

A new Eocene *Dicranomyia* Stephens, 1829 (Diptera: Limoniidae) from Baltic amber

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ABSTRACT: A new species of the genus *Dicranomyia* Stephens, 1829 (Diptera: Limoniidae) from Baltic amber is characterised, illustrated and described. This finding represents the second fossil of the subgenus *Melanolimonia*. The morphological features of the new species and the morphology comparison with its closest fossil relatives are discussed.

KEY WORDS: Crane-flies, fossil insects, morphology, new species, taxonomy.



The crane-fly genus *Dicranomyia* is well represented amongst fossil Diptera. To date, over 40 fossil species of this genus have been described. The extinct representatives of *Dicranomyia* are known from different ages (mainly from the Eocene, but also from younger epochs such as the Oligocene or Miocene) and from different parts of the world.

The oldest representatives of the genus *Dicranomyia* are known from the earliest Eocene Mo Clay of Denmark (Henriksen 1922; Krzemiński 2001). Fourteen species are known from late Eocene Baltic amber (Meunier 1899, 1906, 1916; Alexander 1931; Savchenko 1967; Krzemiński 2000b; Kania *et al.* 2013; Kania 2014; Krzemiński *et al.* 2015). A further 15 species of this genus from this epoch are preserved as compression fossils: four from the Green River Formation, USA (Scudder 1877; Cockerell 1908); three from the latest Eocene Bembridge Marls of England (Cockerell & Haines 1921; Cockerell 1922); and eight from Florissant, USA (Scudder 1894) (Table 1).

Two species of *Dicranomyia* are known from the Oligocene: one from the Oligocene of France (*Dicranomyia antennifera* Théobald, 1937) and one from Russia (Krzemiński 2000a).

Seven species are known from the Miocene: *Dicranomyia alexbrowni* Podenas & Poinar, 2012, *Dicranomyia chiapa* Podenas & Poinar, 2012, *Dicranomyia mexa* Podenas & Poinar, 2012 and *Dicranomyia vella* Podenas & Poinar, 2012 from Mexico; *Dicranomyia fera* Podenas & Poinar, 1999 and *Dicranomyia lema* Podenas & Poinar, 1999 from the Dominican Republic; and *Dicranomyia sergio* Krzemiński & Gentlini, 1992 from Italy.

Representatives of four subgenera of *Dicranomyia* have been recorded in Baltic amber. The most common amongst Baltic amber inclusions are representatives of the subgenus *Dicranomyia*, also the most numerous species in Recent fauna. The representatives of other subgenera are rare in Baltic amber, represented only by single species: *Dicranomyia (Melanolimonia) krzeminskii* Kania, 2014 and *Dicranomyia (Sivalimnobia) herczeki* Krzemiński & Kania, 2015 (*in* Krzemiński *et al.* 2015).

The newly described species is the second representative of the subgenus *Melanolimonia* in Baltic amber.

1. Material and methods

This study is based on material from the collection of the Institute of Systematic and Evolution of Animals, Polish Academy of Sciences (ISEA PAS) (one specimen; male). The specimen was studied using a Nikon SMZ 1500 stereomicroscope. Photomicrographs were taken with a Nikon DS-Fil camera equipped with a microscope. Drawings were made from specimens and photographs. Measurements were taken with NIS-Elements D 3.0 software. The length of the discal cell was measured from the hind edge of the discal cell to the connection of cross-vein m–m with vein M₃. M₃ was measured from the connection of cross-vein m–m with vein M₃ to the edge of the wing (Kania 2014). The term “d-cell base” is used after Krzemiński 1993. The drawings were made by IK.

2. Systematic palaeontology

Order: Diptera Linnaeus, 1758

Family: Limoniidae Speiser, 1909

Genus: *Dicranomyia* Stephens, 1829

Subgenus *Melanolimonia* Alexander, 1964

Type species. *Tipula moria* Fabricius, 1787 (original designation).

