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THIONIA DOUGLUNDBERGI SP. NOV. FROM THE MIOCENE DOMINICAN AMBER (HEMIPTERA: FULGOROMORPHA: ISSIDAE) WITH NOTES ON EXTINCT HIGHER PLANTHOPPERS

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Abstract.— The new extinct species *Thionia douglundbergi* **sp. nov.** of the recent genus *Thionia* Stål, 1859 from the Miocene Dominican amber is described. The morphological features of the genus are discussed in brief. The fossil record of 'higher' Fulgoroidea in New World fossil resins is discussed.

Key words.— Hemiptera, Fulgoromorpha, Issidae, *Thionia*, new species, Hispaniola, Miocene, Dominican amber, fossils.

INTRODUCTION

Planthoppers (Hemiptera: Fulgoromorpha: Fulgoroidea) are widely distributed throughout the World group of plant-sucking bugs. The fossil record of the superfamily, as compression fossils and resin inclusions reaches the Jurassic. The superfamily comprises 25 families, both extant and extinct (Szwedo *et al*. 2004, Bourgoin and Szwedo 2008), presenting numerous taxonomic and phylogenetic problems.

New World fossil 'higher' planthoppers

The so-called 'higher" Fulgoroidea comprise families Acanaloniidae, Caliscelidae, Eurybrachidae, Flatidae, Gengidae, Hypochthonellidae, Issidae, Lophopidae, Ricaniidae, Tettigometridae and Tropiduchidae. According to Shcherbakov (2006) these lineages are known in fossil record just above the Cretaceous/Palaeogene boundary, in the early Palaeocene. Several forms ascribed to Flatidae, Lophopidae, Nogodinidae, Ricaniidae and Tropiduchidae had been described from Palaeocene, Eocene, Oligocene and Miocene deposits and fossil resins of the New World (Szwedo *et al*. 2004, Petrulevičius 2005, Shcherbakov 2006, Solórzano Kraemer and Petrulevičius 2007).

However, molecular, morphological and palaeontological research on the relationships of 'higher' Fulgoroidea give no concluding remarks so far. In fact, 'higher Fulgoroidea phylogeny, relationships and classification is a "witch cauldron" of ideas, proposals of classification and relationships of particular subunits and lineages (Yeh *et al*. 1998, 2005, Emeljanov 1999, Yeh and Yang 1999, Soulier-Perkins 2000, 2001, Gnezdilov 2003, 2007, Gnezdilov and Wilson 2006, Shcherbakov 2006, Urban and Cryan 2007, Szwedo 2008).

Placement in particular families and lower units of almost all taxa placed formerly in 'higher' Fulgoroidea units calls for revision and re-consideration. Particularly, the limits of the Tropiduchidae-Issidae-Nogodinidae-Ricaniidae lineage are very nebulous and various subunits (subfamilies, tribes and genera – both extant and extinct) are placed in various groups by various authors.

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Fossil resins

The most famous insect-bearing Cenozoic fossil resins of the New World are Dominican amber and Mexican amber, both aged Miocene (Eskov 2002, Solórzano Kraemer 2007). Dominican amber is the fossilised resin of a leguminose tree *Hymenaea*, of the Early to Middle Miocene age collected in various sites of the Dominican Republic (Iturralde and MacPhee 1996, Kosmowska-Ceranowicz 2000, Weitschat 2007). Dominican arthropods are extremely numerous and diverse (Wu 1996, Poinar and Poinar 1999, Arillo and Ortuño 2005). The general appearance of the fauna is that of the average Central American tropical forest, mixed with a few exotic elements, with most species and some genera being extinct (Poinar 1992, Wu 1996, Poinar and Poinar 1999, Arillo and Ortuño 2005). Mexican (Chiapas) amber is of the same botanical origin as the Dominican amber (Langenheim 1966, 2003, Poinar and Brown 2002, Solórzano Kraemer 2007). It is now considered to be middle Miocene in age (Solórzano Kraemer 2007, Solórzano Kraemer and Petrulevičius 2007). Mexican amber comes from a number of localities in the Simojovel area in the Mexican state Chiapas (Hurd *et al*. 1962). The fossil fauna is rather similar to that of Dominican amber (Poinar 1992).

