



Zootaxa 4469 (1): 001–069
<http://www.mapress.com/j/zt/>

Copyright © 2018 Magnolia Press

Monograph

ISSN 1175-5326 (print edition)

ZOOTAXA

ISSN 1175-5334 (online edition)

<https://doi.org/10.11646/zootaxa.4469.1.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:42680994-585D-4230-B574-8DB398341B23>

ZOOTAXA

4469

American Asteraceae-feeding *Astrotischeria* species with a highly modified, three-lobed valva in the male genitalia (Lepidoptera, Tischeriidae)

JONAS R. STONIS^{1,2,5}, ARŪNAS DIŠKUS¹, FERNANDO CARVALHO FILHO³ & OWEN T. LEWIS⁴

¹*Vytautas Magnus University and Baltic-American Biotaxonomy Institute, Studentų St. 39, Vilnius LT-08106, Lithuania*

²*Nature Research Centre, Akademijos St. 2, Vilnius LT-08412, Lithuania*

³*Departamento de Zoologia, Museu Paraense Emilio Goeldi, Av. Perimetral, 1901, Montese, CEP 66077-830, CP 399, Belém, PA, Brazil*

⁴*Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, United Kingdom.*

⁵*Corresponding author: E-mail: stonis@leu.lt; stonis.biotaxonomy@gmail.com*



Magnolia Press
Auckland, New Zealand

Accepted by L. Kaila: 7 Jun. 2018; published: 3 Sept. 2018

JONAS R. STONIS, ARŪNAS DIŠKUS, FERNANDO CARVALHO FILHO & OWEN T. LEWIS
American Asteraceae-feeding *Astrotischeria* species with a highly modified, three-lobed valva in the male genitalia (Lepidoptera, Tischeriidae)
(*Zootaxa* 4469)

69 pp.; 30 cm.

3 Sept. 2018

ISBN 978-1-77670-448-4 (paperback)

ISBN 978-1-77670-449-1 (Online edition)

FIRST PUBLISHED IN 2018 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: magnolia@mapress.com

<http://www.mapress.com/j/zt>

© 2018 Magnolia Press

All rights reserved.

No part of this publication may be reproduced, stored, transmitted or disseminated, in any form, or by any means, without prior written permission from the publisher, to whom all requests to reproduce copyright material should be directed in writing.

This authorization does not extend to any other kind of copying, by any means, in any form, and for any purpose other than private research use.

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

Table of contents

Abstract	3
Introduction	3
Material and methods	9
Taxonomic treatment	14
The <i>Astrotischeria trilobata</i> species group (designated here)	14
<i>Astrotischeria trilobata</i> Diškus & Stonis, sp. nov.	14
<i>Astrotischeria amazonica</i> Diškus & Stonis, sp. nov.	27
<i>Astrotischeria maya</i> Diškus & Stonis, sp. nov.	27
<i>Astrotischeria selvica</i> Diškus, Carvalho-Filho & Stonis, sp. nov.	36
<i>Astrotischeria casila</i> Diškus & Stonis, sp. nov.	37
<i>Astrotischeria onae</i> Diškus & Stonis, sp. nov.	43
<i>Astrotischeria furcata</i> Stonis & Diškus, sp. nov.	49
<i>Astrotischeria plagifera</i> (Meyrick, 1915)	49
<i>Astrotischeria heliopsisella</i> (Chambers, 1875)	55
<i>Astrotischeria ambrosiaeella</i> (Chambers, 1875)	57
<i>Astrotischeria occidentalis</i> (Braun, 1872)	60
Discussion	60
Acknowledgements	66
References	66

Abstract

We review eleven *Astrotischeria* Puplesis & Diškus (Lepidoptera: Tischeriidae) species which possess a novel character for the Tischeriidae family: a highly modified valva of the male genitalia with one ventral and two dorsal lobes (or processes). The species are distributed in the Americas, including the USA, Caribbean (St. Thomas), Central America (Belize, Guatemala and Honduras), and South America (Ecuador, Bolivia, and Brazil). Species for which the biology has been studied are associated with host plants from Asteroidea of the Asteraceae family. The following seven species are described as new: *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, *A. amazonica* Diškus & Stonis, **sp. nov.**, *A. maya* Diškus & Stonis, **sp. nov.**, *A. selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**, *A. casila* Diškus & Stonis, **sp. nov.**, *A. onae* Diškus & Stonis, **sp. nov.**, and *A. furcata* Stonis & Diškus, **sp. nov.** A new informal species unit, the *A. trilobata* group, is designated for diagnostic purposes despite some doubts about monophyly of the group. *Astrotischeria longeciliata* (Frey & Boll) is synonymized here with the North American *A. helianthi* (Frey & Boll), a species not belonging to the *A. trilobata* group, **syn. nov.** For the first time, a method of rearing of adults from mining larvae, specifically adopted for Tischeriidae, is detailed. All species treated in the paper are illustrated with photographs or drawings of the adults, male genitalia, and, if available, the female genitalia, leaf mines and habitats. A distribution map for the species of the *A. trilobata* group and a scheme of the trophic relationships of the global Tischeriidae fauna are also provided.

Key words: American fauna, Asteraceae, Asteroidea, *Astrotischeria*, host plants, leaf miners, leaf mines, Neotropics, new species, the *trilobata* group

Introduction

Documentation of the world's fauna. The Tischeriidae or trumpet moths represent an important but small family of tiny leaf-mining Lepidoptera. The family is almost cosmopolitan and its living members are known from all continents, except Australia and Antarctica. Tischeriidae species are represented in diverse terrestrial ecosystems from the tropics to the temperate regions but, as a rule, the family is more abundant in subtropical and tropical regions, except for cooler habitats of the tropics at elevations above 3500 m (to date, no tischeriid has been found at an elevation above 3600 m).

A brief history of research on Tischeriidae was provided by Puplesis & Diškus (2003). Since then, several papers dealing with Tischeriidae have been published, notably: Landry & Roque-Albelo (2004); Puplesis *et al.* (2004); Mey (2010); Puplesis & Diškus (2005); Diškus & Stonis (2012, 2015); Stonis & Diškus (2007, 2008); Lees & Stonis (2007); Sinev (2008); Heppner (2008); Stonis *et al.* (2008, 2014, 2016a, 2017a); Huang & Tan (2009); Nieukerken (2010); Sato (2011); Navickaitė *et al.* (2011); Koçak & Kemal (2012); Karsholt & Nieukerken (2013); Diškus *et al.* (2014); Laštuvka & Laštuvka (2015); Kurtz & Embacher (2016); Kobayashi *et al.* (2016); Xu *et al.* (2017, 2018).

At present, about 128 Tischeriidae species have been described worldwide, including three documented but unnamed species from South Africa by Puplesis & Diškus (2003). Most of these species are listed in the Catalogue of the global fauna by Diškus & Puplesis (2003). However, 17 species have been described during the last 15 years, after the catalogue by Diškus & Puplesis (2003). Among numerous researchers involved in description of Tischeriidae species, only a few authors are responsible for the bulk of the currently known Tischeriidae. Edward Meyrick described 11 species, mainly from tropical regions (Meyrick 1908, 1911, 1915a,b, 1934, 1936), i.e. nearly 9 % of the fauna. Annette Frances Braun described 26 currently recognized Nearctic species, about 20 % of the world fauna. Finally, a tandem of two authors, Arūnas Diškus and Jonas Rimantas Stonis (formerly Puplesis) have contributed with 39 species, described from Palaearctic, Oriental, Afrotropical and Neotropical regions. Additionally, new species from the USA (3 species), Belize (7 species), Guatemala (18 species), Honduras (4 species), Ecuador (5 species), Peru (10 species), Bolivia (6 species), Brazil (1 species), South Africa (2 species), and the countries of South East Asia (9 species) are already recognized, and are under preparation for publication by J.R. Stonis and A. Diškus with co-authors.

Diagnostics of Tischeriidae. The first detailed and contemporary characterization of the family was provided by Braun (1972), which three decades later was followed by Davis (1999) and more exhaustively by Puplesis & Diškus (2003). Some new data were added recently by Kobayashi *et al.* (2016) and Stonis *et al.* (2017a).

Adult tischeriids are very small, with wingspans ranging from 5.4 to 10 mm. The male genitalia have a well-developed uncus but usually a fully absent gnathos (Fig. 1). The female ovipositor is not of the piercing type, and comprises a pair of ovipositor lobes and a second pair of often smaller lobes (Fig. 2). Among the most distinctive diagnostic features of the family is the length of the male antennal sensillae trichodea, which usually exceed the width of the flagellum by more than 4.5–10 times, thus being strikingly long. Despite being very fine, they are clearly noticeable; females also possess sensillae but they are much shorter, usually exceeding the width of flagellum by less than 2.5–3 times; they are often indistinct without careful examination or even dissection (Fig. 25). In both males and females, sensillae trichodea have strongly recurved and sometime thickened bases. The 3rd antennal segment is greatly enlarged (Fig. 22). The frontal tuft (Figs. 131–134, 162, 194, 195) projects over the triangular or trapezoid face, which is smoothly covered with scales (Figs. 134, 162). Among other characters that also have diagnostic importance for family recognition are the following genitalia characters: in the male genitalia, the phallus is strongly narrowed and usually bifurcated at its apex; in the female genitalia, the ovipositor lobes are covered with dark, short, strongly thickened, stout “peg setae” which are often visible even without dissection; beside the stout anterior and posterior apophyses, there are unique rod-like or plate-like projections of probably modified 8th and 9th sternites. Following Braun (1972), these are collectively referred here as prela (Fig. 2).

Trophic interactions of Tischeriidae. Larvae of these insects are all leaf miners; that is to say during all instars the larvae live inside leaves, feeding on the green tissues (parenchyma) producing irregular, blotch-like or similar leaf mines and they can have significant impacts on their host plants by reducing the assimilatory tissue. Therefore, Tischeriidae are sometimes regarded as pests or potential pests of cultivated plants (Kuznetsov 1994).

The leaf-mining larvae of Tischeriidae are very selective in their food choice: they are stenophagous (monophagous or oligophagous). They are associated with eighteen host-plant families. However, the number of host-plant families may slightly differ in the recent literature (Puplesis & Diškus 2003, Xu *et al.* 2017, 2018) because of new discoveries and continuing increase in the number of host plants recorded (Xu *et al.* 2017, 2018), and because of taxonomic changes in botanical nomenclature. The recent transfer of the host-plant genus *Bridelia* Willd. from Euphorbiaceae to Phyllanthaceae removes the Euphorbiaceae as a host-plant family for Tischeriidae. Currently Tischeriidae are known from Phyllanthaceae, Hyperaceae (Malpighiales), Fabaceae (Fabales), Rosaceae, Rhamnaceae, Ulmaceae, Urticaceae (Rosales), Fagaceae, Betulaceae (Fagales), Combretaceae, Lythraceae (Myrtales), Anacardiaceae (Sapindales), Malvaceae (including subfamilies Tilioideae, Sterculioideae; Malvales), Theaceae, Symplocaceae, Ericaceae (Ericales), Apocynaceae (Gentiales), and Asteraceae (Asterales). Five of these host-plant families were added only recently: Urticaceae (Puplesis & Diškus 2005, Stonis *et al.* 2017a), Betulaceae, Symplocaceae (Kobayashi *et al.* 2016), Fabaceae (Xu *et al.* 2017), and Ulmaceae (Xu *et al.* 2018). In temperate regions host plants from Rosaceae and Fagaceae prevail, in North America also with Malvaceae and Asteraceae.

Taxonomic composition of the family. For a long time, all the Tischeriidae were placed in the genus *Tischeria* Zeller, 1839. Currently Tischeriidae comprises four genera: *Tischeria* (*sensu stricto*) with 33 described species, *Coptotriche* Walsingham, 1890 (restored to generic status by Puplesis & Diškus 2003), now comprising 60 described species, *Astrotischeria* Puplesis & Diškus, 2003 with 26 described species, and the recently erected

Paratischeria Diškus & Stonis with 9 described species (Stonis *et al.* 2017a, Xu *et al.* 2017). More changes in the taxonomy of the family are to be expected (Stonis & Diškus *in prep.*). Notes on diagnostics of *Tischeria*, *Coptotriche* and *Astrotischeria* can be found in Puplesis & Diškus (2003), and diagnostics of *Paratischeria* was provided in Stonis *et al.* (2017a).

Diagnostic characters of *Astrotischeria*. Male genitalia with divided valva (Fig. 1); the second, dorsal lobe is rather indistinct only in the North American *A. explosa* (Braun) and *A. pallidipenella* (Braun). Uncus short and with four lobes (two slender and longer lateral, and two usually rounded and shorter median); only three species of 26 of *Astrotischeria*, *A. ephaptis* (Meyrick), *A. pallens* Puplesis & Diškus, and *A. onae* Diškus & Stonis, **sp. nov.**, possess rather long, bilobed uncus. Gnathos absent. Ventral lobe of valva slender, except for *A. onae*. Basal process of valva long or very long. Anellus distinct, thickened laterally, usually slightly bilobed distally, sometimes very strongly developed, notably in *A. casila* Diškus & Stonis, **sp. nov.** (Fig. 175), and particularly in *A. onae* (see Fig. 175). Juxta always absent. Phallus very slender, deeply divided at apical part, and usually without spines, except for a very few species (*A. selvica* Diškus & Stonis, **sp. nov.**, *A. maya* Diškus & Stonis, **sp. nov.**, and *A. scalesiaella* B. Landry). Female genitalia with stout anterior and posterior apophyses and well developed prela; sometimes, i.e. in *A. marginata* (Braun), *A. gregaria* (Braun), *A. astericola* (Braun), *A. explosa* (Braun) and many species of the *A. trilobata* group, prela are greatly prolonged or in the form a chitinized plate. Ductus spermathecae usually with a few small coils, except for *A. casila* Diškus & Stonis, **sp. nov.** and *A. selvica* where coils are numerous and rather large.

By sharing a developed anellus, slender valva, slender, apically bifurcated phallus in the male genitalia, and sometimes large coils of ductus spermathecae in the female genitalia, *Astrotischeria* mostly resembles the pan-tropical or subtropical *Paratischeria* Diškus & Stonis. A preliminary molecular analysis (Stonis *et al.* 2017a) showed that these genera are closely related. However, species of *Parastischeria* never possess a divided valva and short, four-lobed uncus (Fig. 3).

All species provided in this treatment belong to *Astrotischeria*. The genus is known only from the Americas, and currently comprises nearly thirty species with striking apomorphies in genitalia and larval host-plant preference on Asteraceae. Some of the earlier records of *Astrotischeria* species feeding on Malvaceae (Diškus & Puplesis 2003, Diškus & Stonis 2015) now appear to belong to the recently erected *Paratischeria*. Nevertheless, still one *Astrotischeria* species, *A. omissa* (Braun 1927), is recorded as a Malvaceae-feeding taxon leading to uncertainty as to whether the host plant has been recorded correctly. In the current paper, along with host-plant data for new species, the host plant of *A. plagifera* (Meyrick) was discovered, which allowed us to document the leaf mine of the species for the first time and to provide new data on the distribution of this species in southern Ecuador.

Documentation of a novel character of *Astrotischeria*. We review eleven American species, including three species from USA, one from Ecuador, and seven new taxa recently discovered in Central America (Guatemala, Belize, Honduras) and South America (Ecuador, Bolivia and Brazil). In most characteristics, all these species fit well the concept of *Astrotischeria*, except for one, novel character: the valva is highly modified (apomorphic) and possesses three lobes (Figs. 4–19) or, in the case of *A. heliopsisella* (Figs. 3, 222, 223), at least an outgrowth shaped as a small lobe. These features are unusual in comparison with the rather simple male genitalia of other Tischeriidae, particularly of *Paratischeria* and *Coptotriche*. The current documentation of such apomorphic species makes an interesting contribution to a better understanding of morphology of Tischeriidae and their evolutionary trends.

Nomenclatorial changes. On the basis of the indistinguishable male genitalia, overlapping range of distribution, and the same host-plant genus *Helianthus* spp., *Astrotischeria longeciliata* (Frey & Boll, 1878: 259) is synonymized here with *A. helianthi* (Frey & Boll, 1878: 258–259), **syn. nov.**

The placement of *Tischeria koehleri* Bourquin (1962) within *Astrotischeria* (Diškus & Puplesis 2003) needs verification. During our current project, we did not have an opportunity to study Bourquin's type, but recently we discovered that in southern regions of South America, Asteraceae-feeding *Astrotischeria* species are rather common. It is important to note that *A. koehleri* (Bourquin) feeds on *Tessaria integrifolia* Ruiz & Pav. (Asteraceae), but *Tischeria* have never been recorded on Asteraceae, and the genus is not known to occur in South America. Therefore, we assume that the placement of Bourquin's *koehleri* in *Astrotischeria* is correct.

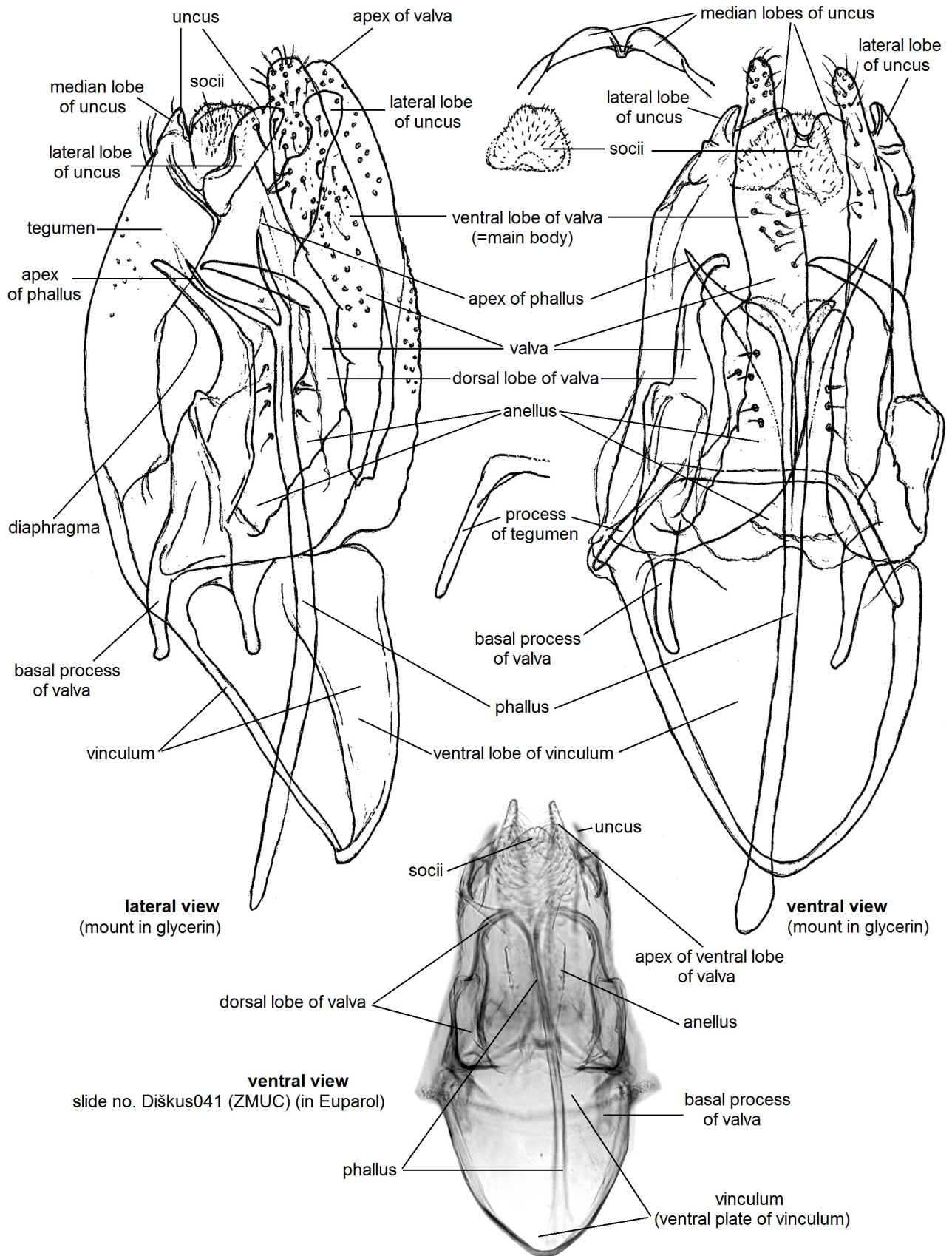
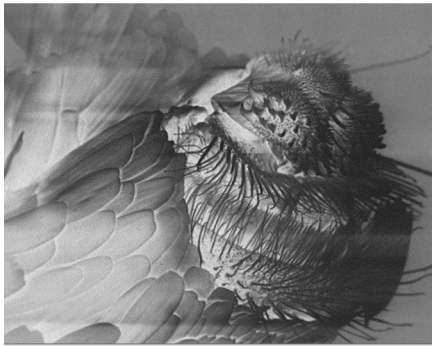
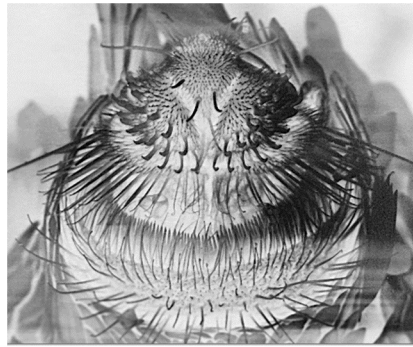