Dicranomyia (Melanolimonia) kukulai sp. nov.
(Figs 1A–B, 2A–C, 3A–B)

Diagnosis. Two short spines on rostral prolongation on inner gonostylus, the first one half the length of the second, inner gonostylus very wide, massive with two wide processes almost black in one third distal of its length; outer gonostylus narrow and hooked; vein Sc elongated, ending behind half the length of Rs, cross-vein m–cu behind the fork of Mb, in one fifth of d-cell base from bifurcation of Mb; M₃ one fifth shorter than length of d-cell; Rs bifurcation before fork of Mb.

Table 1 List of fossils belonging to the genus *Dicranomyia*, known from the Eocene (age given after Grimaldi & Ross (2017)).

Species	Age	Locality
<i>Dicranomyia faecaria</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia fontainei</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia fragilis</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia inferna</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia loewi</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia longipes</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia saxetana</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia stagnorum</i> Scudder, 1894	Priabonian	Florissant, USA
<i>Dicranomyia exhumata</i> Cockerell, 1922	Priabonian	Isle of Wight, England
<i>Dicranomyia undulata</i> Cockerell & Haines, 1921	Priabonian	Isle of Wight, England
<i>Dicranomyia (Dicranomyia) alexandri</i> Kania, 2013	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) baltica</i> Kania, 2014	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) ewa</i> Kania, 2014	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) gorskii</i> Kania, Krzemiński & Penar, 2013	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) graciosa</i> Meunier, 1916	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) grandis</i> Meunier, 1899	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) kalandyki</i> Krzemiński, 2000b	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) lobata</i> Meunier, 1906	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) meunieri</i> Alexander, 1931	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) perpendicularis</i> Savchenko, 1967	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) sinuata</i> Meunier, 1916	Priabonian	Baltic Region
<i>Dicranomyia (Dicranomyia) succinica</i> Kania, 2014	Priabonian	Baltic Region
<i>Dicranomyia (Melanolimonia) krzeminskii</i> Kania, 2014	Priabonian	Baltic Region
<i>Dicranomyia (Melanolimonia) kukulai</i> sp. nov.	Priabonian	Baltic Region
<i>Dicranomyia (Sivalimnobia) herczeki</i> Krzemiński & Kania, 2015	Priabonian	Baltic Region
<i>Dicranomyia primitiva</i> Scudder, 1877	Ypresian-Lutetian	Utah, USA
<i>Dicranomyia rhodolitha</i> Cockerell, 1908	Ypresian-Lutetian	Wyoming, USA
<i>Dicranomyia rostrata</i> Scudder, 1877	Ypresian-Lutetian	Utah, USA
<i>Dicranomyia stigmata</i> Scudder, 1877	Ypresian-Lutetian	Utah, USA
<i>Dicranomyia thybotica</i> Henriksen, 1922	Ypresian	Denmark
<i>Dicranomyia bellissima</i> Krzemiński, 2001	Ypresian	Denmark
<i>Dicranomyia freiwaldi</i> Krzemiński, 2001	Ypresian	Denmark
<i>Dicranomyia speciosa</i> Krzemiński, 2001	Ypresian	Denmark

Etymology. The specific name is dedicated to Professor Krzysztof Kukuła (Department of Environmental Biology, University of Rzeszów), the eminent biologist, ecologist and specialist on ichthyofauna.

Material examined. Holotype, male. No. MP/3555, Coll. Institute of Systematic and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland.

Description. *Body* dark brown, with almost black part of hypopygium, 5.8 mm long (Fig. 2A).

Head not large, with huge eyes; antenna not well visible with elongated, cylindrical flagellomeres, first flagellomeres about 0.1 mm long; palpus 4-segmented; the last palpal segment cylindrical and elongated.

