areas of what is now southern Chile and New Zealand.

However, it is unknown for the present if the present distribution of *Rotoita* and *Chiloe* results from direct migration from the *Baeomorpha* Realm to the South Temperate Zone, or results from shrinking of what once was world-wide distribution. Nor are we aware yet of the time, scale and directions of past migration events of *Baeomorpha* and its unknown relatives, one of which could have resulted in origin of living Rotoitidae in New Zealand and Chile. The history of relictual aphids in the southern temperate zone analyzed by Perkovsky and Wegierek (2017b) might be found instructive in respect to the living Rotoitidae as well.

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