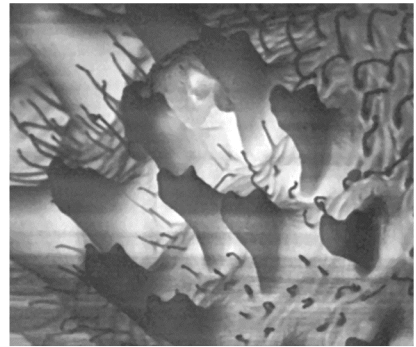
FIGURE 1. Morphology of male genitalia of *Astrotischeria karsholti* Puplesis & Diškus, the type species of *Astrotischeria*.



ovipositor (lateral view)



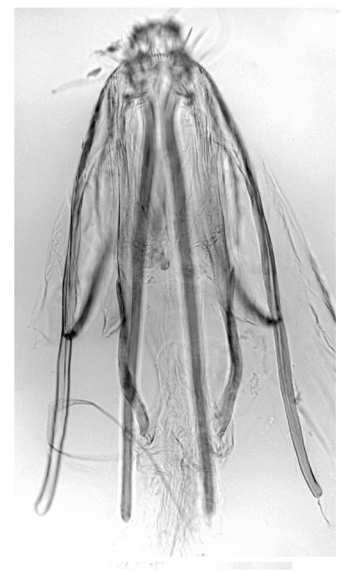
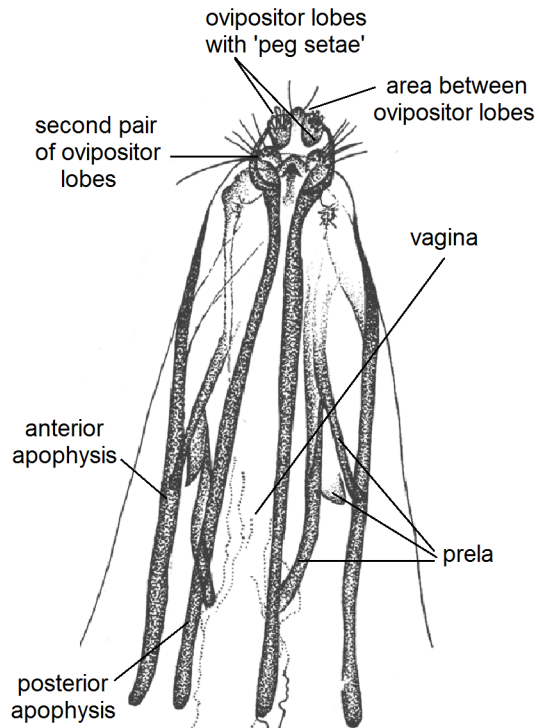
ovipositor (ventral view)



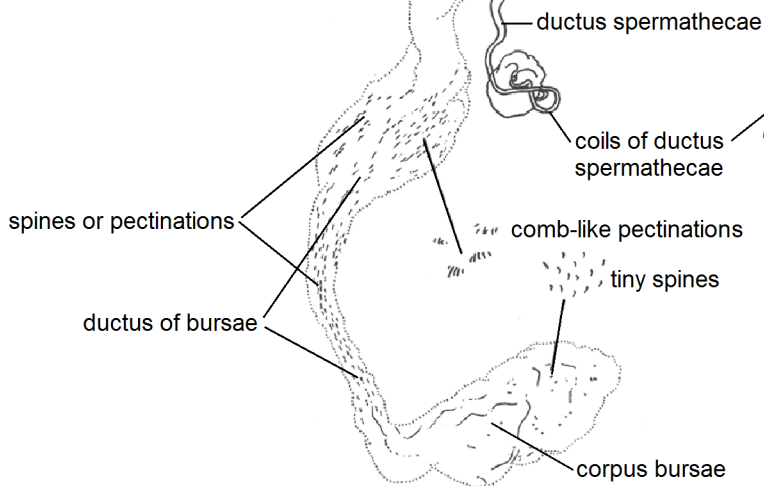
"peg setae"



slide Diškus042 (ZMUC)



slide Diškus042 (ZMUC)



Note: a membranous, sac-shaped utriculus absent or lost in slide Diškus042 (ZMUC)

♀ *Astrotischeria karsholti*
slide Diškus042 (ZMUC)

FIGURE 2. Morphology of female genitalia of *Astrotischeria karsholti* Puplesis & Diškus, the type species of *Astrotischeria*. Note: the figured ovipositor belongs to a non-*Astrotischeria* species, *Coptotriche angusticolella* (Duponchel) (after Puplesis & Diškus 2003).

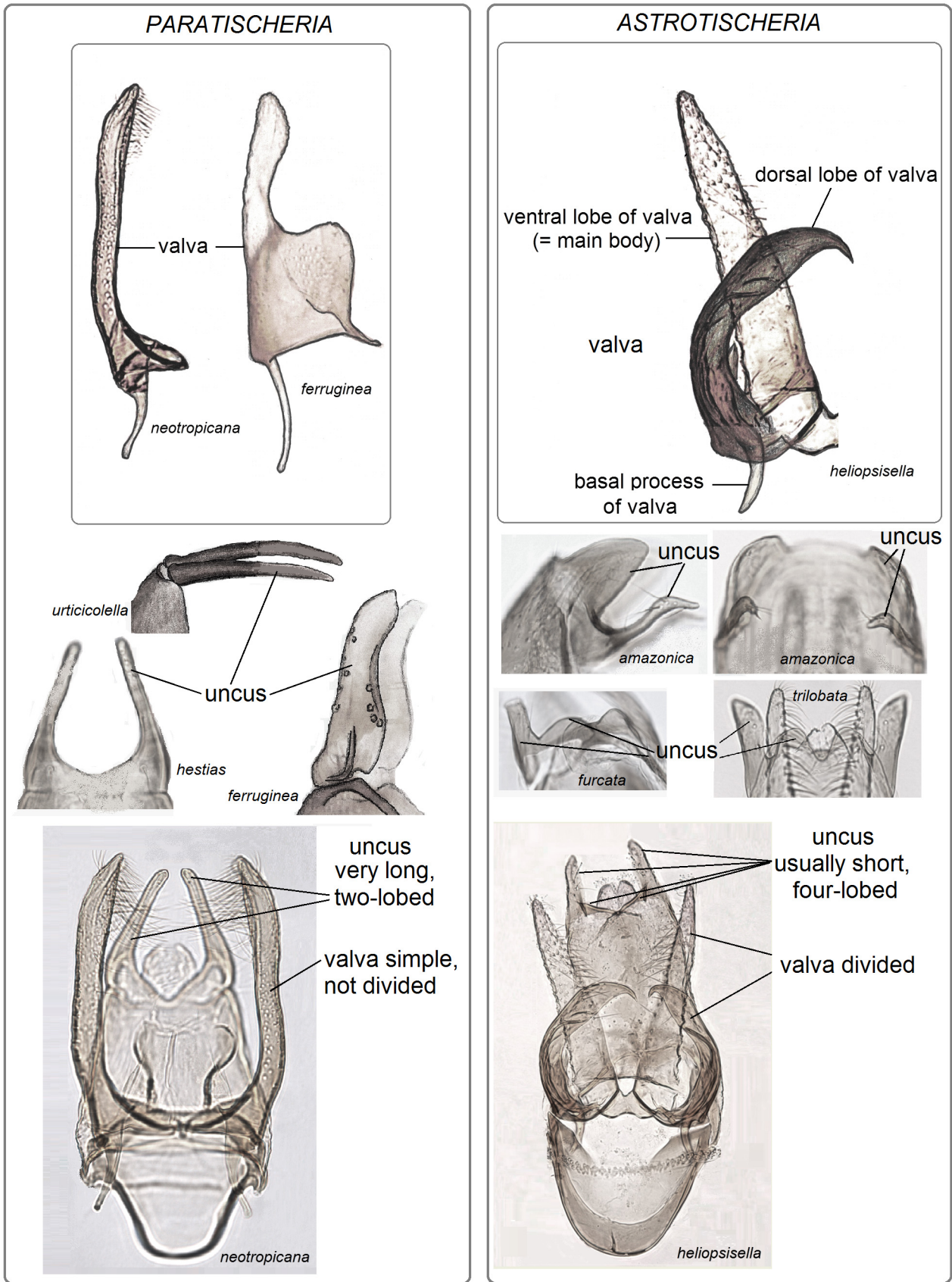


FIGURE 3. Diagnostics of *Astrotischeria* Puplesis & Diškus, 2003 (*Astrotischeria* compared with the most resembling and supposed related *Paratischeria* Diškus & Stonis, 2017).

Material and methods

The material used for this study, deposited in the Zoological Museum, Natural History Museum of Denmark, Copenhagen, and the Natural History Museum, London (BMNH), was collected by Owen T. Lewis in 1997–1998 (see Lewis *et al.* 2002), and J.R. Stonis (formerly Puplesis) in 1998 in Belize, Virginijus Sruoga in 2007 in Ecuador, Arūnas Diškus in 2012–2017 in Belize, Guatemala, Honduras, Ecuador and Bolivia, and Fernando Carvalho Filho in 2016–2017 in Brazil. Additionally, the series of the North American *Astrotischeria heliopsisella* and *A. ambrosiaeella*, and one male specimen from the Caribbean by Lord Walsingham (now designated as a paratype of *A. selvica*) were received for our study from The Natural History Museum, London (United Kingdom).

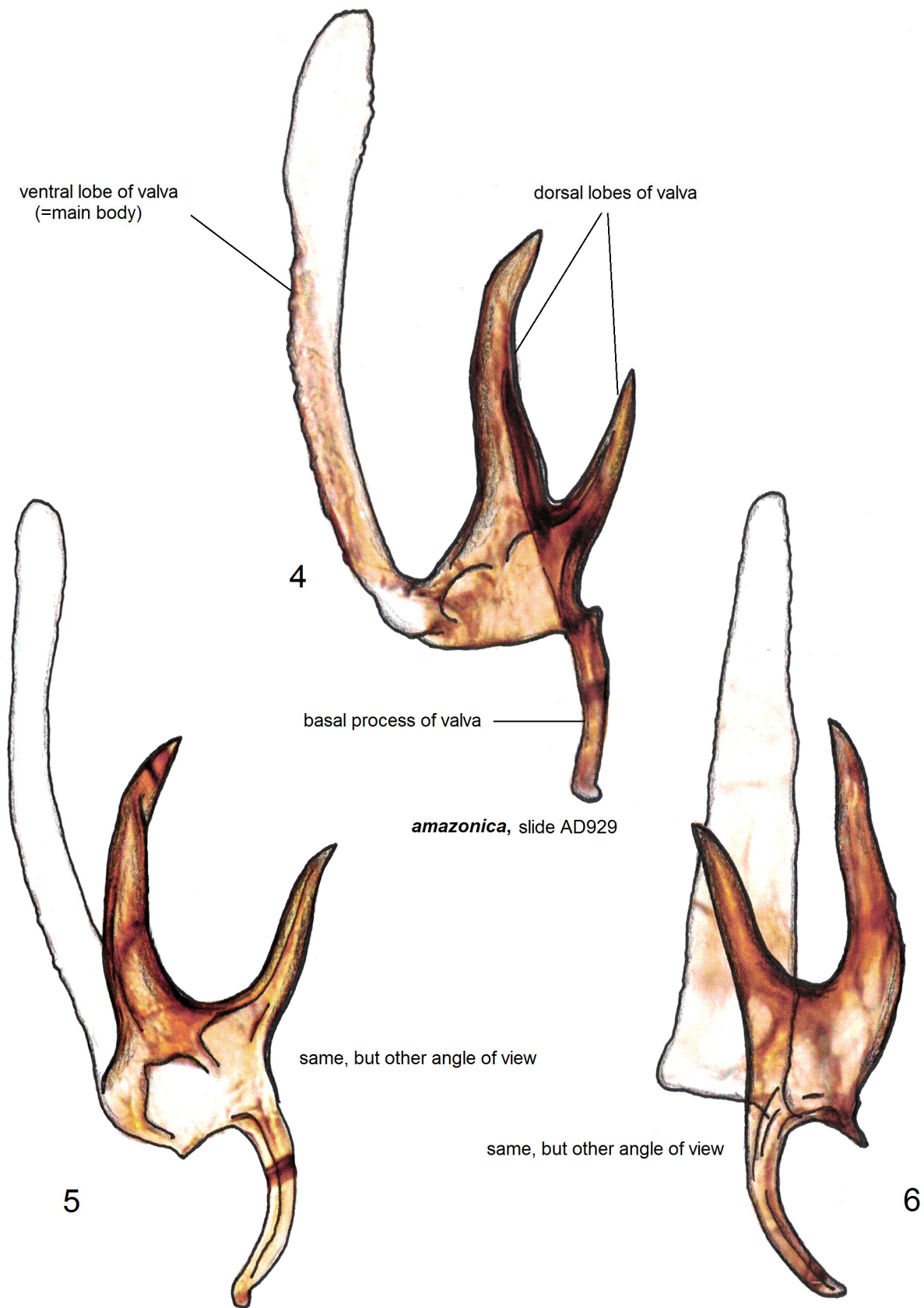
Some studied material was collected using light traps (described in Puplesis 1994 and Puplesis & Robinson 2000), but most of the adult specimens were reared from mining larvae. The latter method, as adapted specifically for Tischeriidae, has not been described previously and, therefore, is discussed below.

Traces of larval activity (leaf mines) can be identified by thorough inspection of host plants or potential host plants. Tischeriidae mines are always found in leaves. Each mine contains only one larva, but, particularly in the case of very abundant mining, cases where two or more mines had merged together were observed. Typically, a leaf has one to three leaf mines, but in cases where mining was very abundant, up to 15 or more leaf mines can be recorded on a single leaf.

With naked eye it is usually possible to determine, when holding a damaged leaf against the light, whether the mine is empty or contains a living or dead larva, or pupa. Mining (alive) larvae are mobile and usually pale to bright green or pale to bright yellow in color. Dead larvae are motionless (when the leaf mine is examined with a magnifying glass) and usually dark throughout or in parts (spotty). Tischeriidae larvae experience high levels of mortality from parasitoid wasps, and larvae or pupae of these parasitoids are often visible within the mine (Lewis *et al.* 2002). Sometimes, especially in early stages of development, larvae can be hardly visible with the naked eye because they are hidden in the initial part of the leaf mine. Usually, larvae are more easily visible from upper side of the leaf, sometimes from underside of the leaf. In our study, mines were documented by photography or by collecting samples of empty mines for further study.

Rearing of adults from mining larvae could be done both in the natural environment and indoors but during our study most adults were reared indoors. The mined parts of the plants together with live larvae or pupae were never cut out, as is the usual practice with Nepticulidae rearing, but taken together with the entire leaf or, better, a section of plant twig or shoot. The most suitable mines for rearing adults are those containing large, late instar larvae or (especially) pupae, because there is less danger that the plant material will dry out or get mouldy before adult emergence. Larvae usually feed for 3–4 weeks until pupation. During the study, almost every sample of the species was raised separately. Leaf mines for samples should be collected very carefully: samples might easily be mixed up if two different species mine the same host plant at the same time and produce similar or variable leaf mines. For rearing mining larvae only medium or large plastic rearing containers were used (both test tubes or Petri dishes were found very inconvenient to use for larval rearing). Larvae spin cocoons inside of leaf mines, in a silky nidus. If only one damaged leaf was found, fresh leaves of a host plant (or another chemically “neutral” plant) were put in layers in the rearing container. In such a way, more moisture was preserved and the host plant was prevented from desiccating. In some cases, a shoot of the host plant containing mining larvae was placed in a tube with water or wet cotton wool, and the shoot was contained within a plastic bag. If there was obvious excess of moisture or condensation on the cover of the container, it was ventilated. Containers were kept in a shaded position, out of direct sunlight. After one week the leaves were carefully examined for the presence of dark pupae which are usually visible in the nidus under transmitted light. The pupae found were cut out together with a rather large (about 2–3 cm) piece of the leaf and put into a clean Petri dish or plastic container, where they were kept at room temperature until adults appeared. The expected time for adults to emerge from pupae indoors is 10–21 days (or, in average, 14–16 days). To prevent pupae from desiccating, a moistened wad of absorbent paper was added, and the cut parts of leaves were usually laid at a distance from each other to prevent the formation and spread of mould. The hatched adults were caught in a small glass tube.

The genital micro-mounts were examined using a *Leica* DM2500 microscope and *Leica* DFC420 digital camera connected with the microscope and computer; each photograph of the genitalia slide was supplied with a slide number and species name (or any other precise identification data if species name was not yet available).



FIGURES 4–6. Dorsal lobes of *Astrotischeria amazonica* Diškus & Stonis, *sp. nov.*, lateral view.



maya, slide AD524

7



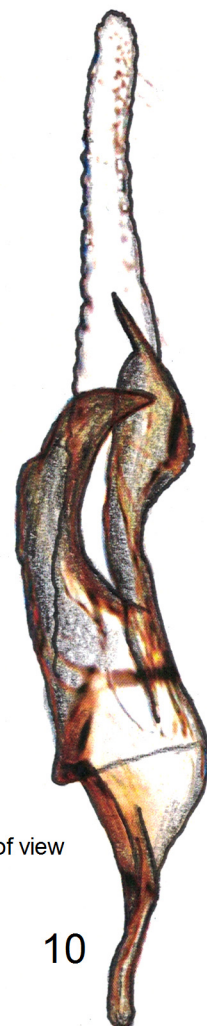
selvica, slide AD919

8



trilobata, slide AD751

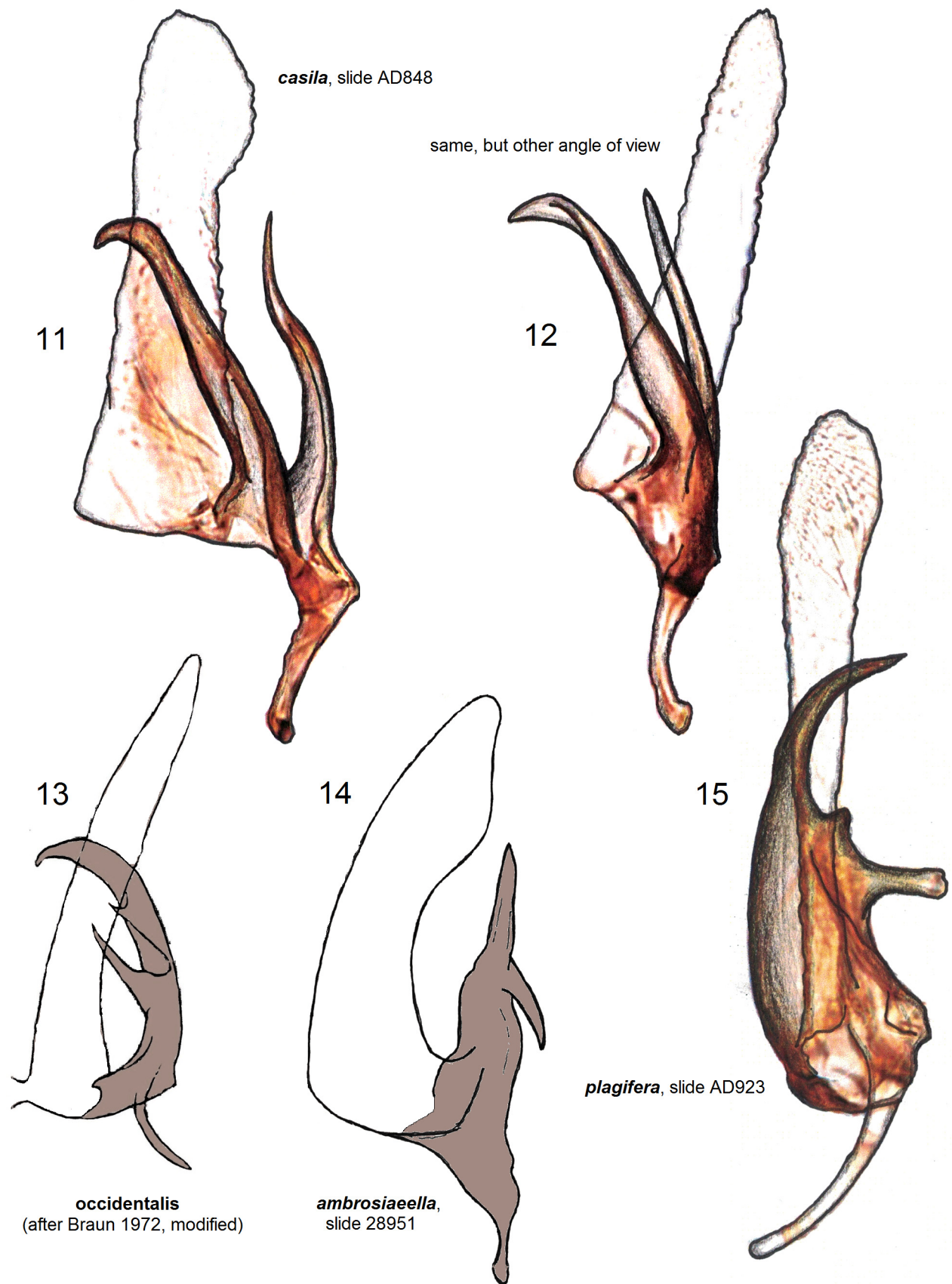
9



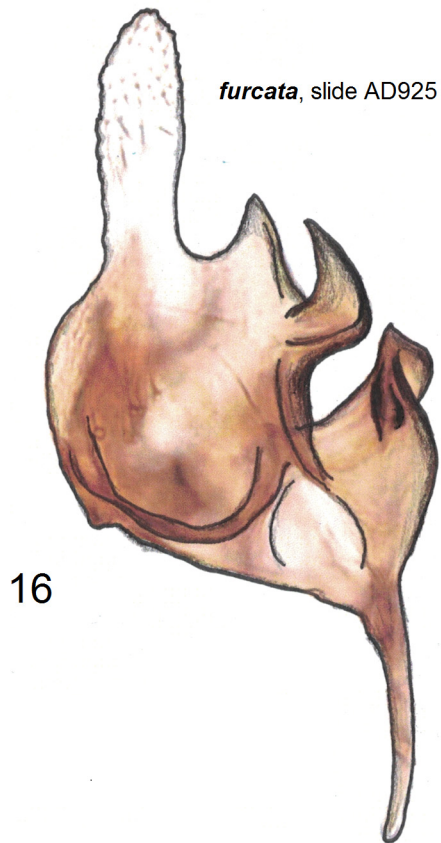
same, but other angle of view

10

FIGURES 7–10. Dorsal lobes of valva, lateral view. 7, *Astrotischeria maya* Diškus & Stonis, **sp. nov.**; 8, *A. selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**; 9, 10, *A. trilobata* Diškus & Stonis, **sp. nov.**



FIGURES 11–15. Dorsal lobes of valva. 11, 12, *Astrotischeria casila* Diškus & Stonis, **sp. nov.**, lateral view; 13, *A. occidentalis* (Braun, 1972), ventral view (after Braun 1972, modified); 14, *A. ambrosiaeella* (Chambers, 1875), lateral view; 15, *A. plagifera* (Meyrick, 1915), ventral view.