Thorax. (Fig. 2A) Wing (Figs 1B, 2A, B) 6.5 mm long, 1.8 mm wide; without spots, pterostigma not visible; vein Sc ending behind half the length of Rs, opposite one fourth of Rs; vein R₅ approximately twice longer than vein Rs; M₃ very short, one fifth shorter than d-cell; d-cell very elongated, twice as long as wide, vein M₁₊₂ one fifth longer than d-cell; cross-vein m-cu almost straight, behind the bifurcation of Mb, situated in one fifth of d-cell base from bifurcation of Mb; A₁ and A₂ elongated, almost straight.

Abdomen. Hypopygium (Figs 1A, 2A, 3A, B): 0.9 mm long, 0.8 mm wide, gonocoxite 0.4 mm long, comparatively narrow, approximately twice as long as wide, with elongated and strong setae, two short spines on rostral prolongation of inner

gonostylus, the first one half the length of the second, inner gonostylus very wide, massive, with two wide processes almost black in one thirds distal of its length; outer gonostylus 0.4 mm long, narrow and hooked.

Comparisons. A newly described species is classified to the subgenus *Melanolimonia*. Previously, only one species of this subgenus was known from Baltic amber: *Dicranomyia (Melanolimonia) krzeminskii* Kania, 2014. The other species known from Baltic amber belong to other subgenera (*Dicranomyia*, *Sivalimnobia*), or are unclassified to a subgenus. In the new species, the inner gonostylus is very wide, with two very wide processes, the outer gonostylus is narrow and hooked. Part of the hypopygium is almost black. In comparison, in *D. (M.) krzeminskii*, the gonocoxite is equal in length to inner gonostylus and two short spines occur on the inner gonostylus. Vein Sc ends opposite approximately half the length of Rs and cross-vein m-cu is straight, situated slightly before the fork of Mb. In *D. (M.) kukulai* sp. nov., cross-vein m-cu is almost straight, situated in one fifth proximal of d-cell base, vein Sc ends behind half the length of Rs and M₃ is very short, shorter than the length of the d-cell; whereas in *D. (M.) krzeminskii* the d-cell is short and vein M₃ is distinctly longer than the discal cell.

These features – an almost black body colour, wing venation with a very elongated vein Sc and the morphology of the hypopygium – enable the classification of the new species to

