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An embarrassing situation requiring urgent action: Colombia, a country of extraordinary biodiversity, still counts only few species of Nepticuloidea (Insecta, Lepidoptera)

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This paper summarizes the scant available data on Nepticuloidea (Nepticulidae and Opostegidae) from Colombia, and convenes systematists, particularly in Colombia, to study these peculiar tiny insects of great theoretical and practical importance.

Key words: Colombia, leaf-miners, Nepticulidae, Opostegidae

INTRODUCTION

The superfamily Nepticuloidea (Nepticulidae and Opostegidae) contains some of the smallest Lepidoptera known, with a wingspan ranging from 3.8–4.0 mm or less. One of the more obvious diagnostic features of Opostegidae is the greatly expanded antennal scape (Fig. 1A), which covers the eye at rest. Nepticulidae also possess an enlarged scape but usually developed to a relatively lesser degree (Fig. 1B) (Davis, Stonis, 2007). The morphology of nepticuloids has been extensively discussed by, among others, Johansson et al. (1990); Puplesis (1994); Puplesis, Robinson (2000); Puplesis, Diškus (2003); Davis, Stonis (2007); and Diškus, Stonis (2012).

Although Nepticulidae and Opostegidae are generally global in distribution, evidence indicates that the greatest diversity of Opostegidae occurs in continental tropical or subtropical regions (Davis, Stonis, 2007). The small size and apparent rarity of most species of Opostegidae, coupled

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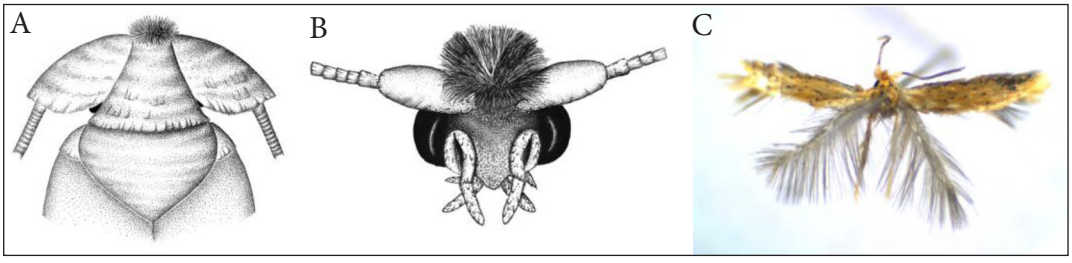

Fig. 1. Adults: A – dorsal view of thorax and head, Opostegidae; B – frontal view of head, Nepticulidae (after Puplesis, Diškus, 2003); C – pinned specimen of *Stigmella robleae*, Colombia

with the great difficulty in locating their usually well-concealed plant-mining larvae, undoubtedly have hindered previous attempts to collect and study this group (Davis, Stonis, 2007). The majority of generally more thoroughly investigated nepticulids are monophagous or oligophagous, among which leaf-miners comprise the largest number, but sometimes larvae mine buds and shoots, keys/samaras (fruits of *Acer*) or young bark. Because of such a lifestyle within assimilating tissues of plants, a number of nepticuloids could be considered pests or potential pests (for a list of pest species from Russia see Kuznetzov, Puplesis, 1994); for that reason they are important from the economic point of view (Puplesis, 1994; Puplesis, Diškus, 2003). The tunnels made by Nepticulidae have characteristic patterns. Mines can be generally categorized as follows: linear (most species) (Fig. 2A, B); blotch (very rare); a combination of a gallery in the first half and a blotch in the second half (Fig. 2C); spiral (helical). The mines of the majority of species are characteristic and have a diagnostic value at the species level.