FIGURES 16–19. Dorsal lobes of valva, lateral view. 16, 17, *Astrotischeria furcata* Stonis & Diškus, **sp. nov.**; 18, 19, *A. onae* Diškus & Stonis, **sp. nov.**

It is impossible to roll and observe or photograph the structures of genitalia laterally when genitalia are in a permanent mount. Therefore we rolled and photographed genitalia in Euparal under the cover slip, or without it, before finally closing the mount with a cover slip; this generated a sort of “3D” image of the genitalia especially useful with complex structures, weakly (or differently) viewed from ventral side (see Figs. 79–82, 169–175, 178–189). Mounts (slides) were placed onto a special card or plastic slide tray and dried for 2–3 months at room temperature or for a minimum of 20 days in a heating oven (at +50°–60°).

The forewing length was expressed as a range when availability of material made this possible, and measured along the costa from the wing base to the apex of the fringe. To get the wingspan length, the forewing length was doubled and the thorax width added, since the tiny specimens of trumpet moths are rarely spread neatly enough to get precise measurements from wing tip to wing tip.

The descriptive terminology of morphological structures follows Braun (1972), and Puplesis & Diškus (2003), except for the term “aedeagus”, which is referred here as “phallus” and the term “cilia”, which is referred here as “fringe”.

The classification of Tischeriidae follows Puplesis & Diškus (2003), the Catalogue of the World Nepticuloidea & Tischerioidea by Diškus & Puplesis (2003), and Stonis *et al.* 2017a.

Institutional abbreviations used in the text for species depository:

BMNH—The Natural History Museum, London, United Kingdom;

ZMUC—The Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark.

Taxonomic treatment

The *Astrotischeria trilobata* species group (designated here)

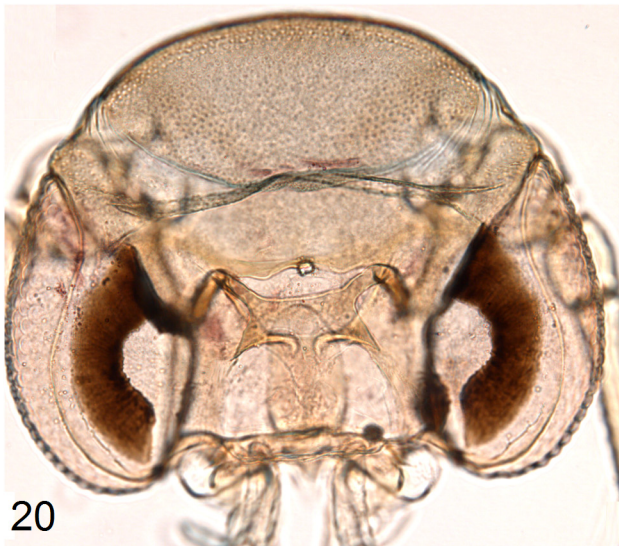
Diagnostics: forewing varied, from rather dark, densely speckled with grey-brown scales to ochre-yellow, sparsely irrorated with brown or black, brown and ochre scales; the latter may form irregular, indistinct oblique stripes or blotches. In the male genitalia, valva with one, usually slender ventral and two shorter, but usually pointed and curved dorsal lobes; the latter lobes are best visible from the lateral view (Figs. 4–19); the second dorsal lobe can be rather indistinct, variously developed in some species. Basal process of valva long or very long. Uncus short and with four lobes (two slender, longer lateral lobes, and usually rounded, shorter median ones) except for one species, *A. onae* Diškus & Stonis, **sp. nov.**, which possesses a rather long, bilobed uncus. Gnathos absent. Anellus prominent, laterally thickened (sometimes very strongly), with a few lateral setae; distally anellus usually with weakly chitinized, rounded lobes. Phallus very slender, apically widened and bifurcated. Female genitalia with well-developed prela which sometimes are greatly prolonged or in the shape of a chitinized plate proximally. Ductus spermathecae usually with a few small coils, except for *A. casila* Diškus & Stonis, **sp. nov.** and *A. selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.** where coils are numerous.

Currently the group comprises 11 species occurring from North America (northern USA) to South America (as far as Bolivia). All species with studied biology are associated with Asteraceae.

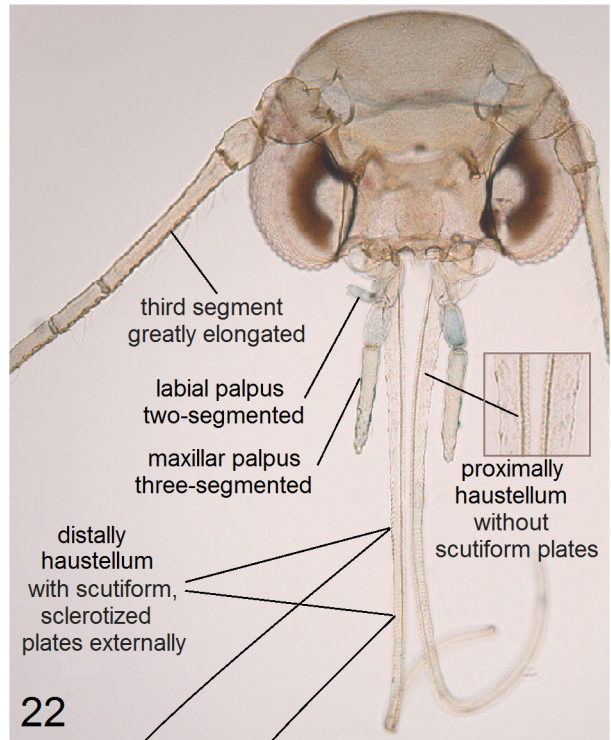
Astrotischeria trilobata Diškus & Stonis, **sp. nov.**

(Figs. 9, 10, 20–69, 233, 245–248)

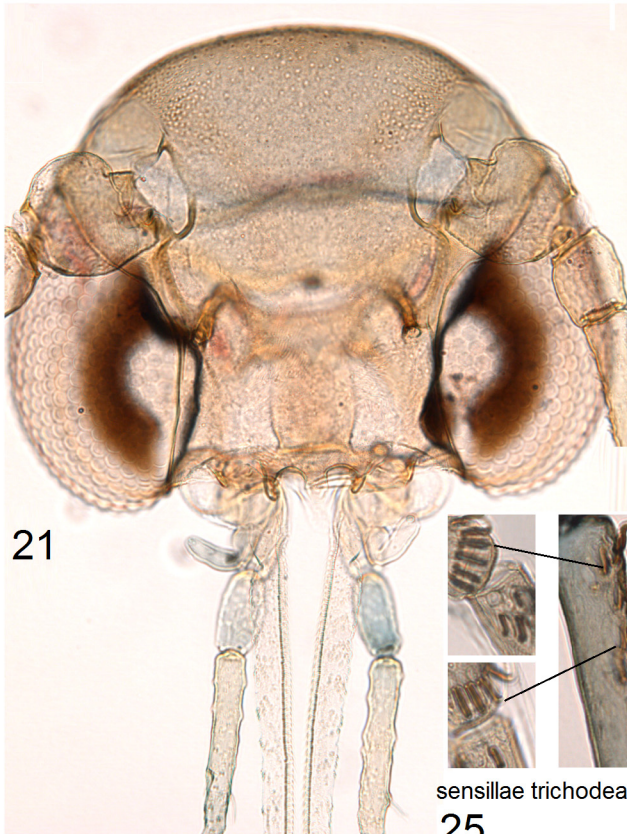
Type material. Holotype: ♂, BOLIVIA, Nor Yungas Province, Coroico, 16°11'54"S, 67°43'13"W, elevation 1650 m, mining larva on *Austroeupatorium inulaefolium* (Kunth) R. M. King & H. Rob. (Asteraceae), 26.iv.2014, ex pupa v.2014, field card no. 5166, A. Diškus, genitalia slide no. AD752♂ (ZMUC). Paratypes: 4 ♂, 10 ♀, same label data as holotype, genitalia slide nos AD749 ♂, AD751 ♂, AD912♀, AD914♀, head and forewing venation slide no. AD913♀ (ZMUC); 7♂, 7♀, 16°12'24"S, 67°43'54"W, 1680 m, on *Austroeupatorium*, 07–16.vi.2018, card no. 5237, A. Diškus, J.R. Stonis, 5 ♂, ECUADOR, Loja Province, Vilcabamba, 4°16'06"S, 79°10'40"W, elevation 1990 m, 22.i.2017, field card no. 5225, A. Diškus, genitalia slide nos AD910♂ (from mature pupa, adult not preserved), AD915♂ (ZMUC).



20



22



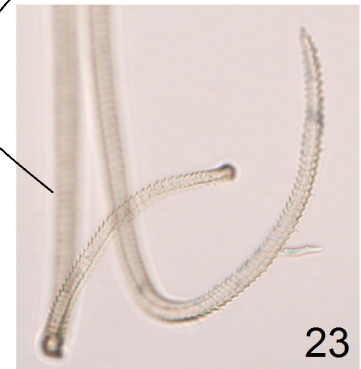
21

100 µm

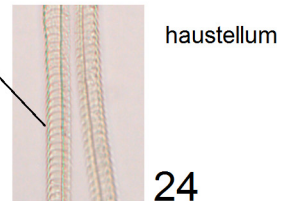


sensillae trichodea recurved and thickened

25



23



24

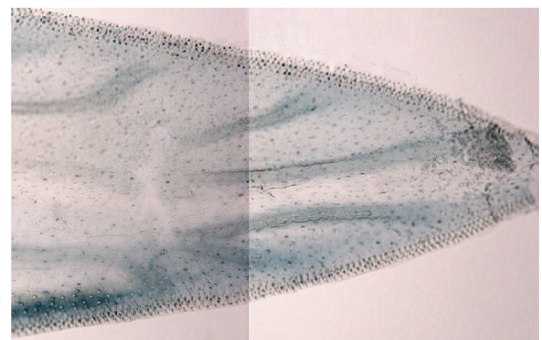
haustellum



26

1 mm

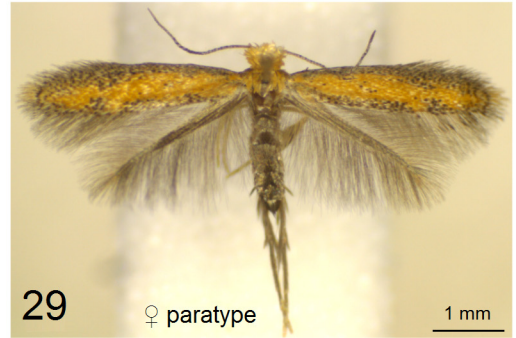
27



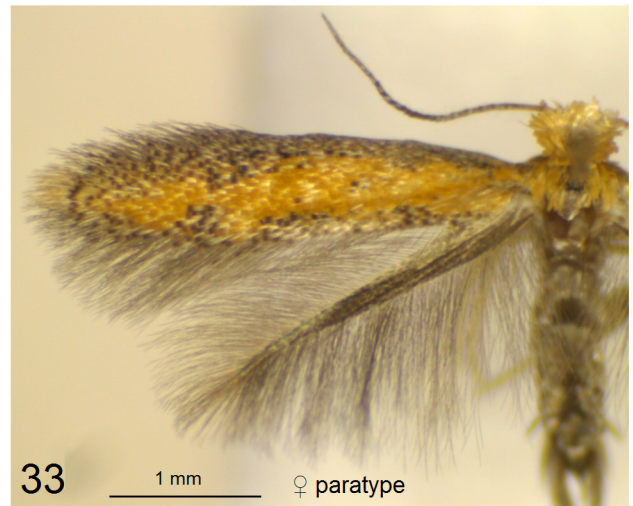
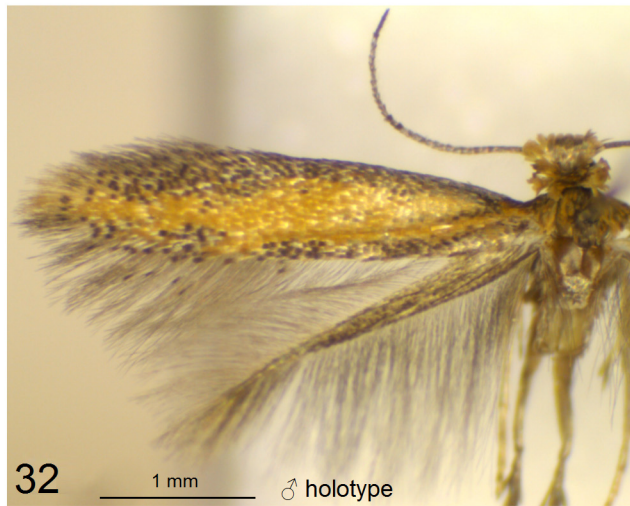
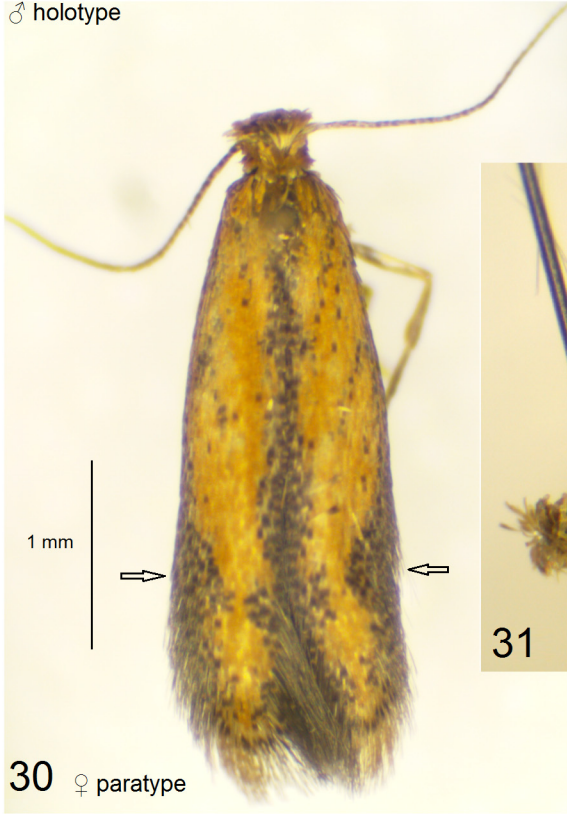
FIGURES 20–27. Details of adult morphology of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, female, paratype, slide no. AD913 (ZMUC). 20–22, descaled head; 23, 24, haustellum; 25, fragment of antenna; 26, 27, forewing venation.



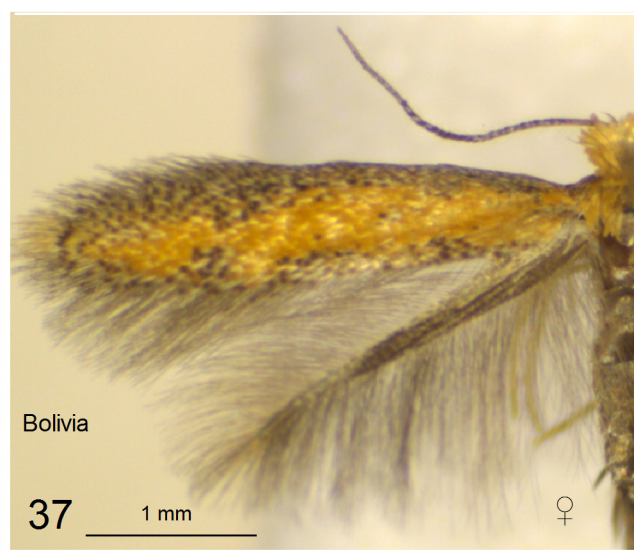
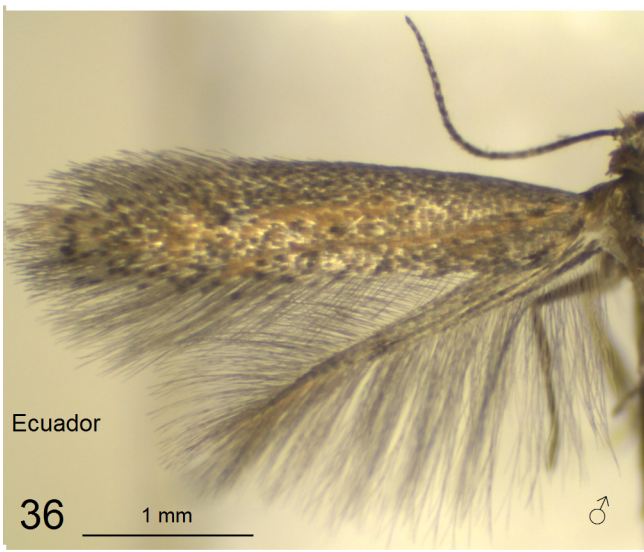
♂ holotype