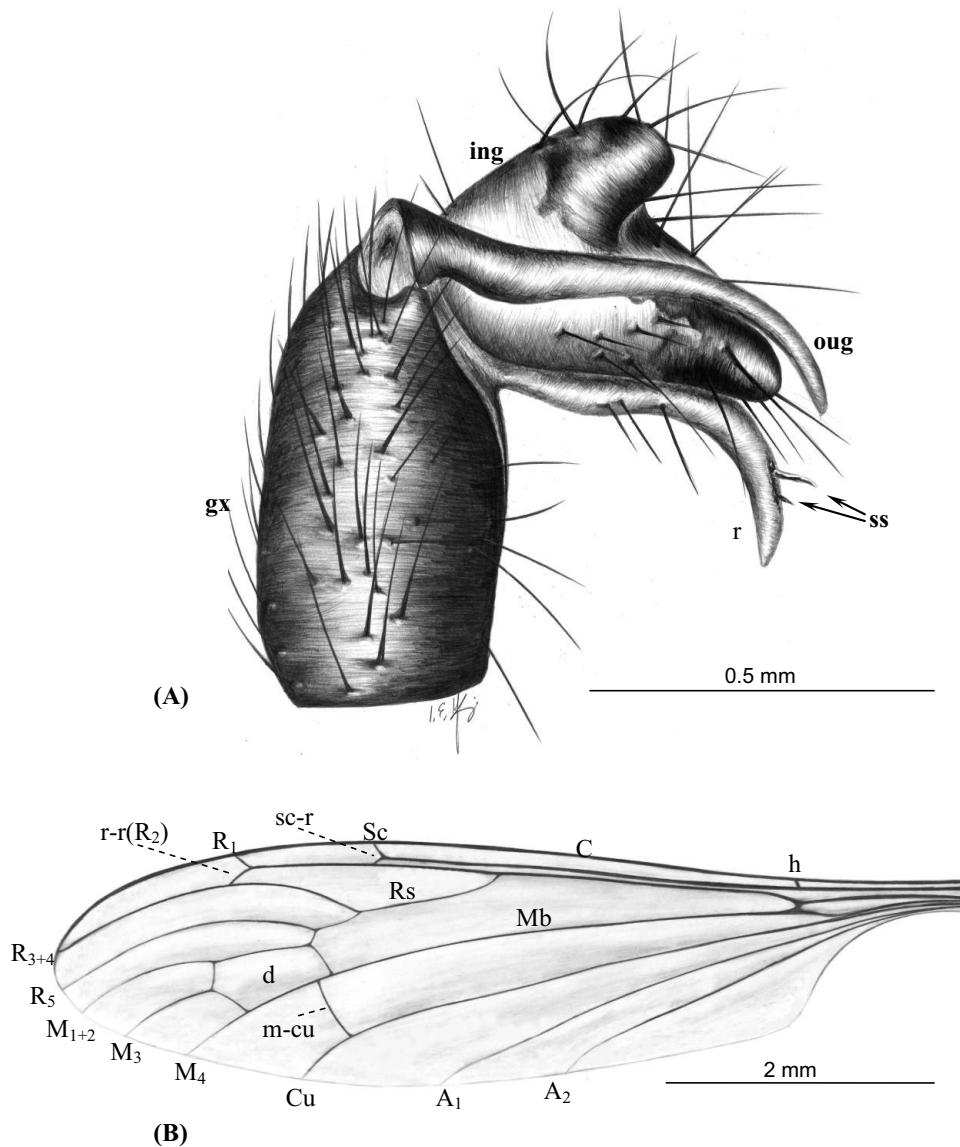


Figure 1 *Dicranomyia (M.) kukulai* sp. nov., MP/3555 (male), ISEA PAS, holotype: (A) gonocoxite and gonostyles, dorsal view, reconstruction; (B) wing venation. Abbreviations: A₁, A₂ = anal veins; C = costa; Cu = cubitus; d = discal cell; gx = gonocoxite; h = humerus; ing = inner gonostylus; M₁₊₂–M₄ = media; Mb = medio-basal vein; m–cu = media–cubital cross-vein; oug = outer gonostylus; r = rostral prolongation of ventral gonostylus (rostrum); R₁–R₅ = radius; Rs = sector radii; Sc = subcosta; ss = spines.

the subgenus *Melanolimonia* and differentiate it from other species classified to the subgenera *Dicranomyia* or *Sivalimnobia* known from Baltic amber.

However, we can see some additional differences in the morphology of the hypopygium, and in the wing venation. In contrast to *Dicranomyia (D.) gorskii* Kania, Krzemiński & Penar, 2013, *Dicranomyia (D.) ewa* Kania, 2014 and *Dicranomyia (D.) lobata* Meunier, 1906, in which there existed a single spine on the rostral prolongation of the inner gonostylus, in *D. (M.) kukulai* sp. nov. there are definitely two, not very elongated, with the first one half the length of the second. In *D. (D.) gorskii* and *D. (D.) ewa*, this spine is very elongated and strong, reaching half the length of the gonostylus. *Dicranomyia (D.) perpendicularis* Savchenko, 1967 and *Dicranomyia (D.) succinica* Kania, 2014 are characterised by two spines on the rostral prolongation of the ventral gonostylus, but these structures are very elongated and strong in these species. In *Dicranomyia (D.) kalandyki* Krzemiński, 2000b, there are three spines of comparable length on rostral prolongation of the inner gonostylus. Moreover, in *D. sinuata* Meunier, 1916, cross-vein m–cu is slightly sinuous, but in *D. (M.) kukulai* sp. nov., this vein is strong.