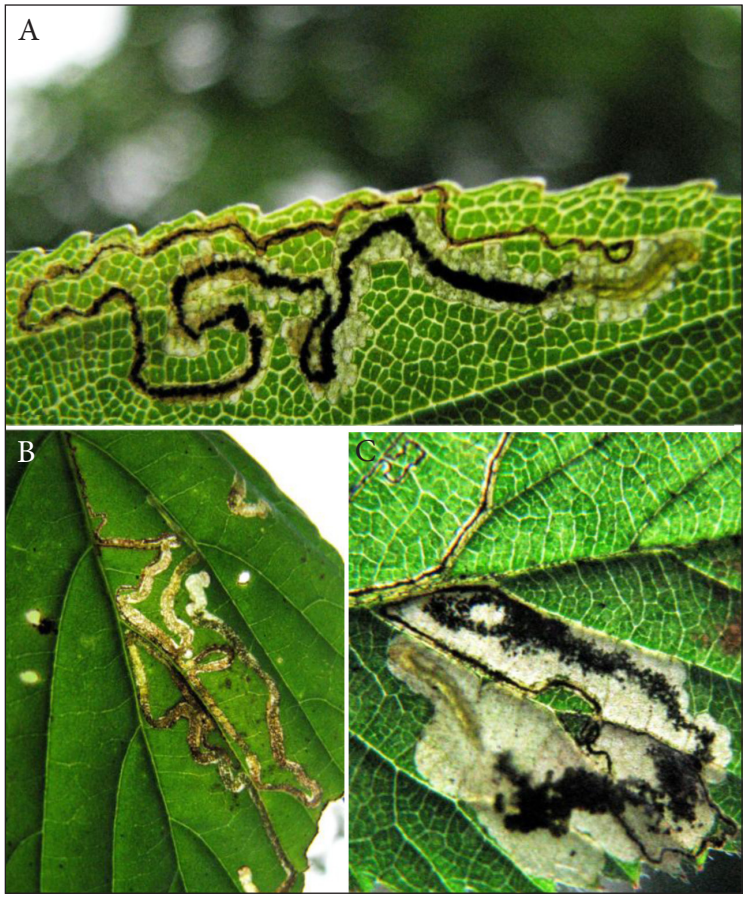

Fig. 2. Leaf-mines of Nepticulidae, Colombia: A, B – linear; C – combined

However, the shape of the mine and the colour and distribution of the frass may vary, depending (amongst many factors) on the thickness of the leaf, light conditions and host-plant species (Diškus, Stonis, 2012). The duration of mining (the larval stage) is usually short, in the majority of cases a matter of a few days, but sometimes this stage may take a few months. Except in a few species, the fully-grown larva emerges from the mine and descends on a silk thread, usually to the ground. Larvae may then hide in detritus, where they spin a silk cocoon. In some species the cocoon is spun on a stem or trunk of the host-plant (Puplesis, Robinson, 2000).

These tiny lepidopterans occur in almost all terrestrial biomes to sandy deserts and rainforest. Because of stenophagy, the sedentary lifestyle and a high rate of endemism, they could serve as a perfect tool for characterizing the richness, origin and faunal relationships of ecoregions and biomes. Climate change or migration of the population and certain commercial projects may cause an incidental introduction of a pest fauna (Diškus, Stonis, 2012).

Currently the world fauna of Nepticuloidea comprises about 1,060 species: 202 species of Opostegidae (Remeikis et al., 2009) and about 860 species of Nepticulidae (Puplesis et al., 2002; Stonis et al., 2014). However, the diversity of these moths has been very little studied in many regions. The goal of this report is to show the scientific community shortcomings on the knowledge on Colombian nepticuloids as an example of a biologically neglected area, and to prepare the ground for future investigations of this fauna.

METHODS

The material can be obtained by rearing adults from mining larvae or by attracting adults to mercury-vapour light from a lamp suspended in front of a white screen (light-collecting). The collecting methods and techniques for genitalia preparation and the protocols for description are outlined in Puplesis, Robinson (2000), Puplesis, Diškus (2003), and Diškus, Stonis (2012).

TAXONOMIC REVIEW OF THE FAUNA OF NEPTICULOIDEA OF COLOMBIA

The first two species recorded from Colombia, *Stigmella johannis* and *Fomoria molybditis*, were described by Zeller (1877) (as "*Nepticula*") from the Colombian material collected by Johann and Nolcken in 1871. They were also the first species recorded from the whole Neotropical Region.