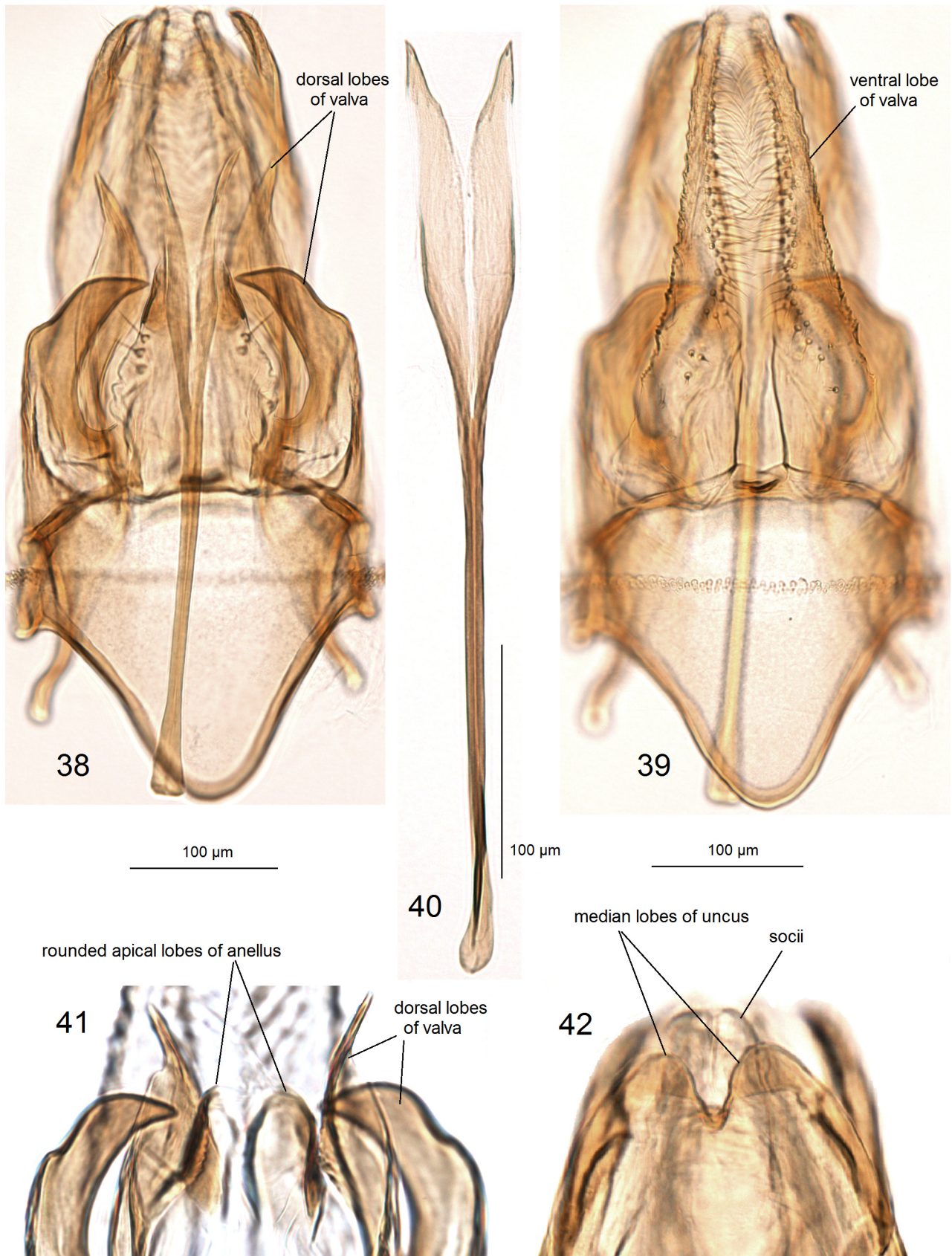
♀ paratype



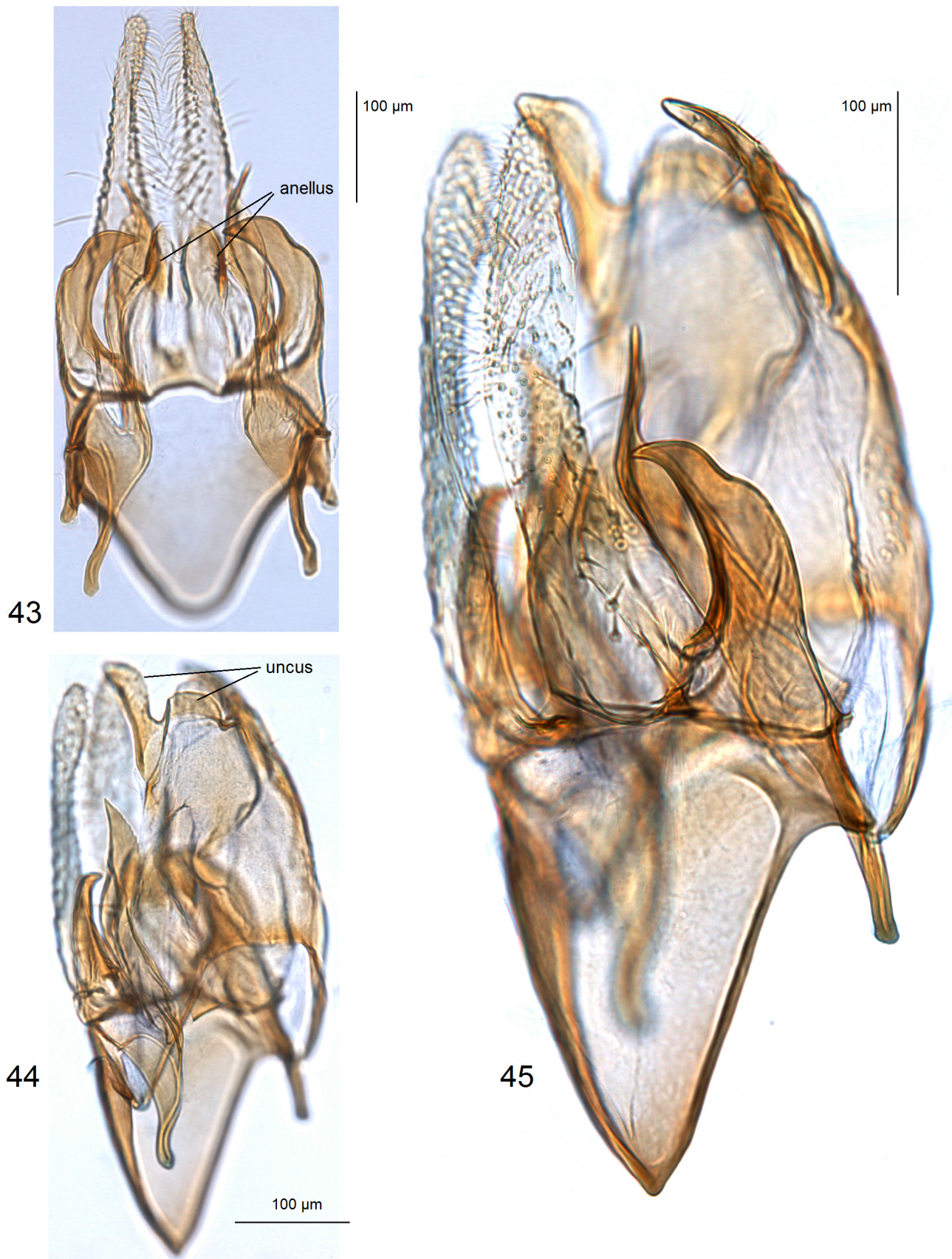
FIGURES 28–33. Adult of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, Coroico, Bolivia (ZMUC).



FIGURES 34–37. Adult of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.** 34–36, specimens from Vilcabamba, Ecuador; 37, a specimen from Coroico, Bolivia, to compare with the specimens from the type locality in Bolivia (ZMUC).



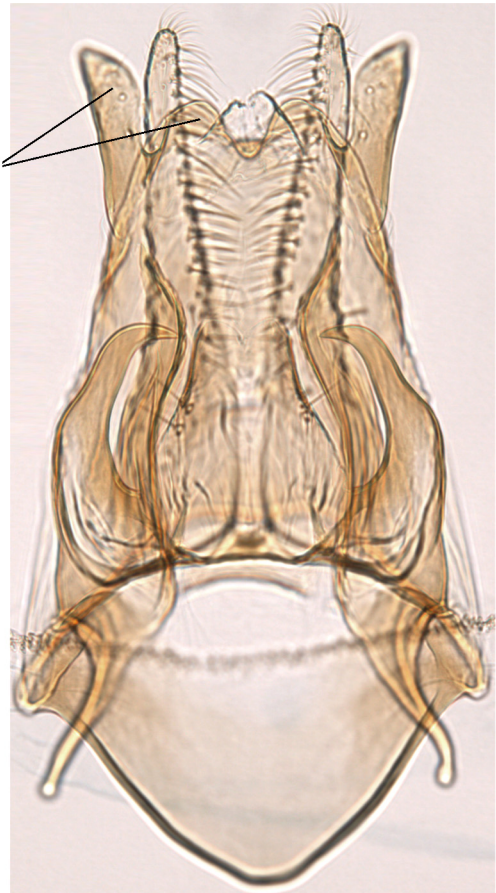
FIGURES 38–42. Male genitalia of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, Coroico, Bolivia (ZMUC). 38, 39, capsule with phallus, holotype, genitalia slide AD752; 40, phallus, paratype, genitalia slide AD751; 41, same, lobes of anellus; 42, median lobes of uncus, holotype, genitalia slide no. AD752.



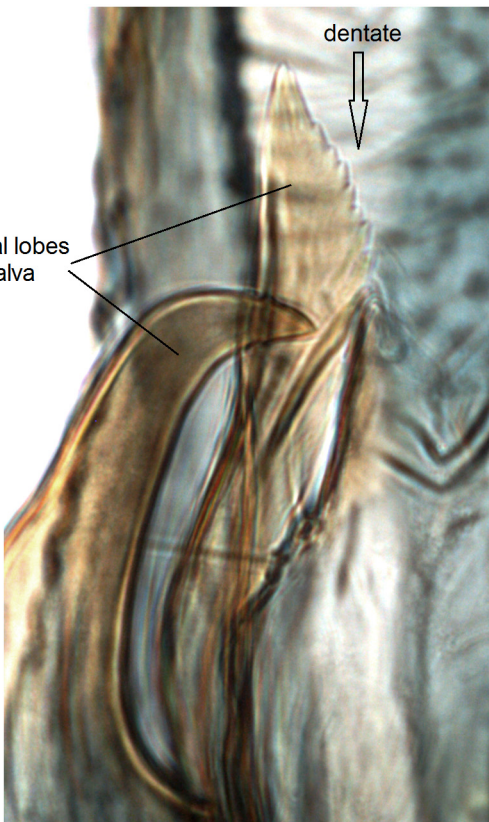
FIGURES 43–45. Male genitalia of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, Coroico, Bolivia (ZMUC). 43, capsule with phallus removed, paratype, genitalia slide AD751; 44, capsule, lateral view, paratype, genitalia slide no. AD749; 45, same, focused on valva.



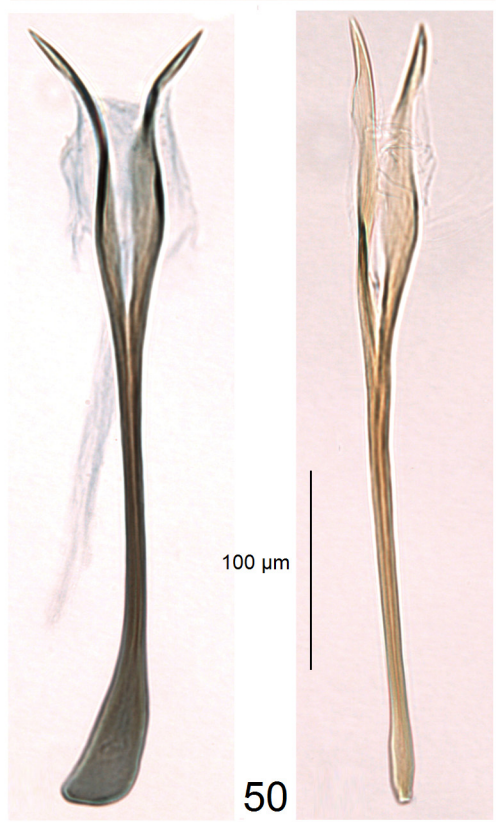
46



47



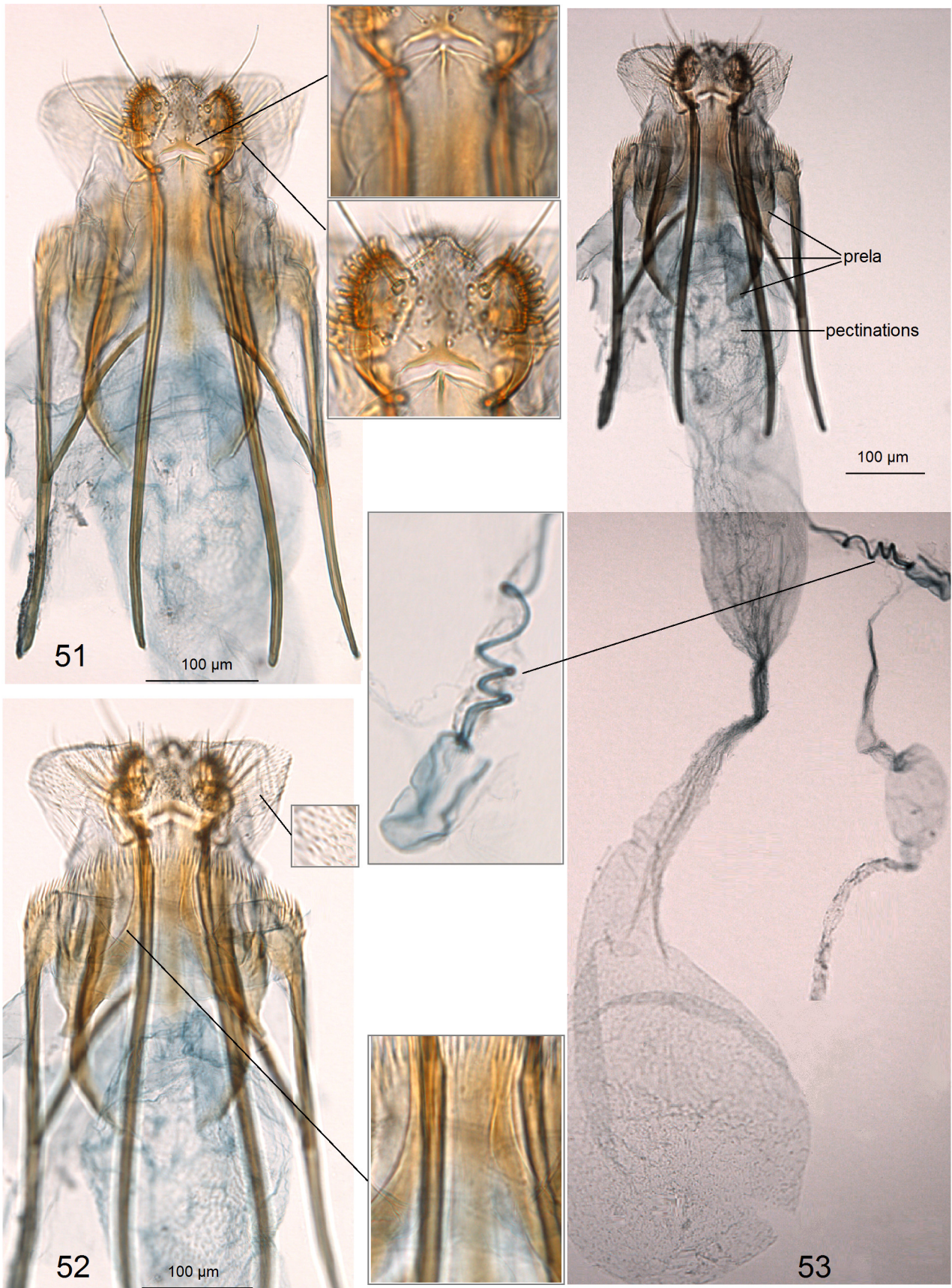
48



49

50

FIGURES 46–50. Male genitalia of *Astrotischeria trilobata* Diškus & Stonis, *sp. nov.*, Vilcabamba, Ecuador (ZMUC). 46, 47, capsule with phallus removed, paratype, genitalia slide AD915; 48, dorsal lobes of valva, paratype, genitalia slide no. AD910; 49, same, phallus; 50, same, genitalia slide no. AD915.



FIGURES 51–53. Female genitalia of *Astrotischeria trilobata* Diškus & Stonis, **sp. nov.**, Coroico, Bolivia, genitalia slide no. AD912, paratype (ZMUC). 51, 52, ovipositor lobes, apophyses and prela; 53, general view.



FIGURES 54–62. Bionomics of *Astrotischeria trilobata* Diškus & Stonis, *sp. nov.* 54–56, host plant *Austro eupatorium inulaefolium* (Kunth) R. M. King & H. Rob., Asteraceae; 57–62, leaf mines, Coroico, Bolivia.



FIGURES 63–69. Leaf mines of *Astrotischeria trilobata* Diškus & Stonis, sp. nov., Vilcabamba, Ecuador.

Diagnosis. The combination of two very wide, apically pointed dorsal lobes of valva and the rather slender but pointed apical lobes of phallus in the male genitalia distinguishes *A. trilobata* **sp. nov.** from all other *Astrotischeria*, including other members of the *A. trilobata* group. The fact that it feeds on *Austroepatorium* also makes this species distinctive.

Male (Figs. 28, 32, 34–36). Forewing length: 2.8–3.5 mm; wingspan: 6.3–7.3 mm. Head: face and palpi pale ochre; frontal tuft comprised of ochre cream and some grey-ochre lamellar scales; antenna with about 42 segments, distinctly longer than half the length of forewing; flagellum metallic grey, annulated with grey-black to black; sensillae very long and fine, cream. Thorax and tegula ochre, speckled with grey-black scales, particularly densely anteriorly. Forewing of the Bolivian specimens (Figs. 28–33, 37) densely speckled with black scales (with metallic grey bases) only laterally; a characteristic, very wide but sinuous longitudinal zone left non-speckled, orange-ochre; forewing of the Ecuadorian specimens (Figs. 34–36) darker: sometimes black scales irrorate almost whole forewing with no (Fig. 36) or very little dark ochre longitudinal zone left (Figs. 34, 35); fringe black-grey on costal margin and tornus, distinctly greyish ochre on termen; fringe-line distinct, formed by black scales; forewing underside brown-black to grey-black, without spots or androconia. Hindwing very slender, black-grey to black on both upper and underside, without androconia; fringe blackish grey. Legs densely speckled with grey scales with little purple iridescence, distally ochreous cream on upper side. Abdomen dark metallic grey to black-grey with some blue and purple iridescence on upper side and laterally, ochreous cream on underside; anal tufts rather indistinct, grey on upper side; genital plates ochreous cream.

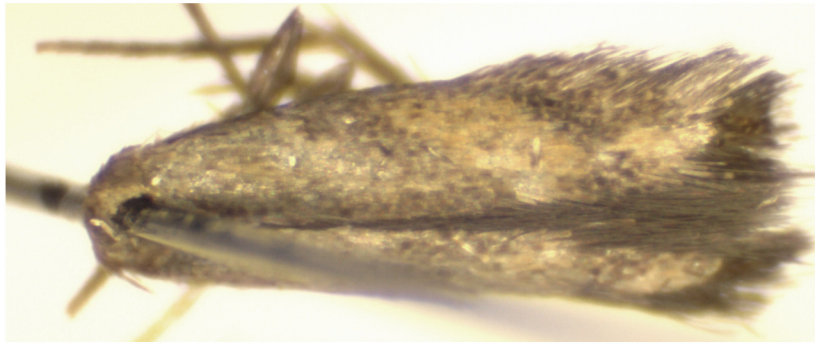
Female (Figs. 20–27, 29–31, 33, 37). Similar to male but forewing pattern usually brighter; sometimes thorax without dark scales, purely ochre. Otherwise as male.

Male genitalia (Figs. 9, 10, 38–50). Capsule 505–560 µm long, 240–280 µm wide. Uncus (Figs. 42, 44–47) consisting of two long lateral lobes and two short, rounded median lobes (Figs. 42). Valva divided (Figs. 9, 10, 39, 45–47): ventral lobe slender, 50–85 µm wide, 305–340 µm long (excluding basal process); dorsal lobes consisting of two lobes: an inwardly curved, distally pointed, 160 µm long lobe (Figs. 11, 12, 38, 43, 45–47) and longer, slightly dentate (Figs. 44, 48), distally pointed lobe (Figs. 9, 10, 38, 45, 48); transtilla absent; basal process of valva long (Figs. 38, 43, 47). Anellus thickened, with 3–4 setae laterally (Figs. 38, 47), and two rounded apical lobes (Figs. 41, 43). Phallus 400–435 µm long, distally deeply bifurcated, without spines (Figs. 40, 49, 50).

Female genitalia (Figs. 51–53). Total length 1135–1200 µm. Ovipositor small, clothed with short, stout and darker, modified setae ('peg setae') (Figs. 51, 53); area between ovipositor lobes triangularly shaped (Fig. 51), with tiny papillae and some setae. Second pair of lobes, lateral and anterior to the ovipositor lobes, significantly smaller, bearing very long slender setae. Anterior and posterior apophyses very long and stout, particularly the posterior ones (Figs. 51, 53); remaining three apophysis pairs (Figs. 51, 52) formed as slender rod-like and wide lobe-like projections (prela, Fig. 53). Tips of one pair of rod-like prela articulating with anterior apophyses in a groove in half of their length (Fig. 51). Vestibulum without antrum, however vestibulum may look thickened laterally because of prela (Fig. 52). Ductus bursae widened posteriorly, with pectinations (numerous indistinct, blunt spines). Corpus bursae round (Fig. 53), without spines or signum. Ductus spermataecae very narrow, with about 4.5 coils (Fig. 53), utriculus very small, oval-shaped (Fig. 53).

Bionomics (Figs. 54–69). Host plant: *Austroepatorium inulaefolium* (Kunth) R. M. King & H. Rob., Asteraceae, a plant species native to South America, from Panama to Argentina and possessing some antimicrobial activity against intracellular and extracellular organisms (Bua *et al.* 2017). Mining larvae recorded from January (in southern Ecuador) and April, June (in Bolivia). Blotch mine (at early stage triangular, afterwards irregular, Figs. 57–69) either without frass or usually with little black or brown-black loose or compact granules of frass irregularly deposited predominantly in the narrow corner of the mine (Figs. 58, 60, 61, 69); the initial, slender part of leaf mine sometimes looks pale green because the unconsumed upper tissue of plant (Figs. 57–61, 69); old leaf mine usually looks pale brown or whitish brown. Silk-lined nidus inside of the mine usually rather indistinct. Larva pale yellowish green, with dark green intestine and blackish brown head (Figs. 62–65). Mining larva better visible from underside of the leaf than upper side; sometimes larva can hardly be seen, particularly in early stages of development because the larva can hide itself in the narrow part of the leaf. Pupation inside of leaf mine, in a silk-lined nidus, without cocoon; pupa brown. Exit slit on usually on upper side, only sometimes on underside of the leaf. Adults known from February and May, July.

Distribution (Fig. 233). Known from the south Ecuadorian (Figs. 245–247) and Bolivian (Fig. 248) Andes at the elevation of about 1600–2000 m.



70

1 mm



100 µm

71



72



100 µm

73



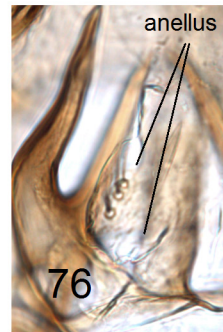
uncus

100 µm

74



75



anellus

76



77



100 µm

78

FIGURES 70–78. *Astrotischeria amazonica* Diškus & Stonis, **sp. nov.**, holotype, Ecuador (ZMUC). 70, male adult; 71, 72, male genitalia, phallus, genitalia slide no. AD929; 73–75, capsule with phallus removed; 76, same, lateral view of anellus; 77; same, ventral lobes of valva; 78, same, apical part of phallus.



100 μ m



FIGURES 79–82. *Astrotischeria amazonica* Diškus & Stonis, sp. nov., holotype, genitalia slide no. AD929, lateral view (ZMUC).

Etymology. The species name is derived from Latin *tris* (three) and *lobatus* (lobed) in reference to the three-lobed valva in the male genitalia.

***Astrotischeria amazonica* Diškus & Stonis, sp. nov.**

(Figs. 4–6, 70–82, 233, 241–244)

Type material. Holotype: ♂, ECUADOR: Napo Province, 1 km N Misahualli, 1°01'28"S, 77°40'02"W, elevation 440 m, 07.ii.2007, V. Sruoga, genitalia slide no. AD929♂ (ZMUC).

Diagnosis. The combination of a very wide uncus and two horn-like dorsal lobes of valva in the male genitalia distinguishes *A. amazonica* sp. nov. from all other *Astrotischeria*, including other members of the *A. trilobata* group.