The newly described species also differs in wing venation from *Dicranomyia (D.) alexandri* Kania, 2013 (in Kania *et al.* 2013), *Dicranomyia (D.) graciosa* Meunier, 1916, *Dicranomyia (D.) grandis* Meunier, 1899, *D. (D.) kalandyki*, *D. (D.) lobata*, *D. (D.) perpendicularis*, *D. (D.) sinuata* and *D. (D.) succinica*, in which vein Sc is very short, ending close to the Rs origin, before the mid-length of Rs or at half the vein sector radii; whilst in the newly described species it is longer.

The cross-vein m–cu is situated before the fork of Mb in *Dicranomyia (D.) baltica* Kania, 2014, *D. (D.) lobata* and *D. (D.) perpendicularis* and at the bifurcation in *D. (D.) alexandri* (at or just behind), *D. (D.) gorskii*, *D. (D.) kalandyki*, *D. (D.) meunieri* and *D. (D.) sinuata*; whilst in the newly described species this vein is situated distinctly behind the fork of Mb. In the new species, the d-cell is very elongated and M₃ is very short, one fifth shorter than the d-cell in *D. (D.) alexandri*, *D. (D.) baltica*, *D. (D.) ewa*, *D. (D.) gorskii*, *D. (D.) graciosa*, *D. (D.) grandis*, *D. (D.) lobata*, *D. (D.) meunieri*, *D. (D.) perpendicularis* and *D. (D.) sinuata*. In *D. (M.) krzemiński*, this vein is equal in length or longer.

There are also the differences between the new species and species known from the Priabonian from Florissant.