In his very brief species description of "*Nepticula*" *molybditis*, P. C. Zeller wrote: "Ein schön erhaltenes ♂ wurde bei Bogotá am Fusse des Guadelupe am 11 Februar Mittags aus Gebüsch geklopft. Merhr Exemplare liessen sich alles Suchens ungeachtet nicht auftreiben" (Zeller, 1877: 455–456). Now the holotype of *Fomoria molybditis* is deposited in the collection of the Natural History Museum in London and so far represents the only known specimen of the species. It is in good condition; however, both antennae are missing. Some 15 years ago, the holotype was dissected (genitalia slide No. 25651BMNH), examined and re-described (see Puplesis, Robinson, 2000). It represents an outstanding species distinguished from all other known Neotropical nepticulids by an unusually long transtilla plate in combination with a long and sinuous basal process of the valva and long narrowed vinculum.

Zeller wrote in the same paper about another species from Colombia, "*Nepticula*" *johannis*: "Dieses einzige Exemplar einer unzweifelhaften Nepticulawurde durch Johann, den fleissingen und geschickten Gehülfen des Barons v. Nolken in Europa und Amerika, bei Bogotá am 27 Mai spat Abends gefangen. Möge diese Art dem Andenken des bald nach der Rückkerhr aus Amerika Verstorbenen gewidmet sein!" (Zeller, 1877: 456–457). The holotype is deposited in the collection of the Natural History Museum in London and is in satisfactory condition with a clear wing pattern, but the wings are not spread. It has been dissected (genitalia slide No. 28843BMNH), examined and re-described (see Puplesis, Robinson, 2000). The species represents a member from the *Stigmella salicis* species group and differs from others by the combination of lustrous silvery postmedian fascia, many almost equal-sized large cornuti in

the phallus, well-separated caudal processes of the gnathos, and broad uncus with four caudal papillae (Puplesis, Robinson, 2000).

Another species of nepticuloid was reported from Colombia by Meyrick (1915): *Opostega pontifex* from Cali, which has been transferred to the genus *Pseudopostega* and also deposited in the collection of the Natural History Museum in London. Unfortunately, this species is represented only by a holotype, which is missing the hindwings and abdomen. Consequently, its sex cannot be determined. The drawing and color description of the hindwing was reconstructed by Stonis according to Meyrick's (1915) original description (Davis, Stonis, 2007: Fig. 244). The remainder of the holotype is well preserved, and may provide sufficient information for eventually recognizing the species (Davis, Stonis, 2007).

The recent trip to universities of Colombia (including the Pontificia Universidad Javeriana and the Universidad Nacional de Colombia in Bogotá), undertaken in February 2013 (Fig. 3) by the first two authors of this publication, resulted in the discovery of two *Stigmella* species on *Quercus humboldtii*. Previously, no *Quercus* feeding nepticulid species had been known from South America. Two discovered species represented *Stigmella robleae* and *S. humboldti* (probably endemic taxa) (Remeikis, Stonis, 2015). It is possible that the *Quercus* feeding fauna of the Colombian Andes is richer than the two species registered: a short observation in Manizales allowed us to presume about at least one more oak-mining species in Colombia.

In addition, one more *Stigmella* adult was reared from a single larva mining on an Asteraceae. It appeared that it belonged to a new species which was previously collected from Central Ecuador. Therefore, the specimen from Colombia added to the knowledge about the distribution of the species which will be described and named in Stonis et al. (submitted).

All these newly collected specimens are deposited in the collection of Pontificia Universidad Javeriana.

For Colombia, we may currently list six species of Nepticuloidea (Fig. 4):

Fig. 3. Map and habitats: A – map of South America (courtesy of T. Patterson, USA); B – cloud forest habitat at Chicaque Nature Park; C – locality at Rio Guatiquia near Villavicencio