Male (Fig. 70). Forewing length about 2.5 mm; wingspan about 5.4 mm. Head: face, palpi and frontal tuft glossy, pale ochre cream; pecten indistinct in the poorly preserved holotype (see Remarks); antenna with about 35–37 segments, longer than half the length of forewing; flagellum cream on upper side, dark grey on underside; sensillae long and fine, whitish cream. Thorax and tegula pale brownish grey. Forewing, except for a few large, irregular pale orange-ochre patches, densely speckled with brown-grey scales; some of these scales with ochre cream tips and little blue, green or purple iridescence; fringe black-grey, including the forewing apex; fringe-line indistinct; forewing underside dark grey-brown, without spots or androconia. Hindwing brownish grey, without androconia; fringe grey-brown. Legs pale brownish grey, with rather strong golden gloss; foreleg and midleg densely speckled with grey-brown scales on upper side. Abdomen brownish grey, distally brownish cream on underside; anal tufts indistinct, grey; genital plates grey.

Female. Unknown.

Male genitalia (Figs. 4–6, 71–82). Capsule about 465 µm long, 200–210 µm wide. Uncus consisting of two slender lateral lobes and two short but very wide median lobes (Figs. 74, 79). Valva divided (Figs. 4–6); ventral lobe (Fig. 75) slender; dorsal lobes consisting of two large, horn-like processes (Fig. 6); transtilla absent. Anellus thickened laterally, with 3 setae (Figs. 76, 79), membranous posteriorly. Phallus about 520 µm long, distally deeply bifurcated, without spines (Figs. 71, 72, 78).

Bionomics. Adults fly in early February. Otherwise biology unknown.

Distribution (Fig. 233). Known from a single locality in Ecuadorian Oriente, disturbed Amazonian rainforest habitat at the elevation of about 440 m (Figs. 241–244).

Etymology. The species name is derived from the Amazon Basin, a place name of South American region in reference to the occurrence in the Amazonian rainforest.

Remarks. Head of the holotype is broken, placed in a plastic tube.

***Astrotischeria maya* Diškus & Stonis, sp. nov.**

(Figs. 7, 83–92, 233–235)

Type material. Holotype: ♂, HONDURAS: Copán Department, Copán Archaeological Site Ruinas, 14°50'13"N, 89°08'37"W, elevation ca. 620 m, 15.ii.2012, A. Diškus, genitalia slide no. AD524♂ (ZMUC).

Diagnosis. From the most similar *A. selvica* it differs in the apically rounded dorsal lobe of valva and the narrow gap between median lobes of uncus.

Male (Figs. 83, 84). Forewing length about 2.9 mm; wingspan about 6.4 mm. Head: face pale brown; palpi brownish cream; frontal tuft comprised of brownish cream lamellar scales; pecten very prominent; antenna with about 36 segments, longer than half the length of forewing; flagellum ochre cream; sensillae very long and fine, brownish cream. Thorax ochre cream; tegula densely speckled with grey-brown scales, particularly densely anteriorly. Forewing slender, speckled with pale brown to dark brown scales, especially densely along costa in apical half of the forewing; most of the dark scales pale-tipped; apically forewing with an elongated, pale yellowish ochre patch; fringe pale brown on costal margin and tornus but yellowish ochre near to the apical patch; fringe-line indistinct, formed by a few black-brown scales; forewing underside brown, without spots or androconia. Hindwing brown on both upper and underside, except narrow edges on upper side which remain cream; no androconia; fringe pale grey-brown. Legs very contrasting in color: bright yellow cream to ochre cream, speckled with dark grey-brown scales on upper side or ochreous cream scales distally.



83

1 mm

apical patch

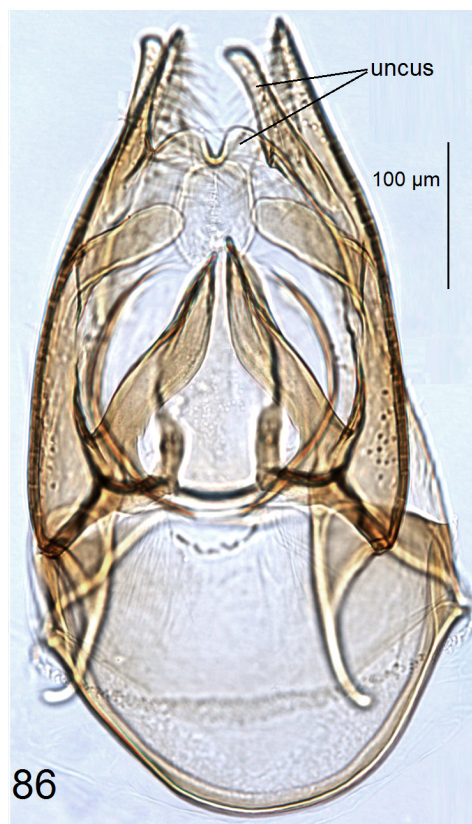


84



85

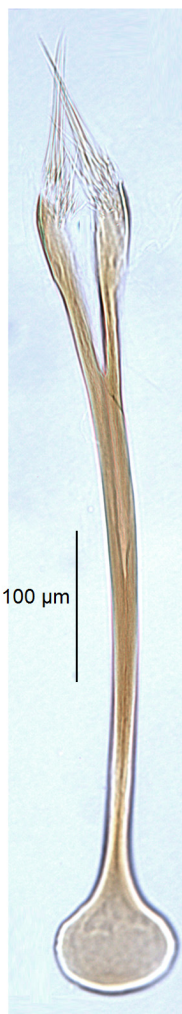
100 μm



86

uncus

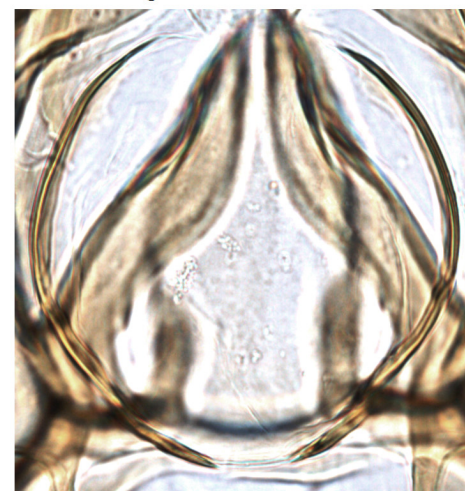
100 μm



100 μm

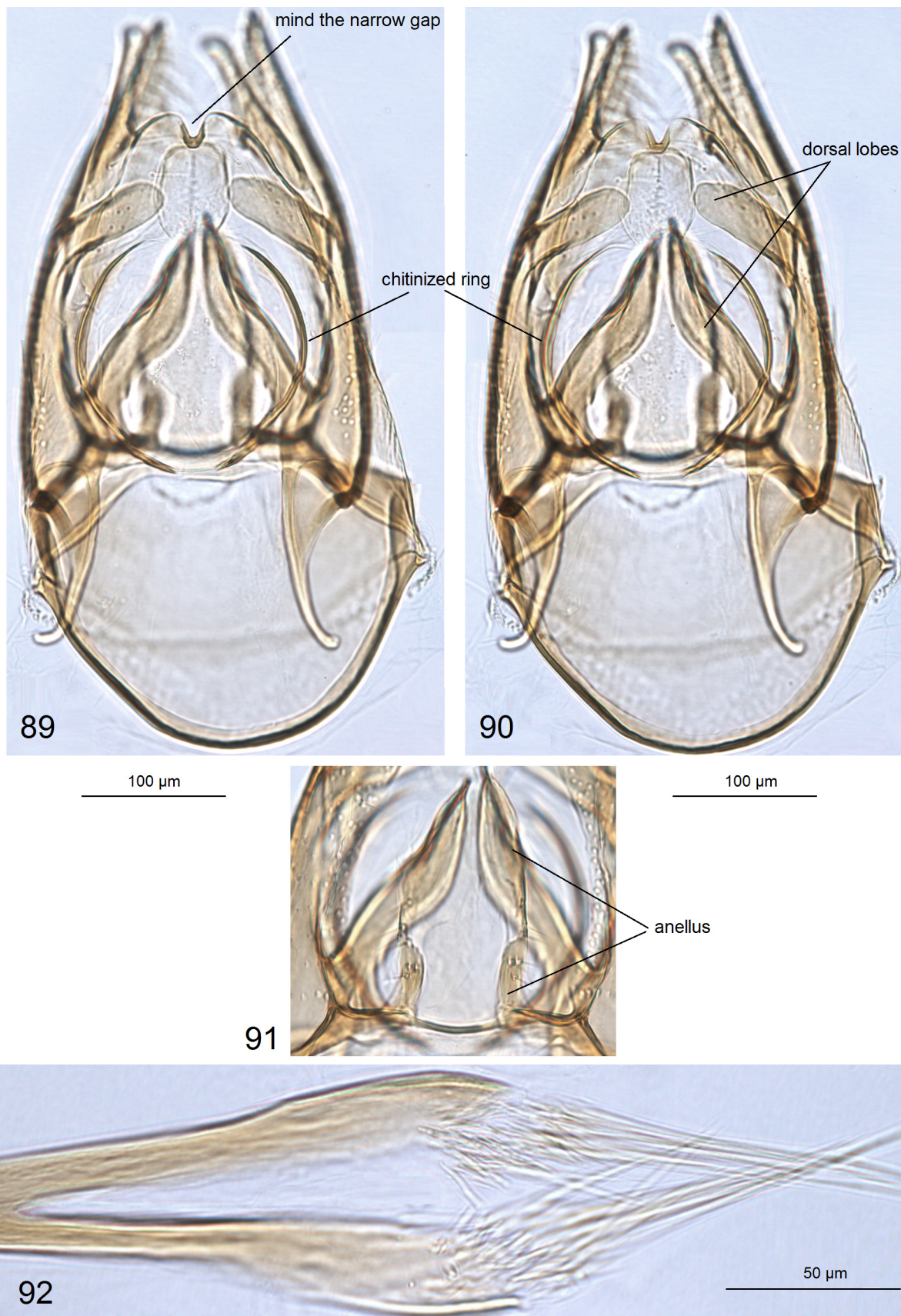
87

chitinized ring

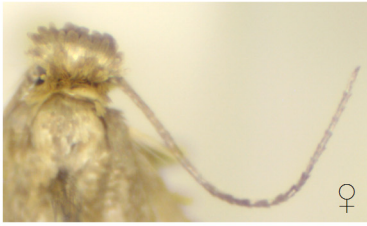


88

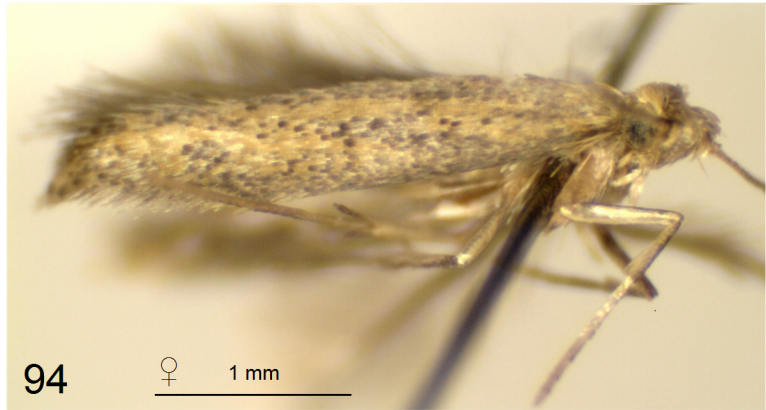
FIGURES 83–88. *Astrotischeria maya* Diškus & Stonis, **sp. nov.**, holotype, Honduras (ZMUC). 83, 84, male adult; 85, 86, male genitalia, capsule with phallus removed, genitalia slide no. AD524; 87, phallus; 88, chitinized ring.



FIGURES 89–92. Male genitalia of *Astrotischeria maya* Diškus & Stonis, **sp. nov.**, genitalia slide no. AD524, holotype, Honduras (ZMUC). 89, 90, capsule with phallus removed; 91, anellus; 92, apical part of phallus.



93



94



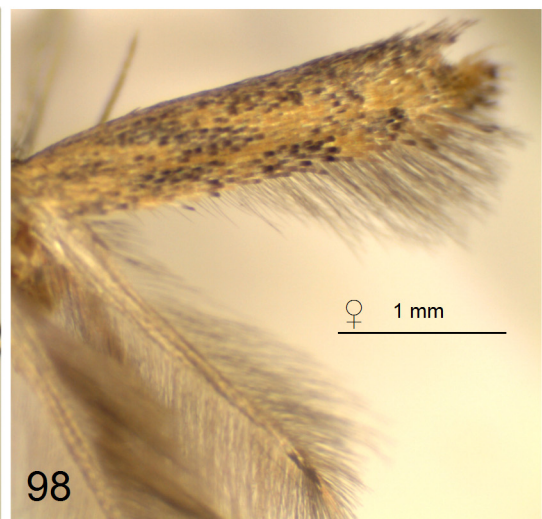
95



96

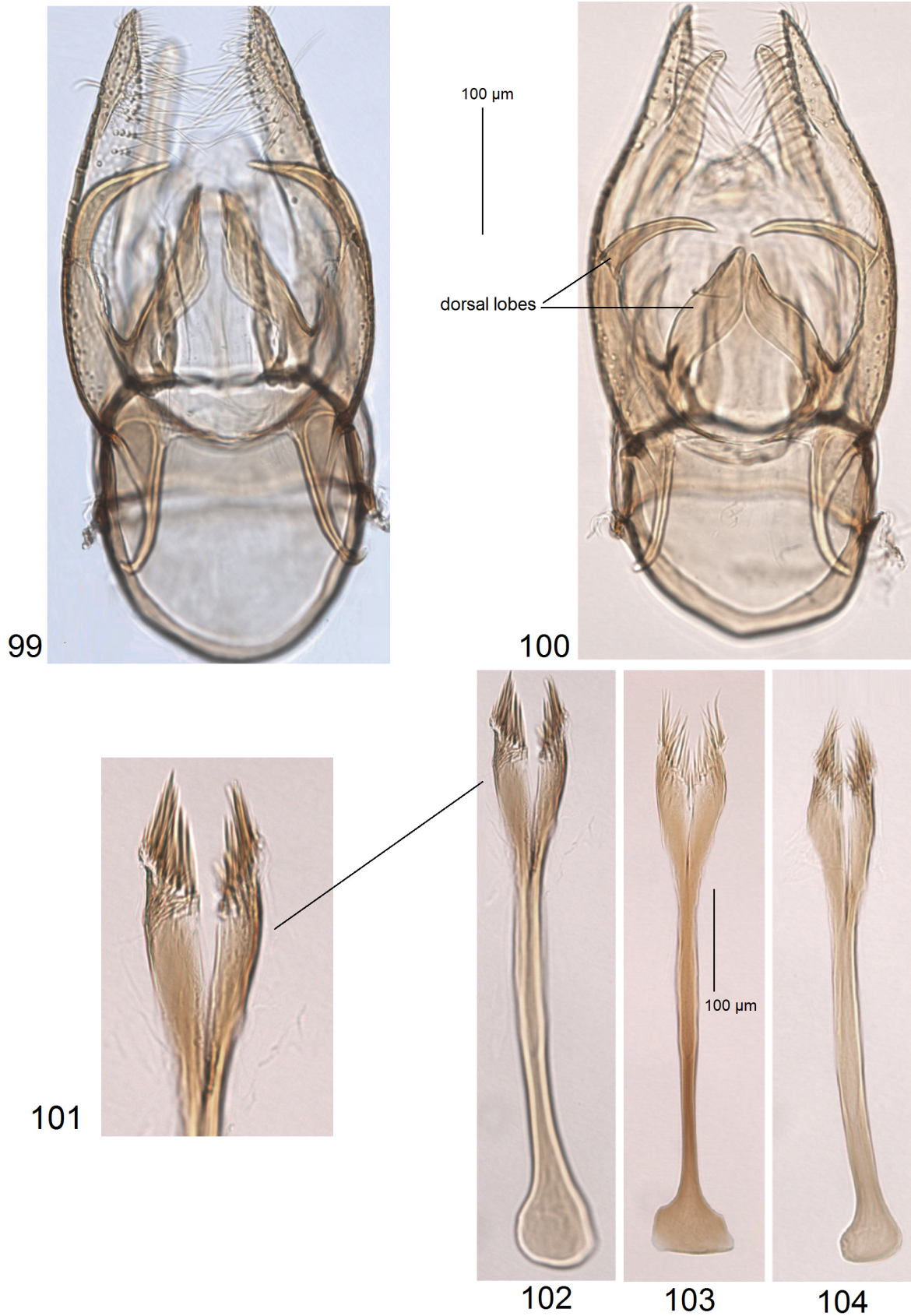


97

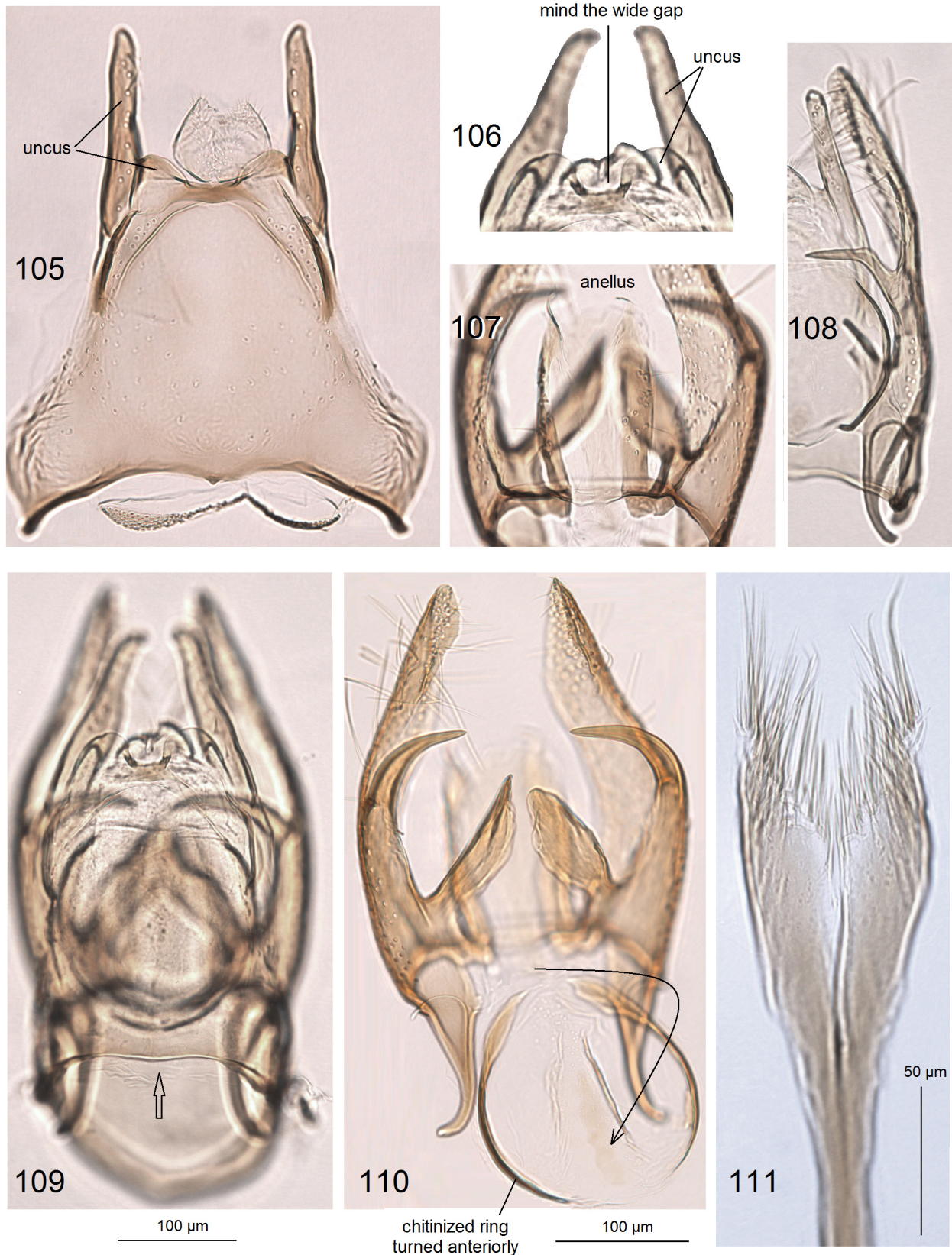


98

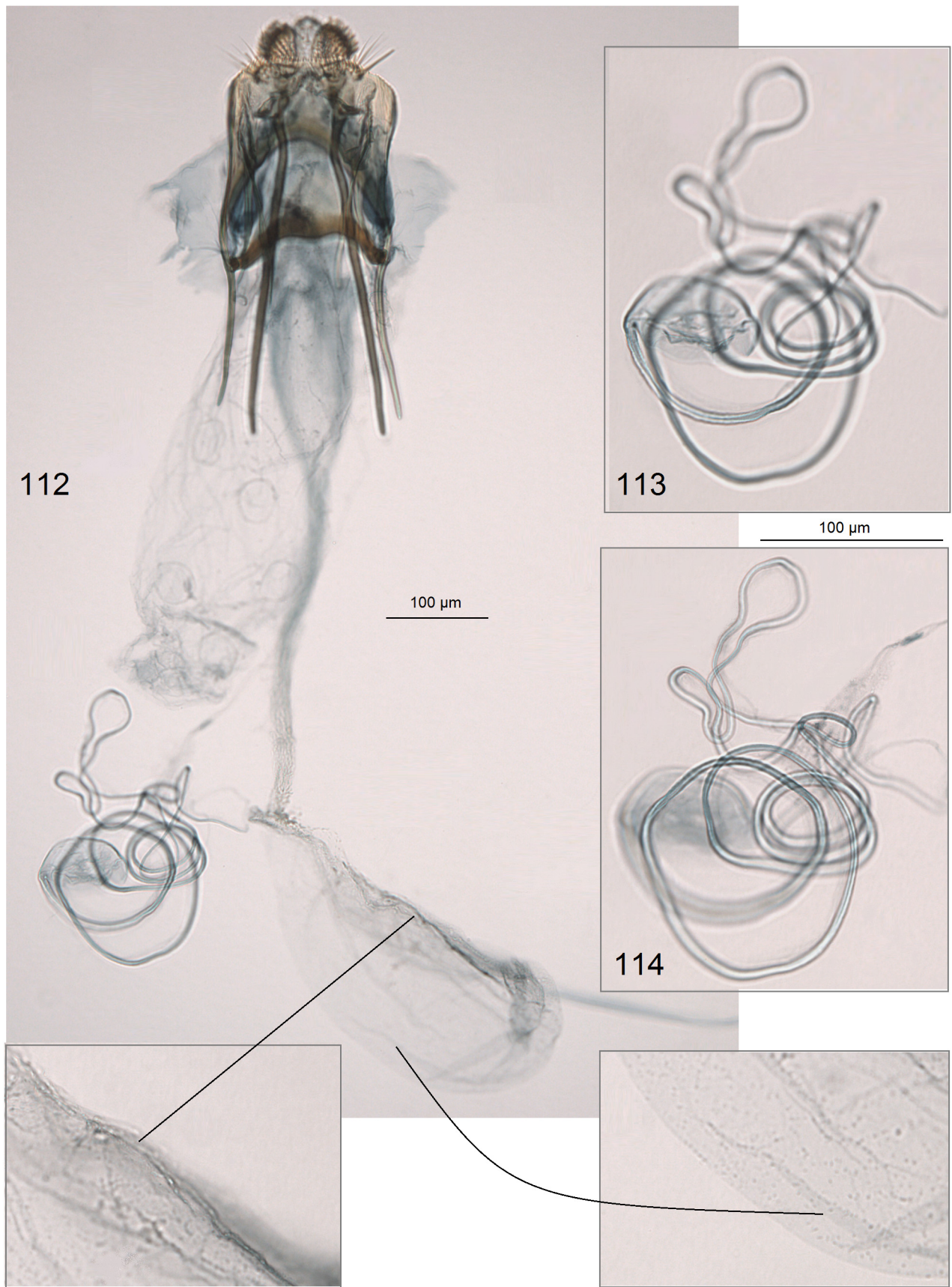
FIGURES 93–98. Adults of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**; 93–95, 97, 98, paratypes, Las Cuevas, Belize (ZMUC); 96, paratype, Tikal, Guatemala (ZMUC).