MATERIAL AND METHODS

The type material of fossil species described below is deposited in the Museum of Amber Inclusions, University of Gdańsk, Gdynia, Poland [MIB UG]. The other examinated specimens of *Thionia*, including types of *Thionia boliviensis* Schmidt, 1910, *Thionia brasiliensis* Schmidt, 1910, *Thionia brevifrons* Schmidt, 1910 and *Thionia pehlkei* Schmidt, 1910 are deposited in the collection of the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw.

The observations had been made using light stereo microscope OLYMPUS® SZH10 with normal and polarized light. Photographs had been made using digital camera and Syncroscopy Auto-Montage™ system and adjusted using Adobe® Photoshop software. Drawings had been made using camera lucida.

TAXONOMY

Thionia Stål, 1859

Type species. *Issus longipennis* Spinola, 1839; by original designation.

Thionia Melichar, 1906 is the huge genus of issidae planthoppers, comprising 72 described species, distributed in the New World throughout, including the Caribbean (Metcalf 1958, Fennah 1965, Wheeler and Wilson 1987). The species included in the genus, at the first glance, look very homogenous and similar to each other. However, the detailed analysis of external morphology presents high variability. It seems that *Thionia* is awaiting taxonomic revision, with numerous taxa not described yet. In the future revision, a set of characters and combination of characters must be taken into consideration for recognition and delimitation of particular species-groups. The characters and combinations of characters presented below resulted from a preliminary analysis of the morphological disparity of a number of specimens, including type-specimens, and descriptions.

Frons. The shape of the frons (Figs 5–12) in the particular species of the genus *Thionia* is variable. For example it is subquadrate in *T. brevifrons* Schmidt, 1910, but elongate, e.g. in *T. brasiliensis* Schmidt, 1910; *T. pehlkei* Schmidt, 1910; *T. proxima* Melichar, 1906. The disc of frons could be equally flattened – *T. brasiliensis* Schmidt, 1910, *T. brevifrons* or unequal, with relief, e.g. *T. colombiae* (Walker, 1851), *T. schmidti* Schmidt, 1910. The surface of the disc of frons could be smooth – *T. brevifrons*, *T. carinata* Melichar, 1906 or granulate – *T. brasiliensis*, T. *proxima* Melichar, 1906, *T. pehlkei* Schmidt, 1910. The median carina could be absent, e.g. *T. brevifrons*, only the median carina could be present, e.g. *T. proxima*, or both median and lateral carinae of frons can be distinct, e.g. *T. brasiliensis*, *T. carinata*, *T. pelkei*. The lateral carinae which can be converging or not converging in lower portion, complete or shortened, connected or not connected in lower portion, could bring another character or set of characters important for taxonomy of the genus *Thionia*.

Clypeus. The median carina of clypeus could be present, e.g. *T. pehlkei*, *T. sinuata* Schmidt, 1910, *T. carinata*, *T. proxima* or absent, e.g. *T. brevifrons* Schmidt, 1910, *T. colombiae*.

Vertex. The shape of the vertex (Figs 13–16) could be subquadrate, e.g. *T. carinata*, *T. bullata* (Say, 1830), transverse (i.e. remarkably wider than long in mid line), e.g. *T. brevifrons*, *T. omani* Doering, 1938, *T. sinuata*, or elongate (i.e. remarkably longer in mid line than broad), e.g. *T. naso* Fowler, 1904; *T. producta* Van Duzee, 1908. The form of the anterior margin of the vertex is variable, and the depth of incision of the posterior margin of vertex and the presence/absence of the median carina of vertex, seem to be specific characters.