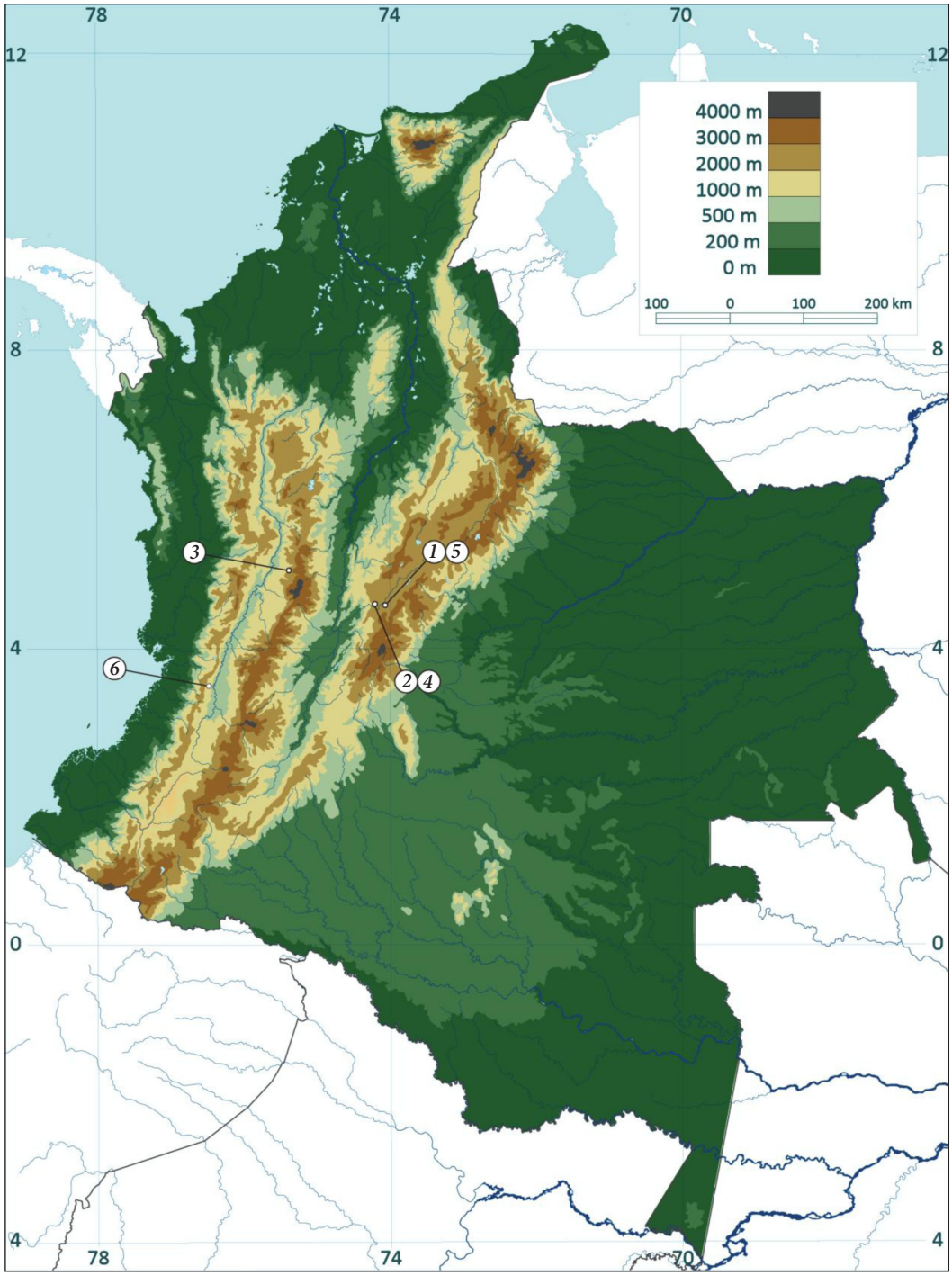

Fig. 4. Distribution of Nepticuloidea currently known from Colombia (*1* – *Stigmella johannis*; *2* – *Stigmella* sp.; *3* – *S. robleae*; *4* – *S. humboldti*; *5* – *Fomoria molybditis*; *6* – *Pseudopostega pontifex*)

Nepticulidae Stainton, 1854

1. ***Stigmella johannis*** (Zeller, 1877) (*Nepticula johannis* Zeller, 1877: 456, 457). Host-plant unknown. Distribution: Colombia (Bogotá). Note: for the species description and illustration, see Puplesis, Robinson, 2000: 28, 29, 63; Figs. 16, 92, 93.