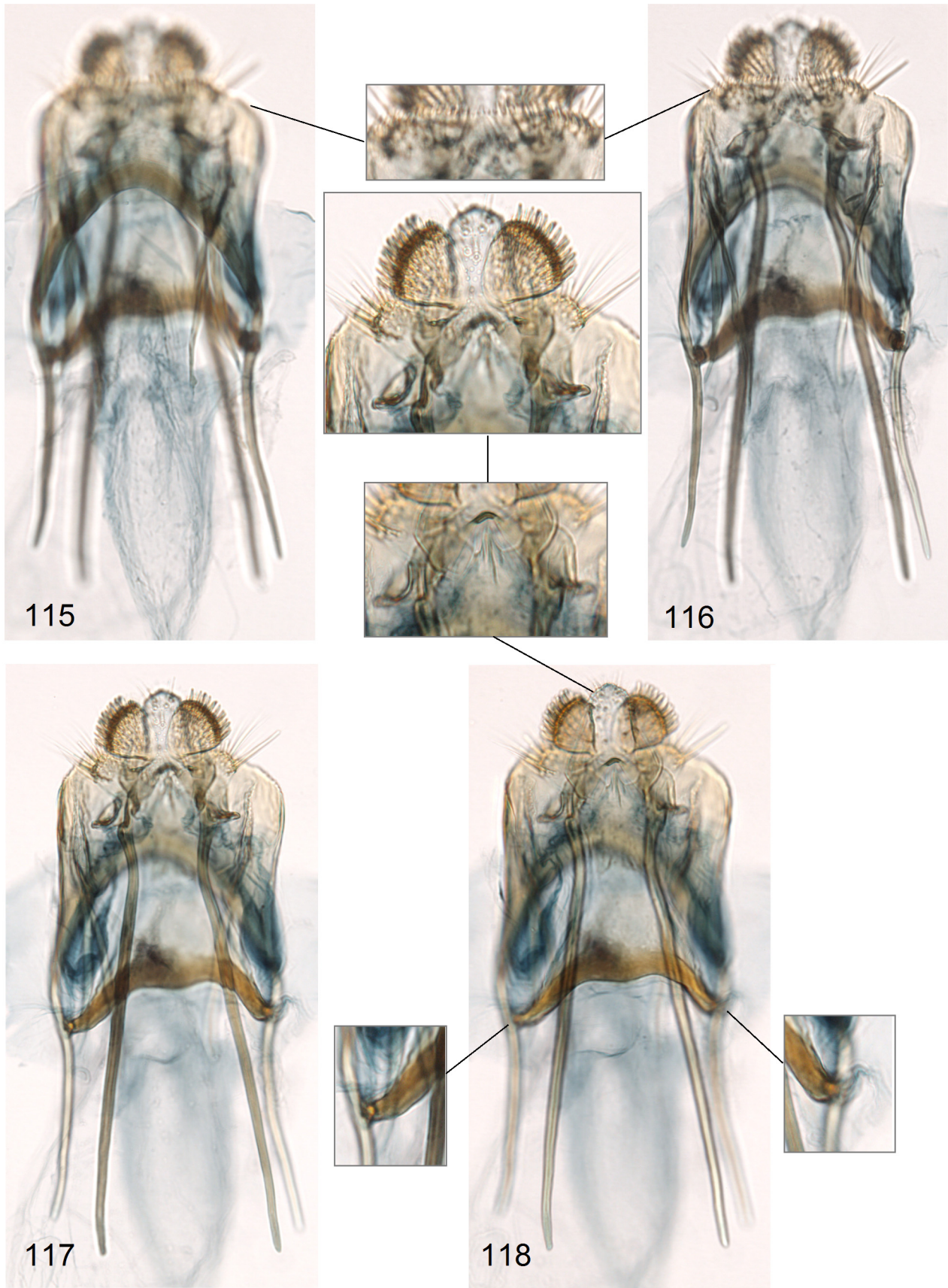
FIGURES 99–104. Male genitalia of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.** (ZMUC). 99, capsule with phallus removed, genitalia slide no. AD920, holotype, Belize; 100, same, genitalia slide no. AD928, paratype, Brazil; 101, 102, phallus, genitalia slide no. AD928, paratype, Brazil; 103, same, genitalia slide no. AD919, paratype, Belize; 104, same, genitalia slide no. AD926, paratype, Brazil.



FIGURES 105–111. Male genitalia of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.** (ZMUC). 105, uncus and tegumen, genitalia slide no. AD919, paratype, Belize; 106, uncus, genitalia slide no. AD928, paratype, Brazil; 107, anellus, genitalia slide no. AD919, paratype, Belize; 108, valva, genitalia slide no. AD926, paratype, Brazil; 109, capsule, dorsal view, genitalia slide no. AD928, paratype, Brazil; 110, valvae and chitinized ring, genitalia slide no. AD919, paratype, Belize; 111, same, apical part of phallus.



FIGURES 112–114. Female genitalia of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**, genitalia slide no. AD924, paratype, Brazil (ZMUC). 112, general view; 113, 114, coils of ductus spermathecae.



FIGURES 115–118. Female genitalia of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**, ovipositor lobes, apophyses and prela, genitalia slide no. AD924, paratype, Brazil (ZMUC).



119

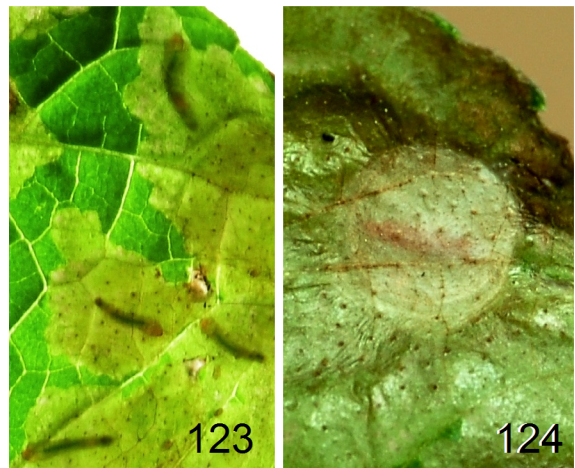
120



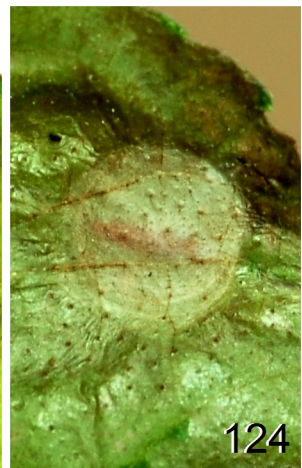
121



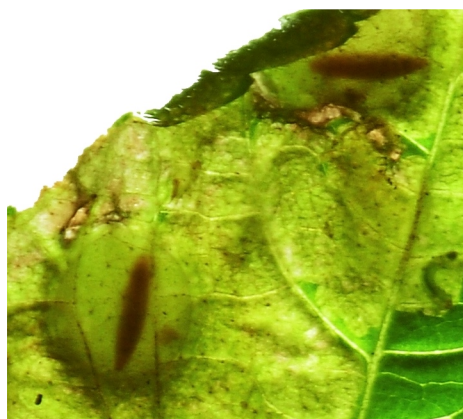
122



123



124



125



126

FIGURES 119–126. Bionomics of *Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, *sp. nov.* 119, 120, host plant *Synedrella nodiflora* (L.) Gaertn., Asteraceae; 121–126, leaf mines, Belem, Brazil.

Female. Unknown.

Male genitalia (Figs. 7, 85–92). Capsule about 520 µm long, 265–280 µm wide. Uncus consisting of two slender, long, lateral lobes and two short, rounded, median lobes (Fig. 86); the gap between median lobes narrow. Valva divided (Fig. 7): ventral lobe slightly curved, about 360 µm long and rather wide (Fig. 85); dorsal lobes consisting of two lobes: an inwardly curved, distally rounded lobe (Figs. 89, 90) and more thickened, distally pointed lobe; transtilla absent; basal process of valva long (Figs. 86, 89). Anellus with 5 setae, thickened only proximally (Fig. 91), distally membranous. Phallus 640 µm long, distally bifurcated and without numerous fine spines (Figs. 87, 92).

Bionomics. Adults fly in February. Otherwise biology unknown.

Distribution (Fig. 233). Known from a single locality in Honduras, at an elevation of about 600 m (Figs. 234, 235).

Etymology. This species is named after the Maya people, a Mesoamerican civilization in reference to the discovery of the species right in the Copán archaeological site, a world-wide famous Mayan ruins in Honduras.

***Astrotischeria selvica* Diškus, Carvalho-Filho & Stonis, sp. nov.**

(Figs. 8, 93–126, 230, 233, 236–238)

Type material. Holotype: ♂, BELIZE: Cayo District, Chiquibul Forest Reserve, Las Cuevas, 16°43'58"S, 88°59'06"W, elevation 580 m, mining larva on *Sphagneticola trilobata* (L.) Pruski (Asteraceae), 4.xi.1997, O. T. Lewis, genitalia slide no. AD920♂ (BMNH). Paratypes (9 ♂, 12 ♀): 2 ♂, 7 ♀, same label data as holotype, 1.x.–4.xi.1997 and 10.vi.–3.vii.1998, O. T. Lewis, genitalia slide nos AD0298♂, AD919♂, AD921♀ (BMNH); 3 ♂, 3 ♀, BRAZIL: State of Pará, Belém, MPEG campus, 1°27'09"S, 48°28'37"W, elevation ca. 330 m, mining larvae on *Synedrella nodiflora* (L.) Gaertn. (Asteraceae), F. Carvalho Filho, genitalia slide nos AD928♂, AD924♀; 2 ♂, 1 ♀, same locality, mining larva on *Tilesia baccata* (L.) Pruski (Asteraceae), 20.vii.2017, F. Carvalho Filho, genitalia slide nos AD926♂, AD941♂ (ZMUC); 1 ♂, 1 ♀, GUATEMALA: Petén region, Tikal National Park, 17°13'28"N, 89°37'10"W, elevation 290 m, 6.ii.2012, field card no. 5073, A. Diškus, genitalia slide nos AD765♂, AD917♀ (ZMUC); 1 ♂, U.S. VIRGIN ISLANDS: St. Thomas, ex pupa 2.iv.1894, Gødman 7178, Lord Walsingham Collection, genitalia slide no. 28950 (BMNH).

Diagnosis. From the most similar species, *A. maya*, it differs by the horn-like, apically pointed dorsal lobe of valva and the distinctly wide gap between median lobes of uncus. The fact that it feeds on *Synedrella*, *Sphagneticola*, and *Tilesia* also makes this species rather distinctive.

Male (Figs. 96, 97). Forewing length: 2.6–3.0 mm; wingspan: 5.6–6.5 mm. Head: face and palpi ochre cream; frontal tuft yellow cream to ochre cream; pecten very prominent, ochre cream with a few pale brown scales; antenna with about 32–35 segments, distinctly longer than half the length of forewing; flagellum pale yellow to pale grey anteriorly, dark grey distally; sensillae very long and fine. Thorax, tegula and forewing vary in coloration, usually yellowish ochre, irregularly speckled with pale brown and blackish brown scales, sometimes with little purple iridescence; fringe ochre-grey on costal margin, pale grey to grey on tornus, yellow-ochre on termen; fringe-line sometimes distinct, formed by blackish brown scales; forewing underside dark brown, without spots or androconia. Hindwing pale grey to brownish grey on both upper and underside, without androconia; fringe brownish grey. Legs ochre cream to pale yellow-ochre, speckled with dark brown scales on upper side. Abdomen grey-black to brown on upper side and laterally (but ochre cream in the specimen from U.S. Virgin Islands), ochre cream to brown on underside; tufts indistinct, ochre cream.

Female (Figs. 93–95, 98). Similar to male.

Male genitalia (Figs. 8, 99–111). Capsule 510–520 µm long, about 250 µm wide. Uncus consisting of two long, slender, lateral lobes, and two very short, rounded, median lobes (Figs. 105, 106). Valva divided (Figs. 8, 110): ventral lobe slightly curved, about 330–360 µm long and rather wide (Figs. 99, 100); dorsal lobes consisting of two elements: an inwardly strongly curved, distally pointed horn-like process (Figs. 99, 110) and wide, distally almost rounded lobe; transtilla absent; basal process of valva long (Figs. 99, 110). Anellus rather long, with 5 setae, thickened laterally (Fig. 107). Phallus 490–560 µm long, distally bifurcated and without numerous slender spines (Figs. 101, 111).

Female genitalia (Figs. 112–118). Total length about 1240 μ m. Ovipositor lobes small; the area between ovipositor lobes triangularly shaped or trapezoid (Fig. 117), with tiny papillae and some setae. Second pair of lobes, lateral and anterior to the ovipositor lobes, significantly smaller, bearing very long, slender setae. Anterior and posterior apophyses very long and stout (Figs. 116, 118); anterior apophyses connected with a heavily chitinized transverse bar (Figs. 112, 115); prela with three pairs of processes; one pair of processes articulating with anterior apophyses and connected with each other by a heavily chitinized transverse bar (Figs. 117, 118). Vestibulum without antrum, however vestibulum may look thickened laterally because the prela (Fig. 115). Ductus bursae widened posteriorly, with very indistinct pectinations. Corpus bursae small, elongated (Fig. 112), without spines or signum. Ductus spermataecae with many large and very large coils (Figs. 113, 114); utriculus absent or broken (Fig. 112).

Bionomics (Figs. 119–126). Host plants: *Synedrella nodiflora* (L.) Gaertn. (Figs. 119, 120) and *Sphagneticola trilobata* (L.) Pruski; in Brazil also *Tilesia baccata* (L.) Pruski (Asteraceae) along with the main host plant *Synedrella nodiflora*. Mining larvae have been recorded from February, June–July, and October–November. Blotch mine (Figs. 121–126) either without frass or with little brown-black loose frass. Silk-lined nidus (Fig. 124) distinct. Larva pale green, with dark green intestine and brown head (Figs. 123, 126). Pupation inside of the leaf mine, in a silk-lined nidus, without cocoon; pupa pale brown (Fig. 125). Adults known from February and April.

Distribution (Fig. 233). Widely distributed in the Neotropics; known from Belize (Figs. 237, 238), Guatemala (Fig. 236), U.S. Virgin Islands, and equatorial Brazil (State of Pará, Belém) at the elevation of about 50–600 m.

Etymology. The species name is derived from latinized Spanish *selva* (forest) in reference to the occurrence of the species in the moist tropical forest of Belize (Chiquibul Forest Reserve) and Guatemala (Tikal National Park).

Remarks. Scaling of the type specimens from Brazil is severely rubbed. Forewing yellowish ochre distally, with a rather distinct fringe-line of brown-black scales.

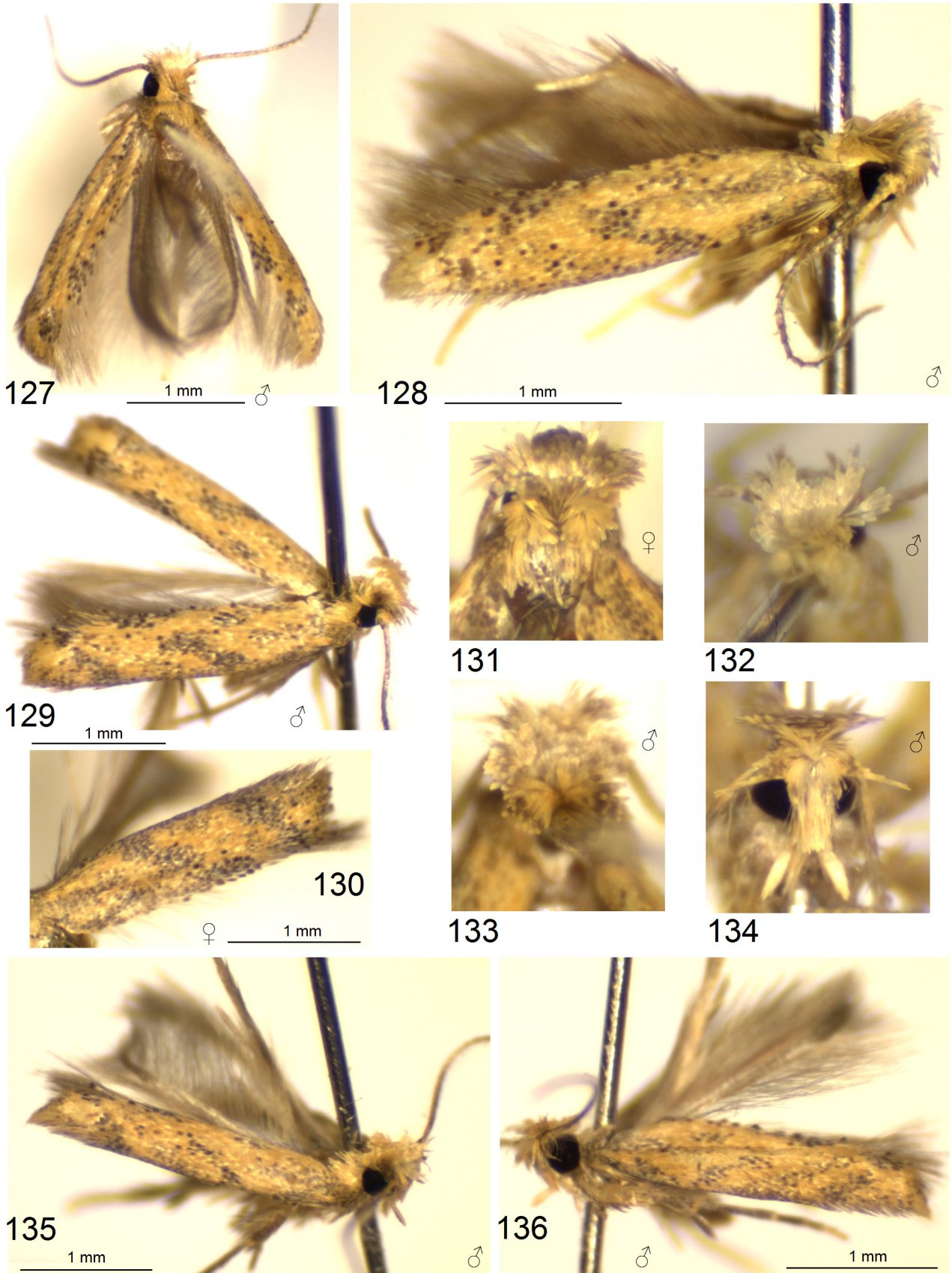
Astrotischeria casila Diškus & Stonis, sp. nov.