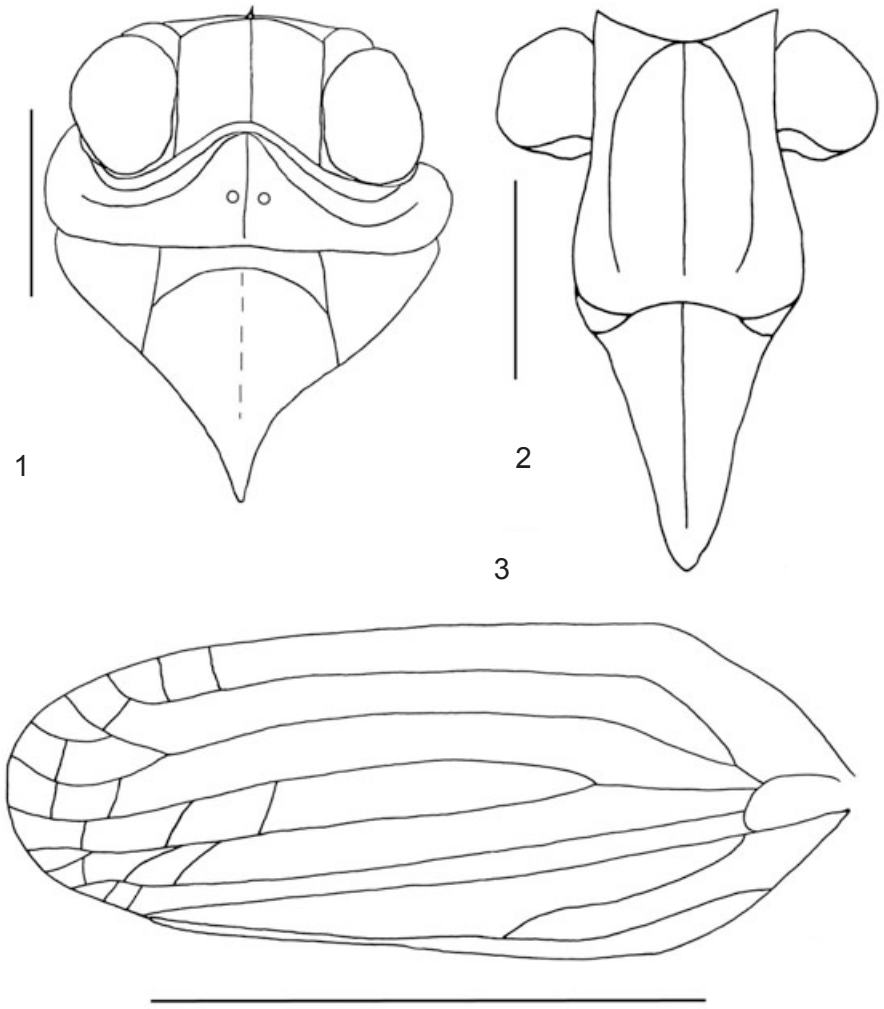
Pronotum. The disc of the pronotum (Figs 13–16) usually is smooth, but in some species, e.g. *T. similis*, *T. proxima* – it is granulated. The presence/absence of longitudinal and transverse carinae seems to be variable among species and specimens. For example, the transverse carina is variably developed in *T. pehlkei*.

Tegmina. The general shape of the tegmen (Figs 17–20) could be wide and relatively short (about twice as long as broad), e.g. *T. brasiliensis* Schmidt, 1910; or elongate and narrowed (remarkably more than twice as long as broad), e.g. *T. brevifrons*, *T. pehlkei*. The surface of the tegmen could be smooth, e.g. *T. boliviensis* Schmidt, 1910, *T. brevifrons, T. pehlkei*; or distinctly granulate, e.g. *T. brasiliensis* Schmidt, 1910. The venation pattern (longitudinal veins straight or curved, the model of forking in apical portions) seems to bring useful characters, but the patterns observed need to be confirmed after more detailed analysis.

Thionia douglundbergi sp. nov.
(Figs 1–4)

Diagnosis. *Thionia douglundbergi* sp. nov. in external appearance is similar to *Thionia carinata* Melichar, 1906. Frons elongate, with disc flattened, with strongly and elevated median carina, lateral carinae developed, not converging downwards. In *T. carinata* frons elongate, median carina present, lateral carinae of frons converging downwards, median "plateau" of frons (area between lateral carinae) elevated. Upper margin of frons arcuately concave (almost straight in *T. carinata*). Clypeus with median carina in both species. Vertex subquadrate with median carina complete in both species. Pronotum with median carina present (median carina absent in *T. carinata*).