2. ***Stigmella* sp.** Described and illustrated in Stonis et al. [submitted, 2015]. Host-plant: Asteraceae. Distribution: Colombia (SE of

Bogotá: Chicaque Nature Park); Ecuador (the Andes).

3. ***Stigmella robleae*** Remeikis & Stonis, 2015. Host-plant: *Quercus humboldtii* Bonpl (section Lobatae). Distribution: Colombia (Manizales). Note: for the species description and illustration, see Remeikis, Stonis, 2015.

4. ***Stigmella humboldti*** Remeikis & Stonis, 2015. Host-plant: *Quercus humboldtii* Bonpl (section Lobatae). Distribution: Colombia (SE of Bogotá: Chicaque Nature Park). Note: for the species description and illustration, see Remeikis, Stonis, 2015.

5. ***Fomoria molybditis*** (Zeller, 1877) (*Nepticula molybditis* Zeller, 1877: 455, 456). Host-plant unknown. Distribution: Colombia (Bogotá). Note: for the species description and illustration, see Puplesis, Robinson, 2000: 43, 68, 95; Figs. 41, 157, 158.

Opostegidae Meyrick, 1893

6. ***Pseudopostega pontifex*** (Meyrick, 1915) (*Opostega pontifex* Meyrick, 1915: 240). Host-plant unknown. Distribution: Colombia (Cali). Note: for the species description and illustration, see Davis, Stonis, 2007: 149; Fig. 244.

DISCUSSION

Colombia is regarded as one of the world's "megadiverse" countries, hosting close to 10% of the planet's biodiversity. Worldwide, it ranks first in bird and orchid species diversity and second in plants, butterflies and freshwater fish (Colombia – Country Profile, 2015). Colombia also has an extraordinary diversity of amphibians and mammals (Colombia, 2015). With 314 types of ecosystems, Colombia possesses a rich complexity of ecological, climatic, biological and ecosystem components. The country has several areas of high biological diversity in the Andean ecosystems, characterized by a significant variety of endemic species, followed by the Amazon rainforests and the humid ecosystems in the Chocó biogeographical area (Colombia – Country Profile, 2015).

Meanwhile, the current list of the Colombian Nepticuloidea comprises only about 0.5% of the world's fauna: 0.6% of Nepticulidae and 0.5% of the world's Opostegidae (or 1.15% of the Neotropical Opostegidae). The situation with Colombia's Tischeriidae (Tischerioidea), a related family (superfamily) to Nepticuloidea, is even worse. Though 115 species are globally known at present (and 70 more newly discovered species from regions of America and South East Asia have been prepared to be described by us), not a single species of these insects from Colombia has been registered yet.

The current situation is rather embarrassing and requires urgent action: extensive taxonomic studies of Nepticulidae and Opostegidae (also Tischeriidae) in different ecosystems and habitats of this amazing country.

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SITUACIJA, KURIAI REIKALINGI SKUBŪS VEIKSMAI: KOLUMBIJOJE, PASIŽYMINČIOJE NEEILINE BIOLOGINE ĮVAIROVE, IKI ŠIOL IŠAIŠKINTA TIK KELETAS NEPTICULOIDEA (INSECTA, LEPIDOPTERA) RŪŠIŲ

Santrauka

Šiame straipsnyje pirmą kartą apibendrinami visi duomenys apie iki šiol labai menkai žinomus Kolumbijos gaubtagalvius (Nepticuloidea) – mažuosius (Nepticulidae) ir baltuosius (Opostegidae), taip pat pateikiamas visų išaiškintų rūšių anotuotas taksonominis sąvadas. Šiuo metu Kolumbijoje išaiškintos Nepticuloidea rūšys sudaro apie 0,5 % pasaulio faunos. Tai nurodoma kaip pakankama priežastis, kodėl tyrėjai turėtų daugiau dėmesio skirti svarbią teorinę ir praktinę reikšmę turinčiai Nepticuloidea Kolumbijoje.

Raktažodžiai: Kolumbija, gaubtagalviai, Nepticulidae, Opostegidae