(Figs. 11, 12, 127–159, 233, 237, 238)

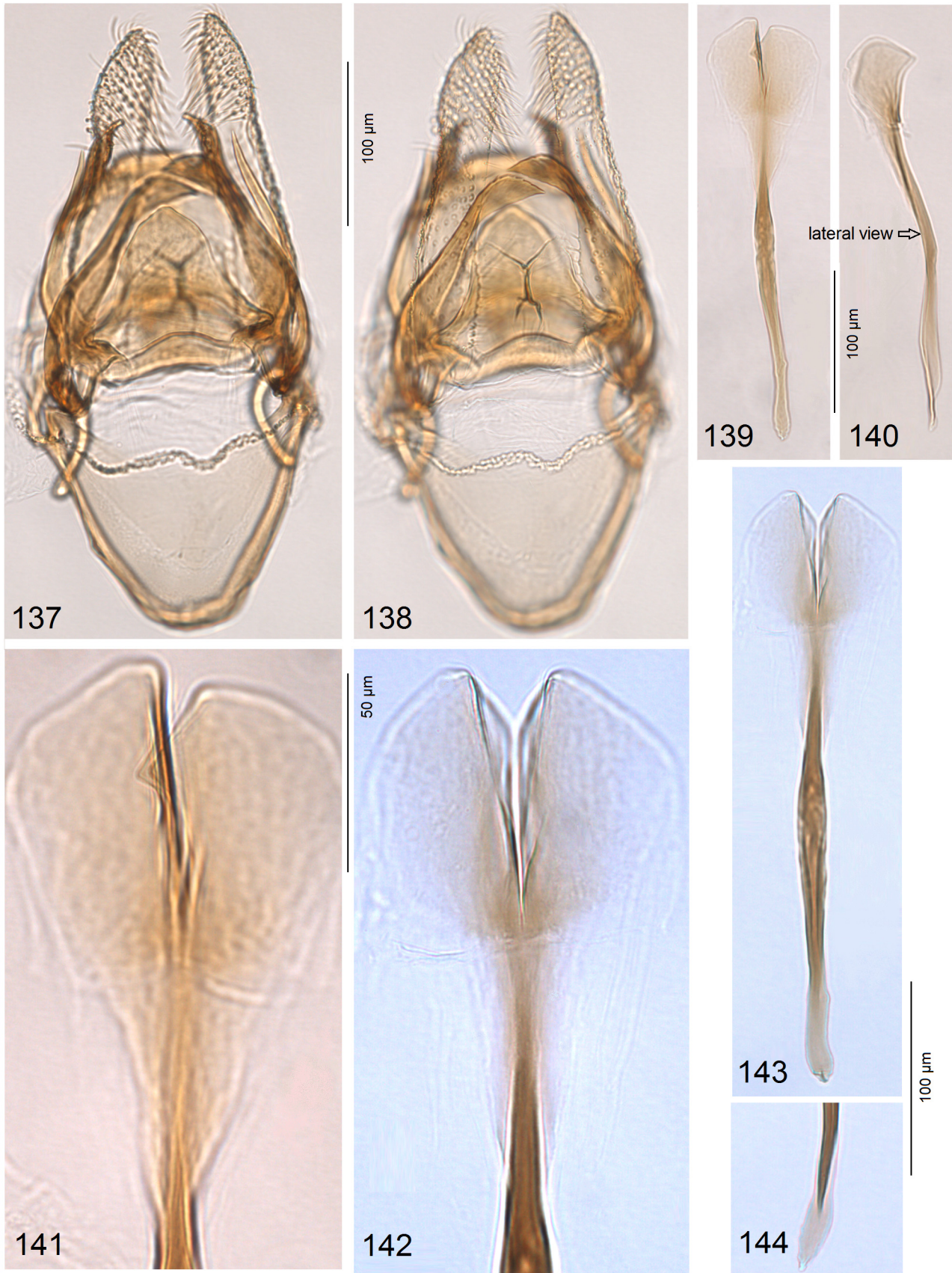
Type material. Holotype: ♂, BELIZE: Cayo District, Chiquibul Forest Reserve, Las Cuevas, 16°43'58"S, 88°59'06"W, elevation 580 m, mining larva on *Montanoa atriplicifolia* (Pers.) Sch. Bip. (Asteraceae), 29.vi.1998, O. T. Lewis, genitalia slide no. AD939♂ (BMNH). Paratypes: 9 ♂, 6 ♀, same label data as holotype, 2.iv.1998 and 13.vi.–12.viii.1998, O. T. Lewis, genitalia slide nos AD0295♂, AD849 ♂, AD940♀ (BMNH); 1 ♂, Cayo District, San Ignacio, secondary forest, 17°09'15"S, 89°04'04"W, elevation 85 m, 17–18.iv.1998, at light, R. Puplesis & S. Hill, genitalia slide no. AD934♂ (BMNH).

Diagnosis. The combination of a helmet-like anellus, merged median lobes of uncus, rather slender, apically pointed dorsal lobes of valva and weakly divided, wide lobes of phallus in the male genitalia distinguishes *A. casila* sp. nov. from all other *Astrotischeria*, including other members of the *A. trilobata* group.

Male (Figs. 127–129, 132–136). Forewing length: 2.4–2.6 mm; wingspan: 5.4–5.8 mm. Head: face and palpi pale ochre-yellow; frontal tuft comprised of lamellar, pale brown, yellow-tipped scales with ochre-yellow bases; sometimes frontal tuft entirely ochre-yellow (Fig. 132); pecten very prominent (Fig. 134), ochre cream, sometimes with a few pale brown scales; collar comprised of slender lamellar scales, usually ochre cream, sometimes scales pale brown distally; antenna with about 37 segments, distinctly longer than half the length of forewing; flagellum cream with some pale brown scales on upper side (mostly in distal half), brownish grey on underside; sensillae very long and fine, therefore, usually indistinct. Thorax ochre-yellow; tegula ochre-yellow distally, densely speckled with brown-black and black scales anteriorly; forewing relatively wide but short, glossy, ochre-yellow, sparsely speckled with brown-black and black scales; usually black scales form irregular, oblique, stripe-like patches; fringe yellowish grey on costal margin, pale grey on tornus, ochre-yellow on termen; fringe-line usually indistinct; forewing underside brown with some purple iridescence, without androconia. Hindwing slender, pale grey to grey, at certain angle of view with some pale green and purple iridescence on both upper and underside, without androconia; fringe pale brownish grey. Legs ochre cream to yellow-ochre, speckled with grey-brown to pale grey-brown scales on upper side. Abdomen relatively short and stout, glossy; on upper side and laterally brown to brownish grey, on underside entirely ochre-yellow or speckled with brown scales; tufts distinct, yellowish cream to brownish cream; genital plates large, yellowish cream.



FIGURES 127–136. Adults of *Astrotischeria casila* Diškus & Stonis, *sp. nov.*, Las Cuevas, Belize. 127–130, general view, paratypes; 131–133, same, frontal tuft and collar; 134, same, face; 135, 136, lateral view, holotype (ZMUC).

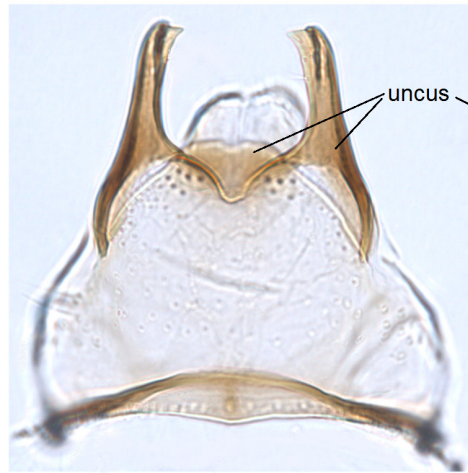


FIGURES 137–144. Male genitalia of *Astrotischeria casila* Diškus & Stonis, **sp. nov.**, Las Cuevas, Belize. 137, 138, capsule with phallus removed, holotype, genitalia slide no. AD939; 139, same, phallus; 140, lateral view of phallus, paratype, genitalia slide no. AD934; 141–144, details of phallus, holotype, genitalia slide no. AD939 (ZMUC).



145

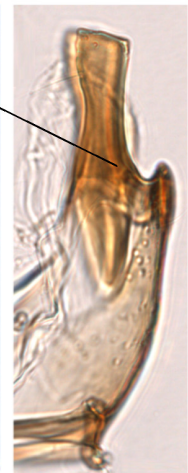
100 µm



ventral view

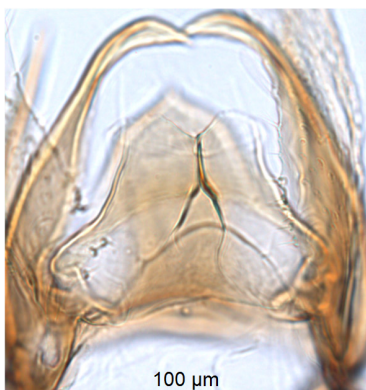
146

100 µm



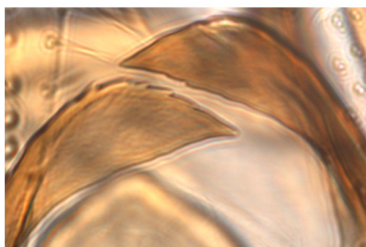
lateral view

147



148

100 µm



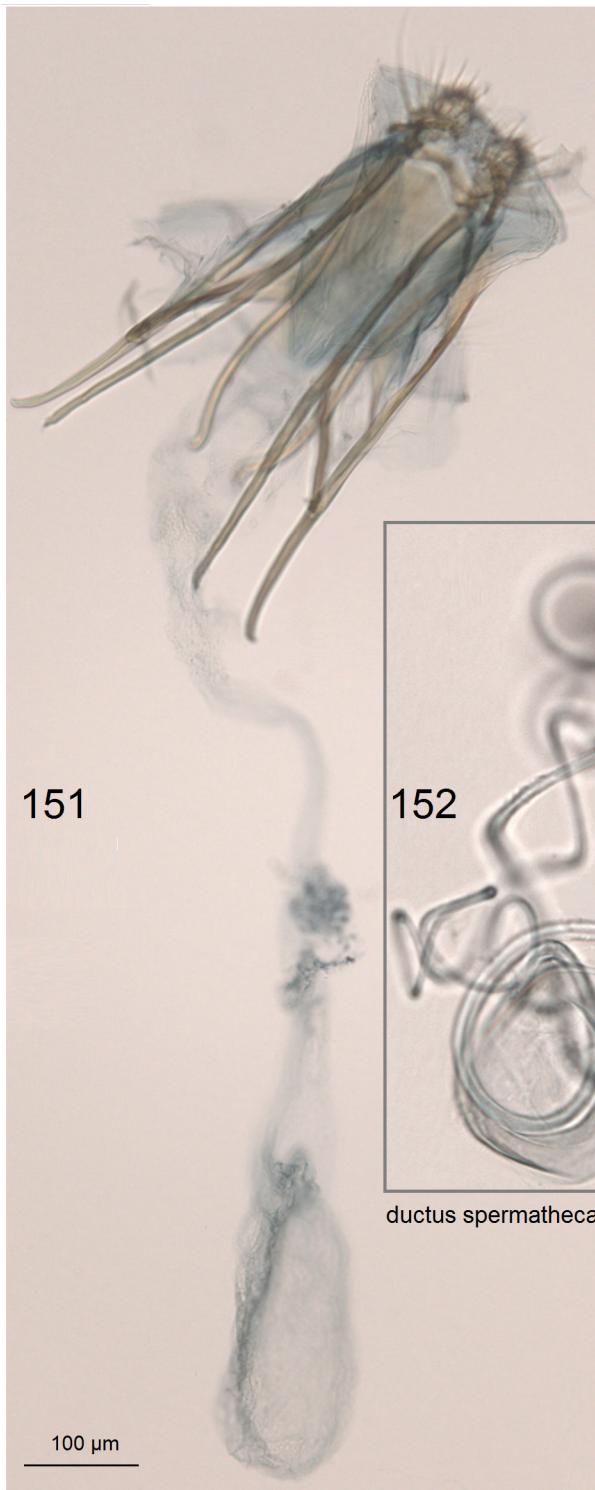
149



150

100 µm

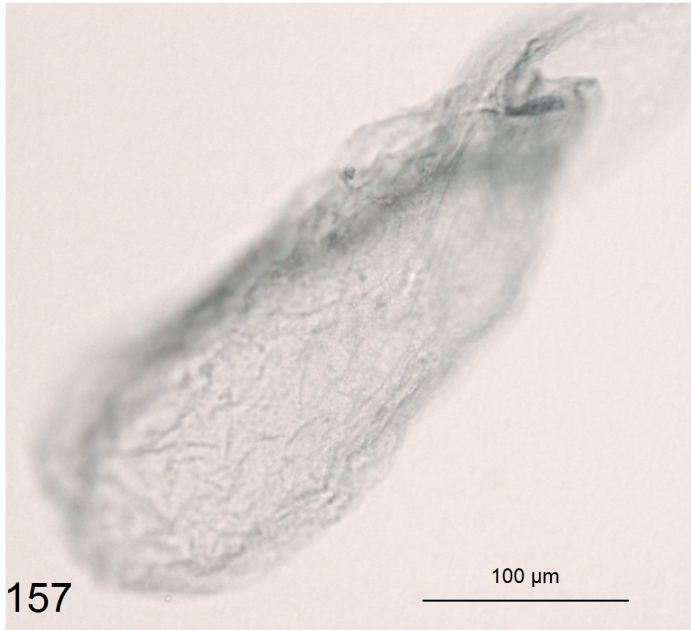
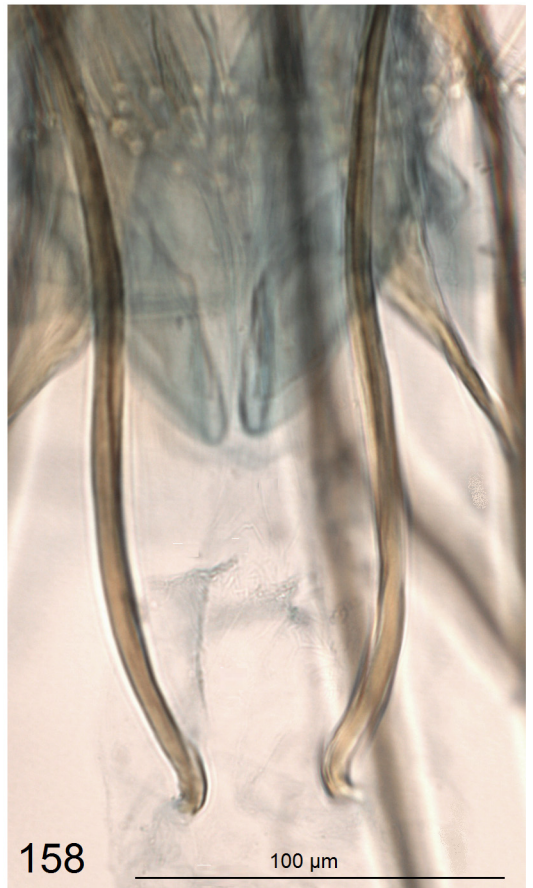
FIGURES 145–150. Male genitalia of *Astrotischeria casila* Diškus & Stonis, **sp. nov.**, Las Cuevas, Belize. 145, capsule with phallus, paratype, genitalia slide no. AD0295; 146, uncus, ventral view, genitalia slide no. AD849, paratype; 147, same, lateral view, genitalia slide no. AD934, paratype; 148, ventral view of anellus, genitalia slide no. AD849, paratype; 149, distal parts of dorsal lobes, genitalia slide AD939, holotype; 150, dorsal lobes, anellus and vinculum, genitalia slide no. AD848, paratype (ZMUC).



ductus spermathecae (enlarged)



FIGURES 151–154. Female genitalia of *Astrotischeria casila* Diškus & Stonis, **sp. nov.**, Las Cuevas, Belize, genitalia slide no. AD940. 151, general view; coils of ductus spermathecae; 153, 154, ovipositor lobes, apophyses and prela (ZMUC).



FIGURES 155–159. Female genitalia of *Astrotischeria casila* Diškus & Stonis, **sp. nov.**, Las Cuevas, Belize, genitalia slide no. AD940. 155, 156, ovipositor lobes; 157, corpus bursae; 158, 159, details of prela (ZMUC).

Female (Figs. 130, 131). Similar to male, only sometimes forewing pattern darker, black stripe-like patches more prominent, and, occasionally, connected into transverse fasciae.

Male genitalia (Figs. 11, 12, 137–150). Capsule about 500 µm long, 210 µm wide. Uncus consisting of two long lateral lobes and short median plate, formed by two merged median lobes (Figs. 146, 147). Valva divided (Figs. 11, 110): ventral lobe, at least at certain angle of view, slightly widened apically (Fig. 145), about 270 µm long, 40–45 µm wide (Figs. 137, 99, 100); dorsal lobes consisting of two elements: wide, distally curved lobe (Figs. 137, 145, 150), and slender, horn-like process (Figs. 12, 14, 150); transtilla absent; basal process of valva long, curved (Figs. 137, 150). Anellus with a chitinized, helmet-like plate dorsally, and with two wide and connected lobes ventrally, each possessing 3–5 setae laterally (Fig. 148). Phallus (Figs. 139, 140, 143) about 300 µm long, distally wide and bifurcated, without spines (Figs. 141, 142).

Female genitalia (Figs. 151–159). Total length about 1250 µm. Ovipositor lobes small (Fig. 153); the area between ovipositor lobes widely rounded, not triangular (Figs. 155, 156), with tiny papillae and some setae. Second pair of lobes, lateral and anterior to the ovipositor lobes, significantly smaller (Fig. 156), bearing very long slender setae. Anterior and posterior apophyses very long and stout (Fig. 153); prela with three pairs of processes; two pairs of processes articulating with anterior apophyses, remaining pair unusually developed, stout and very long (Figs. 154, 158). Vestibulum without antrum but with two unusual, membranous lobes (Figs. 154, 159). Ductus bursae long but slender (Fig. 151), without distinctive pectinations. Corpus bursae very small, elongated (Fig. 157), without spines or signum. Ductus spermataecae with many large and very large coils (Fig. 152); utriculus absent or broken in Fig. 151.

Bionomics (Figs. 119–126). Host plant: *Montanoa atriplicifolia* (Pers.) Sch. Bip. (Asteraceae). Mining larvae recorded from June to August. Leaf-mine blotch-like. Adults known from April and July–August.

Distribution (Fig. 233). The species occurs in moist tropical (secondary and primary) forest of Belize (Central America), at elevation of about 80–600 m (Figs. 237, 238).

Etymology. The species name is derived from Latin *casila* (wearer of a helmet) in reference to the most distinctive character, the helmet-like anellus in the male genitalia.

Astrotischeria onae Diškus & Stonis, sp. nov.

(Figs. 18, 19, 160–175, 233)

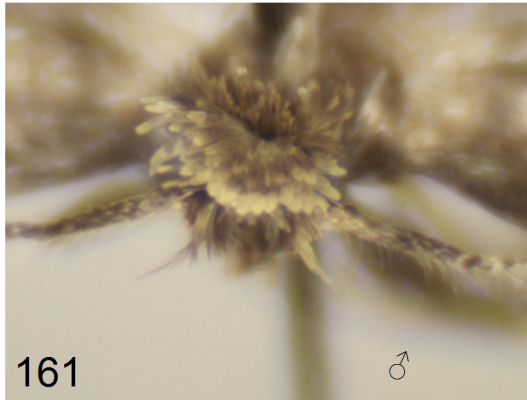
Type material. Holotype: ♂, GUATEMALA: Antigua Guatemala, San Juan del Obispo, 14°31'07"N, 90°43'50"W, elevation 1680 m, 25.ii.2012, field card no. 5114, A. Diškus, genitalia slide no. AD909♂ (ZMUC).

Diagnosis. The combination of a wide valva with unique-shaped dorsal lobes (see Figs. 18, 19), strongly developed anellus with lateral horn-like processes, long, bilobed uncus in the male genitalia, and a dark-speckled forewing distinguishes *A. onae* sp. nov. from all other *Astrotischeria*, including other members of the *A. trilobata* group.

Male (Figs. 160–163). Forewing length about 3.7 mm; wingspan about 8.1 mm. Head: face greyish cream; palpi yellowish cream; frontal tuft comprised of yellowish-tipped, brownish grey lamellar scales; antenna with about 37 segments, distinctly longer than half the length of forewing; flagellum grey on both upper and underside; sensillae long but rather indistinct. Thorax and tegula covered with brownish grey, predominantly cream-tipped scales. Forewing densely irrorated with brownish grey scales with some ochre gloss; in apical third, forewing also speckled with black scales; fringe pale brownish grey; fringe-line distinct, formed of black scales; forewing underside grey-brown, except small, irregular scaleless patch on the base, without androconia. Hindwing brownish grey on both upper and underside, without androconia; fringe brownish grey. Legs glossy, brownish cream, on upper side densely covered with blackish brown scales with little purple iridescence. Abdomen grey-brown to blackish grey on both upper and underside; anal tufts long, dark grey; genital segments cream.

Female. Unknown.

Male genitalia (Figs. 18, 19, 164–175). Capsule about 590 µm long, 260 µm wide. Uncus (Fig. 165) consisting of two long, slender lateral lobes. Valva divided (Figs. 18, 19, 169–175): ventral lobe (Figs. 164, 171) very wide, about 365 µm long (excluding basal process); dorsal lobes consisting of two elements: wide, distally curved lobe (Figs. 18, 19, 169, 173), and slender, horn-like process; transtilla absent; basal process of valva rather long, curved (Figs. 165, 170). Anellus strongly chitinized laterally, with a distinct spine-like process on each side (Figs. 175), and a few setae (Fig. 174). Phallus (Figs. 166–168) about 400–405 µm long, distally widened and bifurcated, without spines (Fig. 168).



FIGURES 160–163. Male adult of *Astrotischeria onae* Diškus & Stonis, **sp. nov.**, holotype, Guatemala (ZMUC). 160, general view; 161, frontal tuft; 162, face; 163, left wings.