Description. Total length: 6.70–8.40 mm. Head with compound eyes (in dorsal view) about as wide as thorax (Fig. 1). Vertex subquadrate, anterior margin weakly arcuate, lateral margins well carinated, parallel, posterior margin deeply, arcuately incised, median carina weakly visible at anterior margin. Disc of vertex flattened. Frons (Fig. 2) elongate, about 1.5



Figures 1–3. *Thionia douglundbergi* sp. nov. (1) Anterior part in dorsal view; (2) face; (3) left tegmen. Scale bar 0.2 mm for 1 and 2, 0.5 mm for 3.

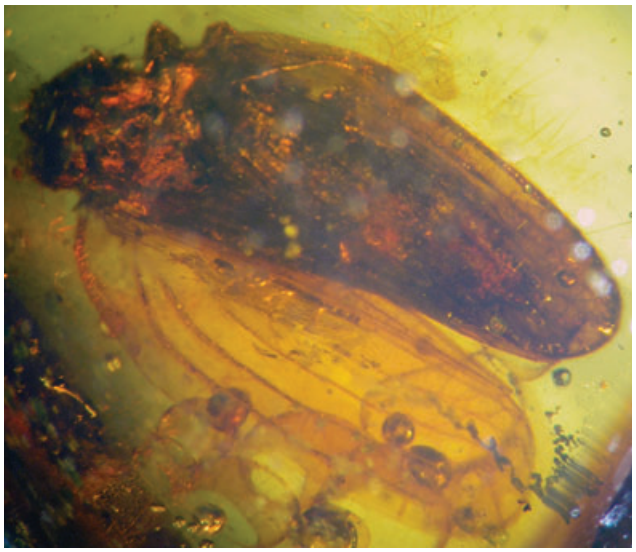


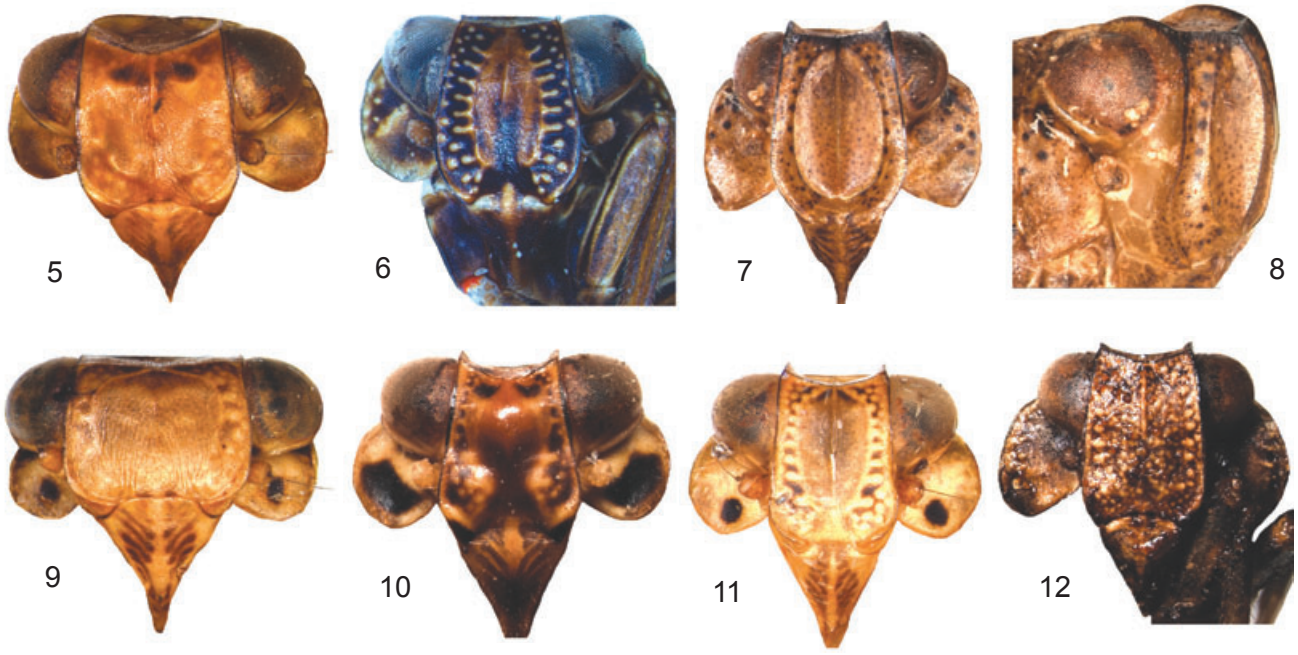
Figure 4. *Thionia douglundbergi* sp. nov. Holotype, general view.