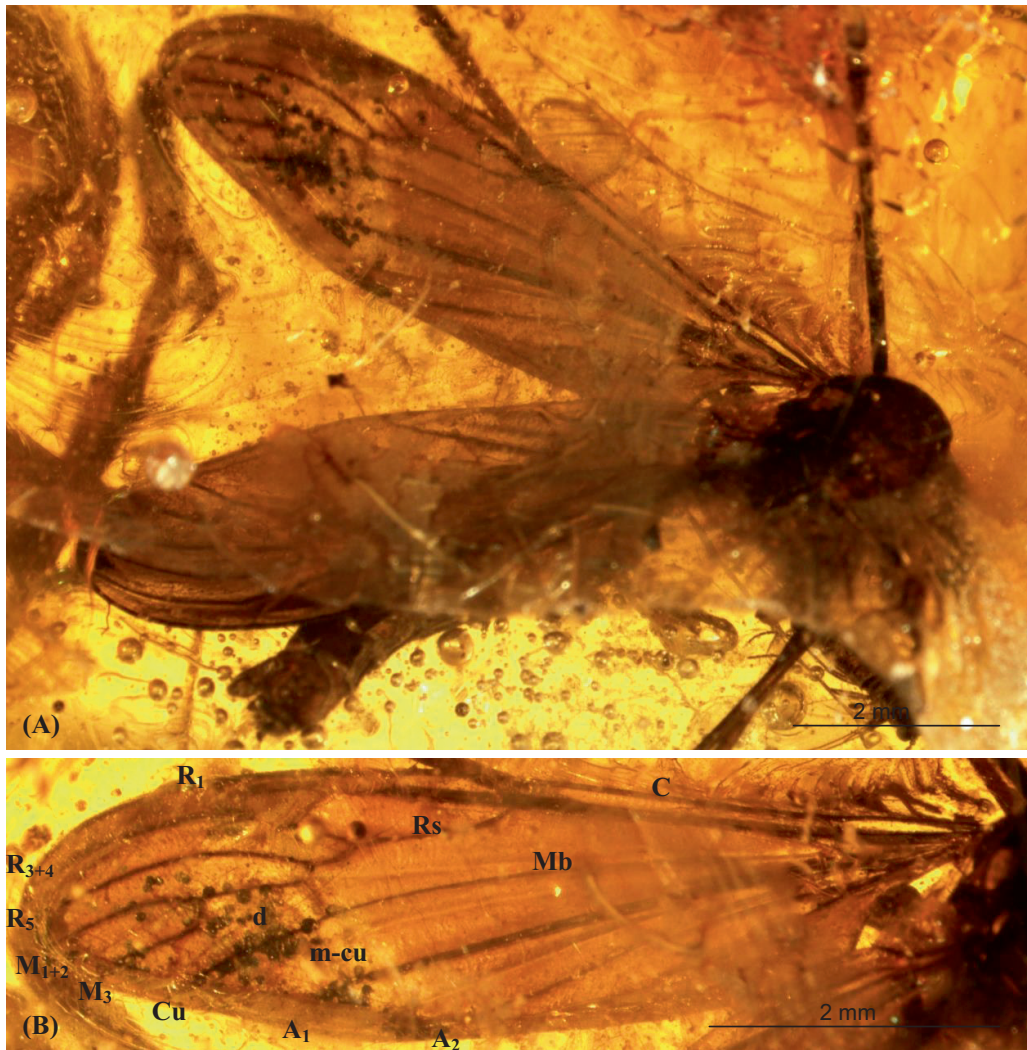


Figure 2 *Diceranomyia (Melanolimonia) kukulai* sp. nov., MP/3555 (male), ISEA PAS, holotype: (A) latero-dorsal view; (B) wing. Abbreviations: A₁, A₂ = anal veins; C = costa; Cu = cubitus; d = discal cell; M₁₊₂, M₃ = media; Mb = medio-basal vein; m-cu = media-cubital cross-vein; R₃₊₄, R₅ = radius; Rs = sector radii.

Diceranomyia longipes, described by Scudder (1894), is a large species with length of wing about 7 mm and discal cell closed, but much narrower apically than at the base by the length of the third posterior cell. In the newly described species, the d-cell is not narrowed. In *D. longipes* and *D. stagnorum* Scudder, 1894, the distal part of the marginal cell, according to Scudder, is almost as long as the proximal. In *D. inferna* Scudder, 1894, *D. fragilis* Scudder, 1894, *D. stigmosa* Scudder, 1894, *D. primitiva* Scudder, 1894, *D. fontainei* Scudder, 1894 and *D. rostrata* Scudder, 1894, the distal part of the marginal cell is much shorter than the proximal; in the new species it is longer. In *D. stagnorum*, the d-cell is opened, whilst the d-cell is closed in the new species.

In *D. exhumata* Cockerell, 1922 and *D. thybotica* Henriksen, 1922, cross-vein m-cu is situated at fork of Mb or just before, M₁₊₂ and M₃ are much longer than the d-cell and the Rs bifurcation is opposite the fork of Mb; but in the new species, cross-vein m-cu is situated behind the fork of Mb and M₁₊₂ and M₃ are shorter in comparison to the length of the d-cell. The fork of Rs in *D. thybotica* and *D. freiwaldi* Krzemiński, 2001 is opposite the fork of Mb; but in the new species, it is distinctly before. Cross-vein m-cu in *D. speciosa* Krzemiński, 2001 and *D. freiwaldi* is situated before the fork of Mb; in *D. bellissima* Krzemiński, 2001 it is situated at the fork of Mb. In these

species, vein M₃ is longer than the d-cell; in the newly described species this vein is positioned after the bifurcation of Mb and M₃, and is shorter than the d-cell. Moreover, in *D. bellissima*, vein Sc is very short, ending just behind the origin of the sector radii, but it is longer in the new species. In *D. freiwaldi*, the distal part of the wing is covered by numerous microtrichia; but microtrichia on the wing does not occur in new species.

D. rhodolitha Cockerell, 1908 is characterised by the occurrence of small dark spots on the costa, 2.6 mm and 4 mm from the base. The wing of the newly described species is pale, without spots.