times as long as wide at upper margin. Upper margin of frons arcuately concave, lateral margins carinate, subparallel, slightly diverging in lower portion. Disc of frons flattened; median carina strongly developed, elevated, almost reaching frontoclypeal suture; lateral carinae distinct, not converging downwards, not joining each other. Clypeus with median carina, median portion of clypeus convex. Rostrum reaching hind coxae. Compound eyes bulging, with small callus at lower portion.

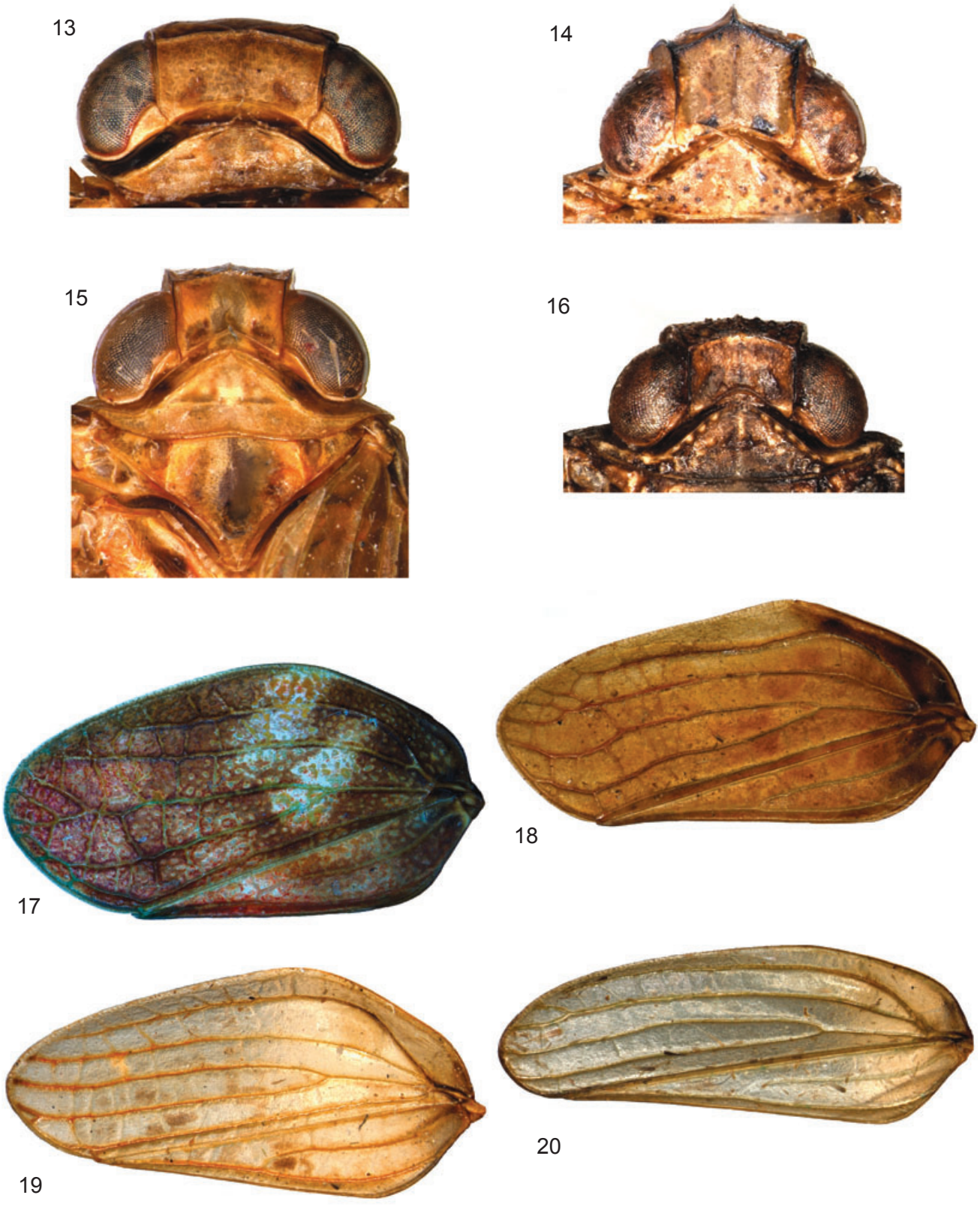
Pronotum tricarinate (Fig. 1), with median carina distinctly visible, lateral impressions well visible; lateral carinae strongly diverging, almost reaching (in dorsal view) to the level of lateral margin of compound eyes. Anterior margin in median portion triangularly produced, exceeding level of posterior margin of compound eyes; posterior margin almost straight. Disc of pronotum smooth. Mesonotum subtriangular; median carina obsolete, lateral carinae well developed, straight, reaching to posterior margin; transverse carina distinctly arcuate, shifted from posterior margin of pronotum. Disc of mesonotum smooth.