A similar morphology of the hypopygium can be found amongst some Recent species of the subgenus *Melanolimonia*, such as *D. (M.) fulvonigrina* Alexander, 1965, where there occur two, not very large, spines on the rostral prolongation on the inner gonostylus; but the position of these spines is not the same as those in to *D. kukulai* sp. nov.

Age and occurrence. Eocene, Baltic amber.

Remarks. According to Ritzkowski (1997) and Perkovsky et al. (2007), Baltic amber has been dated to 38–47 Ma. As Wappler (2003, 2005) suggests, based on analyses of glauconites from the Sambia Peninsula which showed that the 'blue earth' formation (amber-bearing Prussian Formation) can be allocated to the Middle Eocene, the Baltic amber can be dated to

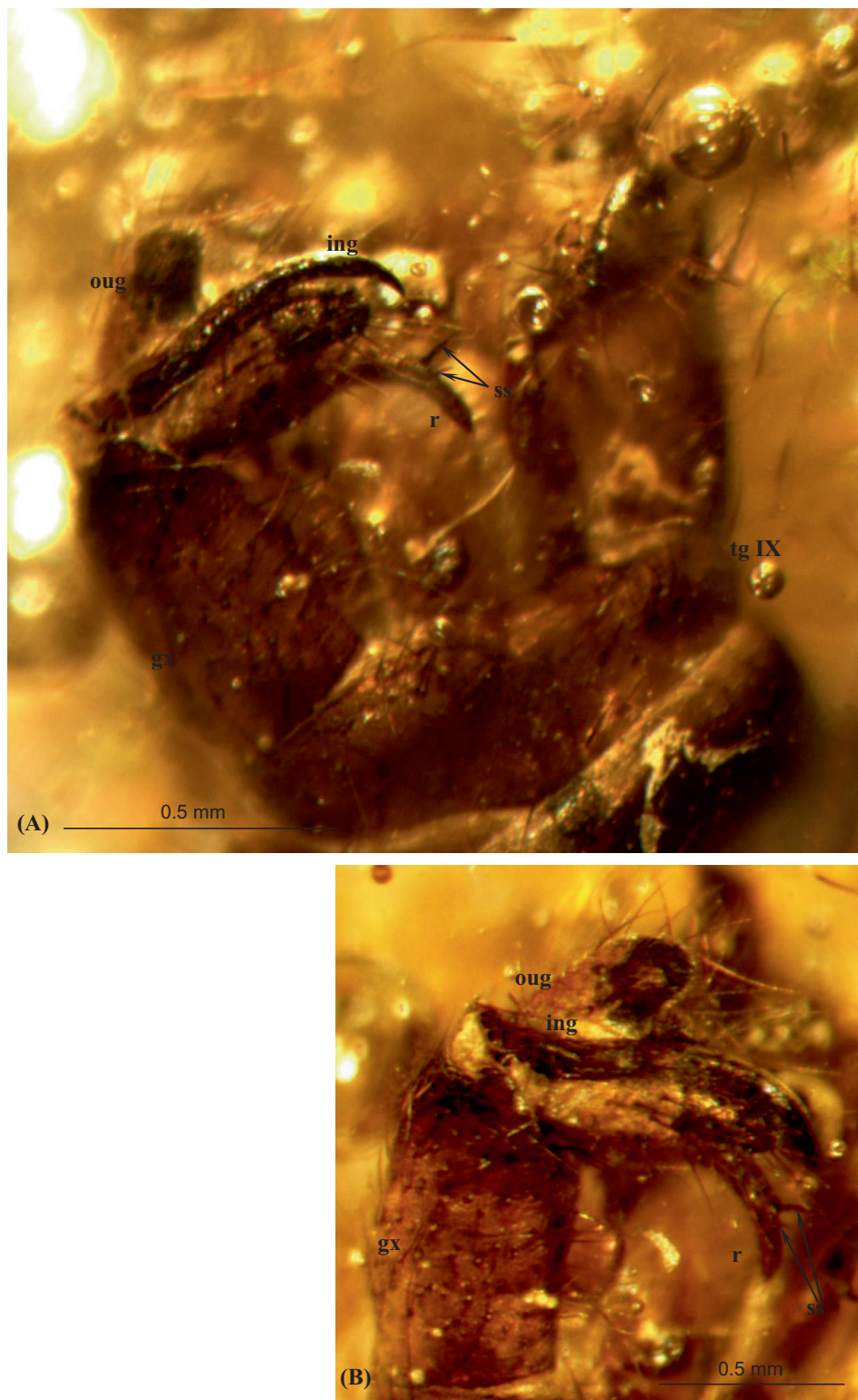


Figure 3 *Diceranomyia (Melanolimonia) kukulai* sp. nov., MP/3555 (male), ISEA PAS, holotype: (A) hypopygium, dorsal view; (B) gonocoxite, gonostyles. Abbreviations: gx = gonocoxite; ing = inner gonostylus; oug = outer gonostylus; r = rostral prolongation of ventral gonostylus (rostrum); ss = spines.

44.1 ± 1.1 Ma (Lutetian). Similarly, Weitschat & Wichard (2010) suggested an older age for the Baltic amber. A Middle Eocene (or older) age of Baltic amber was argued by Perkovsky *et al.* (2007); he suggested that the age of Baltic amber should be estimated as Late Eocene (Bartonian/Priabonian: 37.7 ± 3 Ma). The age of Baltic amber is debatable. However, according to the latest information of Grimaldi & Ross (2017), a Priabonian (Upper Eocene) age is most likely for this kind of fossil resin.

3. Conclusions

Whilst the genus *Diceranomyia* comprises ca.1,300 species and is distributed worldwide, the representatives of the subgenus *Melanolimonia* are not so numerous in species and occur only in the Palaearctic (west Palaearctic: 15 species; east Palaearctic: 16 species), Oriental (19 species) and Nearctic (four species) regions (Oosterbroek 2016).