Hind tibia elongate and slender, with two lateral spines, apex with 8 teeth, arranged in almost straight line; lateral teeth distinctly bigger than internal ones. Basitarsomere with a row of 8 apical teeth, arranged in deeply arcuate line, lateral teeth bigger than internal ones; second tarsomere with 2 small lateral teeth.

Tegmina (Fig. 3) elongate, narrow, tapering apicad and membranous, without granules. Longitudinal veins almost straight; Costal margin arcuate in basal portion, almost straight after breaking point. Vein Sc+R leaving basal cell as short common stem, shallowly arcuate. Stem Sc+RA distinctly broken in anterior portion, then parallel to costal margin; terminal ScRA single. Vein RP forked in apical portion, slightly basad of apex of clavus, with three terminals. Stem M forking at



Figures 5–12. Representative of the genus *Thionia*, face. (5) *T. boliviensis* Schmidt, (6) *T. brasiliensis* Schmidt, (7–8) *T. carinata* Melichar, (9) *T. brevifrons* Schmidt, (10) *T. colombiae* (Walker), (11) *T. pehlkei* Schmidt, (12) *T. proxima* Melichar.



Figures 13–20. (13–16) Representatives of the genus *Thionia*, anterior part. (13) *T. brevifrons* Schmidt, (14) *T. carinata* Melichar, (15) *T. pehlkei* Schmidt, (16) *T. proxima* Melichar, (17–20) Representatives of the genus *Thionia*, tegmina: (17) *T. brasiliensis* Schmidt, (18) *T. boliviensis* Schmidt, (19) *T. brevifrons* Schmidt, (20) *T. pehlkei* Schmidt.

about basal $^1/_3$ of tegmen length, with three terminals. Stem CuA not forked, with single terminal. Clavus very long, with apex exceeding $^3/_4$ of tegmen length. Claval vein Pcu and A_1 fused at about half of clavus length. Two transverse veinlets, perpendicular to costal margin, slightly basad of ScRA terminal; single veinlet *ir*, two veinlet *r-m* in apical portion, three veinlets *im*, three veinlets m-cu, of which two basal distinctly oblique; two postclaval veinlets *icu*, reaching margin of tegmen, almost perpendicular to it. Clavus without transverse veinlets.

Hind wing not visible.

Male genital structures extremely weakly visible.

Material. Holotype, male, No MIB UG 5278, specimen with partly damaged anterior dorsal portion of the body, slightly distorted, with abdomen damaged. Paratype, male MIB UG 5279; specimen quite well preserved, but weakly visible because of numerous bubbles within the amber, concealing the inclusion. Deposited in the Museum of Amber Inclusions, University of Gdańsk, Gdynia, Poland.