Amongst the known fossils, representatives of this subgenus are extremely rare (Evenhuis 2015). Until now, only one species has been described from the fossil record (by Kania 2014). A new species, which is characterised by an almost black part of the hypopygium, is the second representative of this subgenus amongst inclusions in Baltic amber. The subgenus *Melanolimonia* is characterised by having a generally black colouration, a rarely brown or polished fulvous, pleura extensively silvery pruinose, with a very broad anterior vertex and width approximately four times the diameter of the antennal scape. The last segment of the antenna in the representatives of *Melanolimonia* is usually elongated and more-or-less constricted at near mid-length. The subcostal vein (Sc) in this subgenus is very long, ending approximately opposite half the length of Rs or longer; the discal cell is closed. The tergite of the male hypopygium ranges in shape from almost truncate at the posterior border, without evident lobes, to profoundly emarginate, forming slender finger-like lobes (Alexander 1964). The outer gonostylus is a simple, curved sickle, hooked with an acute tip, as in *D. (M.) kukulai* sp. nov. The aedeagus is usually conspicuously expanded and abundant scabrous points with setae occur at the outer end of this structure.

The representatives of the subgenus *Melanolimonia* currently occur only in the Northern Hemisphere, as its presence has not been noted in Australian, Oceanian, Afrotropic or Neotropical regions. We have no data regarding the occurrence of the extinct and extant representatives of *Melanolimonia* from the Southern Hemisphere. The other representatives of *Dicranomyia*, known from the Eocene, come from Europe and North America. The oldest Eocene representatives of *Dicranomyia* are known from the Early Eocene (Ypresian) of Europe (four species), and also from North America – from the USA (Ypresian/Lutetian border). Many more species known from latest Eocene (Priabonian), are mainly from Europe, as well as from North America (Table 1).

4. Acknowledgements

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