Etymology. The specific epithet is given after Doug Lundberg, amber collector, who offered the specimens for the elaboration and scientific collection of the Museum of Amber Inclusions, University of Gdańsk.

Age and occurrence. Miocene, Dominican amber, Hispaniola Island, Dominican Republic.

DISCUSSION

A few taxa of 'lower' and 'higher' planthoppers are know from fossil resins, mainly of Miocene ambers of Hispaniola and Mexico (Szwedo and Ross 2003, Szwedo *et al*. 2004, Solórzano Kraemer and Petrulevičius 2007). Among the families Cixiidae: *Mnemosyne* sp. and *Oeclixius amphion* Fennah, 1963, *Oligocixia electrina* Gebicki et Wegierek, 1993, are known; Delphacidae: '*Eucanyra*' sp., Derbidae: *Cedusa credula* Emeljanov et Shcherbakov, 2000 and *Dysimia imprudens* Emeljanov et Shcherbakov, 2000, *Cedusa baylissae* Szwedo et Ross, 2003; Kinnaridae: *Oeclidius browni* Bourgoin et Lefebvre, 2002 and *Oe. salaco* Emeljanov et Shcherbakov, 2000, *Quilessa stolida* Emeljanov et Shcherbakov, 2000 (Bourgoin and Lefebvre 2002, Emeljanov and Shcherbakov 2000, Fennah 1963, Gebicki and Wegierek 1993, Szwedo and Ross 2005, Solórzano Kraemer 2007). 'Higher' Fulgoroidea are represented by the nymph of a Flatidae (Fennah 1963) and a few Nogodinidae: *Tonacatecutlius gibsoni* Stroiński et Szwedo, 2000, *Tainosia quisqueyae* Szwedo et Stroiński, 2001 and '*Nogodina*' *chiapaneca* Solórzano Kraemer et Petrulevičius, 2007 (Stroiński and Szwedo 2000, Szwedo and Stroiński 2001, Solórzano Kraemer 2007, Solórzano Kraemer and Petrulevičius 2007). What is interesting, as most of the genera of "lower" Fulgoroidea are extant, in 'higher' Fulgoroidea the genera are *Tonacatecutlius* and *Tainosia* are extinct, while generic placement of species described by Solórzano Kraemer and Petrulevičius (2007) remain doubtful. The reason for such statement is the recent situation in Nogodinidae classification. The internal classification of the family and its nearest relatives, placement of several extant and extinct taxa in or out of Nogodinidae is under strong discussion (Penny and O'Brien 2000, Shcherbakov 2006, Gnezdilov 2007). New World Nogodinidae await for review and revision, numerous new genera and species are to be described (Penny and O'Brien 2000, Szwedo and Stroiński unpublished data).

However, the species described above, representing the first record of Issidae in New World fossil resins, could be placed without doubt in the extant genus *Thionia*.

As mentioned above, placement of '*Nogodina*' *chiapaneca* in this genus should be reconsidered. The internal classification and limits of lower taxa: tribes and genera within Nogodinidae are still under debate (Emeljanov 1999, Shcherbakov 2006, Gnezdilov 2007). On the base of the photograph presented of '*Nogodina*' *chiapaneca* several important features should be rechecked, e.g. structure of the head, legs and genital block, and after this the generic placement could be suggested.

Further investigations on extinct planthoppers from New World are necessary, more specimens and data must be available. As example, photographs of the specimens probably belonging to *Thionia* were presented in a few papers, e.g. Wu (1996), Poinar and Poinar (1999). Several other families are reported as well, not only from resins, but also from rocks (Szwedo *et al*. 2004). The accumulation of primary data with incremental knowledge, could result in new possibilities of testing biogeographic scenarios, e.g. models of formation of New World faunas in general, migration routes and origination of continental and the Carribean islands faunas. Elaboration of new materials and new data on fossil New World planthoppers will bring a huge contribution to knowledge on phylogeny and evolutionary patterns of particular groups and lineages of these insects.

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