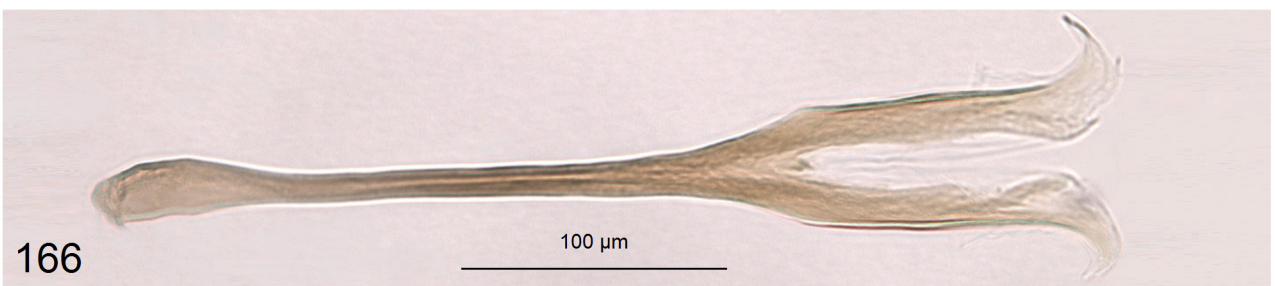


164

100 μ m



165

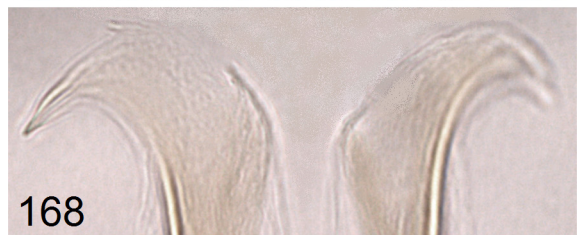


166

100 μ m

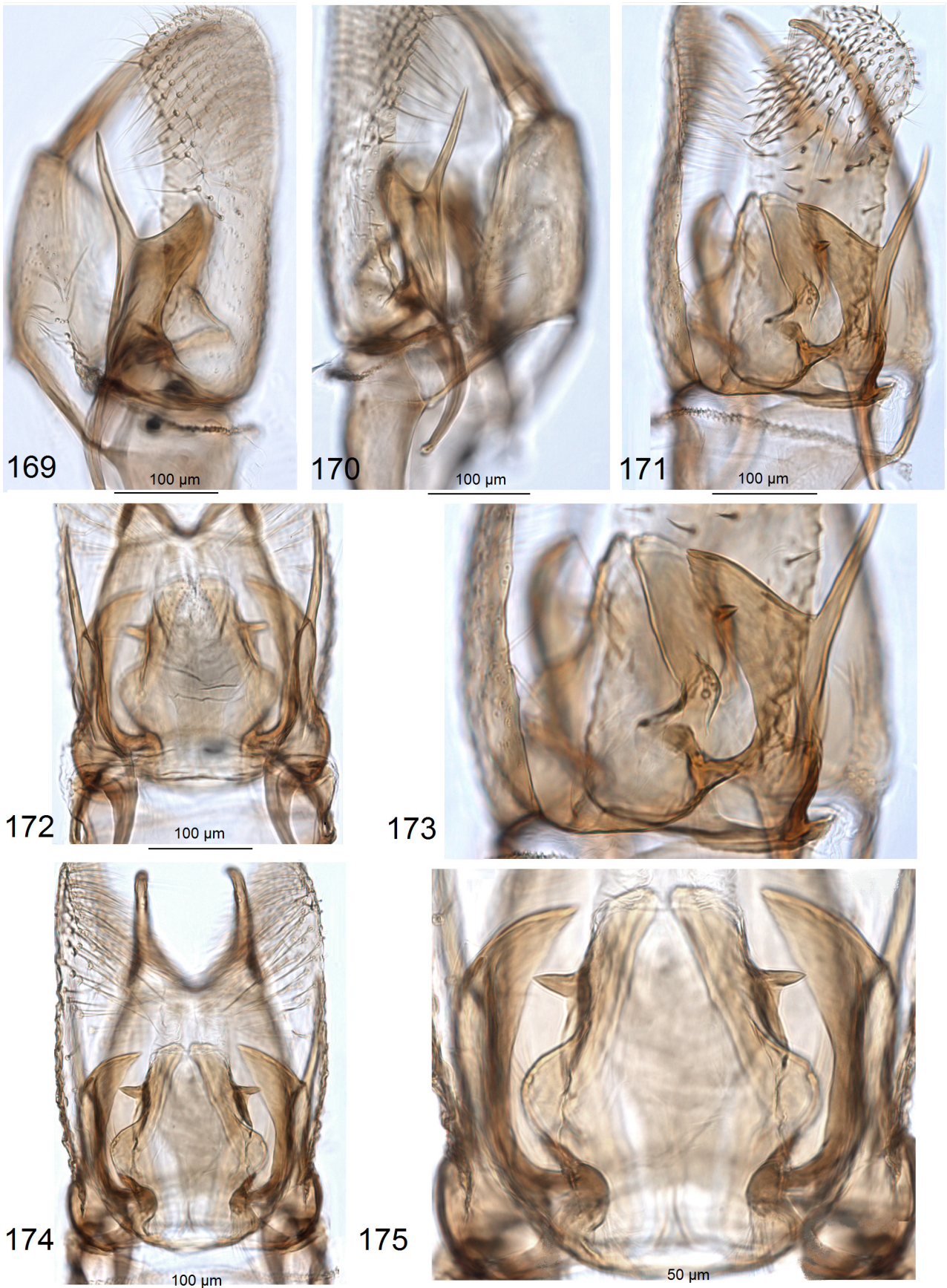


167



168

FIGURES 164–168. Male genitalia of *Astrotischeria onae* Diškus & Stonis, **sp. nov.**, genitalia slide no. AD909, holotype, Guatemala (ZMUC). 164, 165, capsule with phallus removed; 166, phallus; 167, same, details.



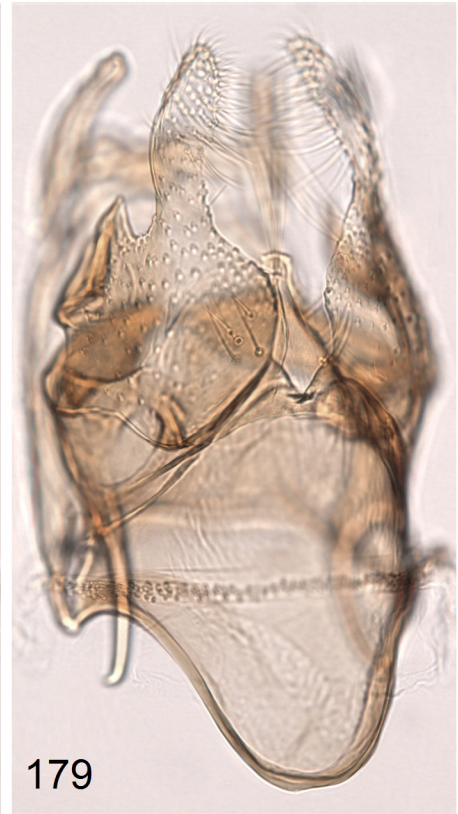
FIGURES 169–175. Details of male genitalia of *Astrotischeria onae* Diškus & Stonis, **sp. nov.**, genitalia slide no. AD909, holotype, Guatemala (ZMUC). 169–171, 173, lateral view; 172, 174, ventral view, focused on dorsal lobes of valvae; 175, anellus.



176 1 mm



178



179



177

100 µm



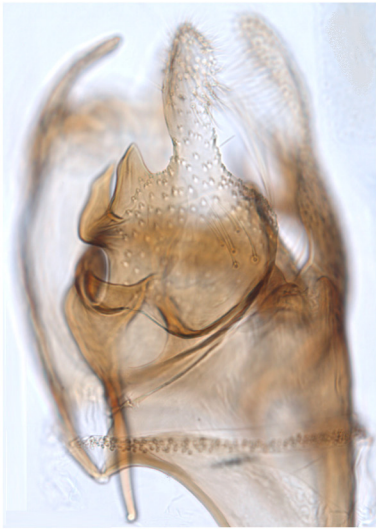
180



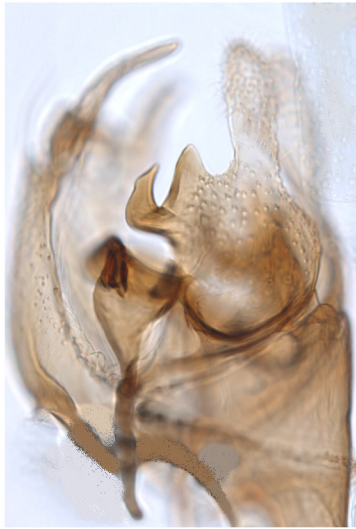
181

100 µm

FIGURES 176–181. *Astrotischeria furcata* Stonis & Diškus, sp. nov., holotype, Belize (BMNH). 176, male adult; 177, male genitalia, phallus, genitalia slide no. AD925; 178–181, same, capsule with phallus removed.

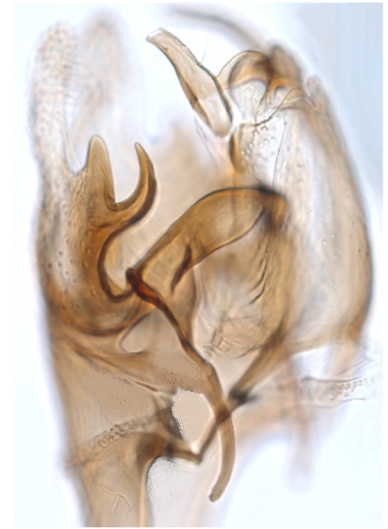


182



183

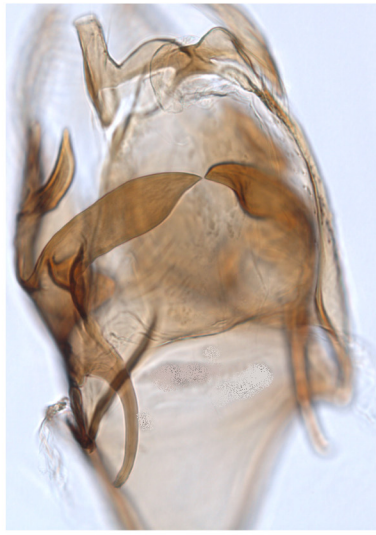
100 µm



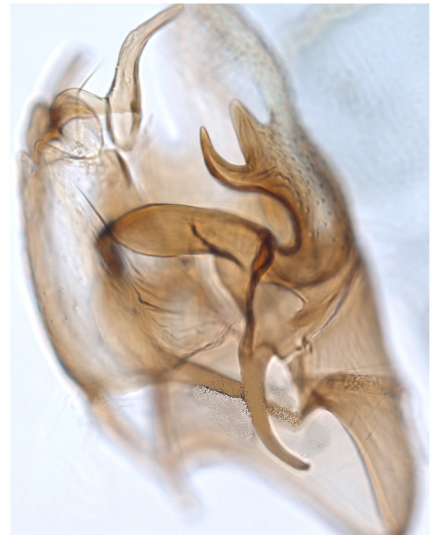
184



185



186



187



188

100 µm



189

FIGURES 182–189. Male genitalia of *Astrotischeria furcata* Stonis & Diškus, **sp. nov.**, holotype, Belize (BMNH). 182–187, lateral view; 188, 189, dorsal view, focused on uncus.

Bionomics. Host plant unknown (unidentified). Mining larva recorded in February. Leaf-mine blotch-like.

Distribution (Fig. 233). Known from a single locality in the highlands of Guatemala, at an elevation of about 1680 m.

Etymology. The species is named in memory of Ona Diškevičienė (1951–2017), late mother of the author (and devoted collector) Arūnas Diškus.

***Astrotischeria furcata* Stonis & Diškus, sp. nov.**

(Figs. 16, 17, 176–189, 233, 239, 240)

Type material. Holotype: ♂, BELIZE: Cayo District, Chiquibul Forest Reserve, Las Cuevas, 16°43'59"S, 88°59'01"W, elevation 590 m, 3–16.iv.1998, R. Puplesis & S. Hill, genitalia slide no. AD925♂ (BMNH).

Diagnosis. The combination of a large uncus, unique-shaped dorsal lobes (see Figs. 16, 17), and the wide apical fork of phallus in the male genitalia distinguishes *A. furcata* sp. nov. from all other *Astrotischeria*, including other members of the *A. trilobata* group.

Male (Fig. 176). Forewing length about 3.5 mm; wingspan about 7.5 mm. Head: face and palpi yellowish cream; frontal tuft comprised of lamellar scales, glossy, yellowish cream centrally, ochre to ochre-brown laterally; antenna longer than half the length of forewing; flagellum yellowish grey to grey, basally yellowish cream; sensillae long, greyish white. Thorax glossy, orange-yellow, with a few scattered blackish brown scales; tegula orange-yellow distally, densely covered with blackish brown scales basally. Forewing glossy, mostly yellowish cream with patchy shade of ochre-orange; black-brown scales scattered laterally and form an oblique, subapical spot along costal margin, and a small, indistinct spot on tornus; fringe grey on costal margin, dark grey to pale brown grey on tornus, but yellowish cream on termen; fringe-line absent or indistinct; forewing underside coarsely covered with dark brown scales with weak greenish and purple iridescence, no androconia. Hindwing pale grey to brown (depends on angle of view), without androconia; fringe pale brown to brown. Legs glossy, golden cream, with brown to dark brown scales and some purple iridescence on upper side.

Female. Unknown.

Male genitalia (Figs. 16, 17, 177–189). Capsule about 520 µm long, 285 µm wide. Uncus (Figs. 181, 184, 186) consisting of two long, slender lateral lobes, and two very short, rounded median lobes. Valva divided (Figs. 16, 17, 178, 182–187): ventral lobe (Fig. 180) wide at basal half, slender at apical half, about 260 µm long (excluding basal process); dorsal lobes consisting of two elements: wide, distally pointed transverse lobe (Figs. 16, 17, 185–188), and short, bifurcate lobe (Figs. 16, 183, 184); transtilla absent; basal process of valva rather long (Figs. 181, 187). Anellus rather indistinct, chitinized laterally, with a few setae on each side. Phallus (Fig. 177) about 425 µm long, distally widely furcated, with two lobe-like processes.

Bionomics. Host plant unknown. Adults fly in April.

Distribution (Fig. 233). Known from a single locality in Belize (Las Cuevas Biological Station), the moist tropical forest habitat, at an elevation of about 600 m (Figs. 239, 240).

Etymology. The species name is derived from Latin *furcatus* (forked) in reference to the furcate dorsal lobe of valva in the male genitalia.

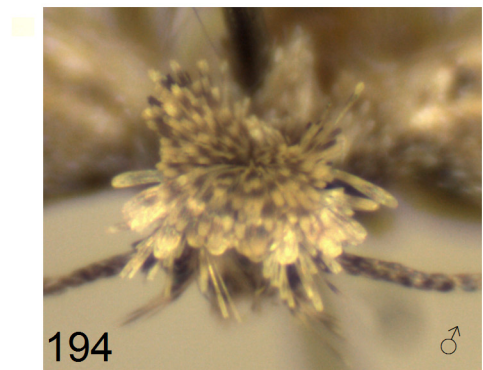
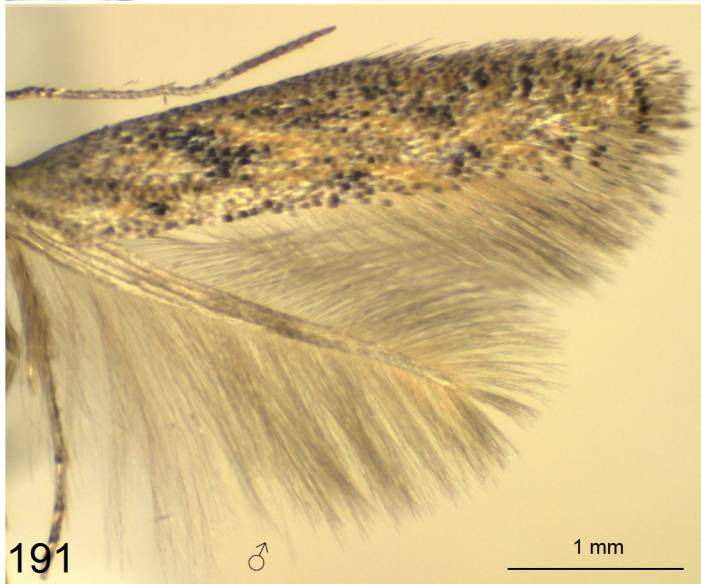
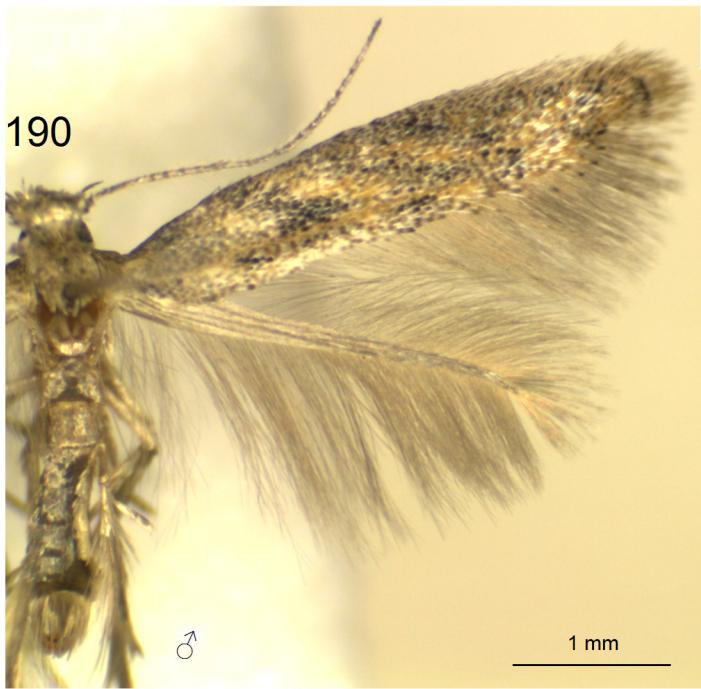
***Astrotischeria plagifera* (Meyrick, 1915)**

(Figs. 15, 190–216, 233, 245–247)

Tischeria plagifera Meyrick, 1915: 246.

Astrotischeria plagifera (Meyrick); Diškus & Puplesis (2003: 428).

Material examined. ECUADOR: 1 ♂ (lectotype), Huigra (Parish), elevation 1370 m, 14.vi.1914, genitalia slide no. 28677♂ (BMNH); 4 ♂, 4 ♀ (paralectotypes), same label data as lectotype, genitalia slide nos 28678♂, 28679♀ (BMNH); 9 ♂, 8 ♀ (not type material), 45 km S Loja, western environments of Vilcabamba, 4°17'42"S, 79°13'15"W, elevation 1950 m, mining larvae on *Rhysolepis incana* (Pers.) H. Rob. & A.J. Moore (Asteraceae), 23.i.2017, A. Diškus, genitalia slide nos AD923♂, AD942♀, AD943♀ (ZMUC).



FIGURES 190–195. Adults of *Astrotischeria plagifera* (Meyrick, 1915), Vilcabamba, Ecuador (ZMUC). 190–193, general view; 194, 195, frontal tuft.



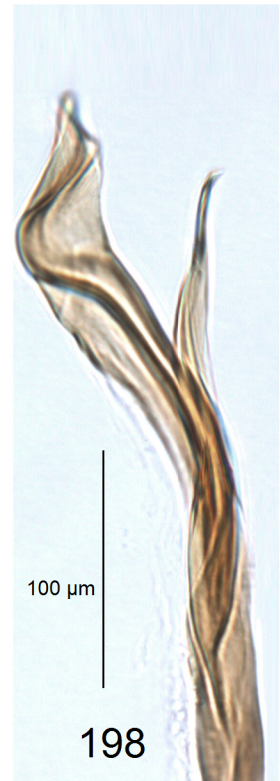
196

100 µm



197

100 µm



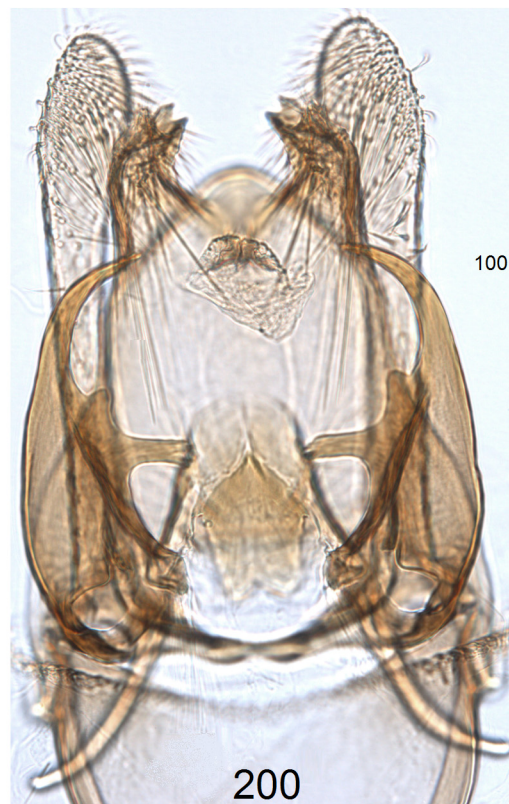
198

100 µm

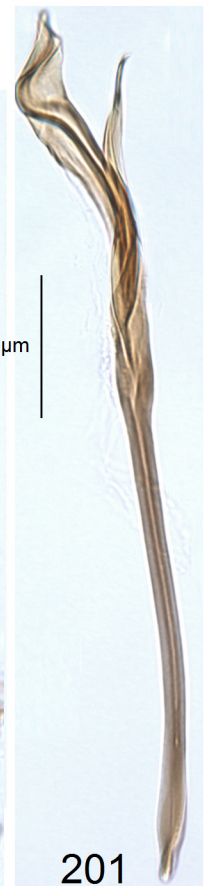


199

100 µm



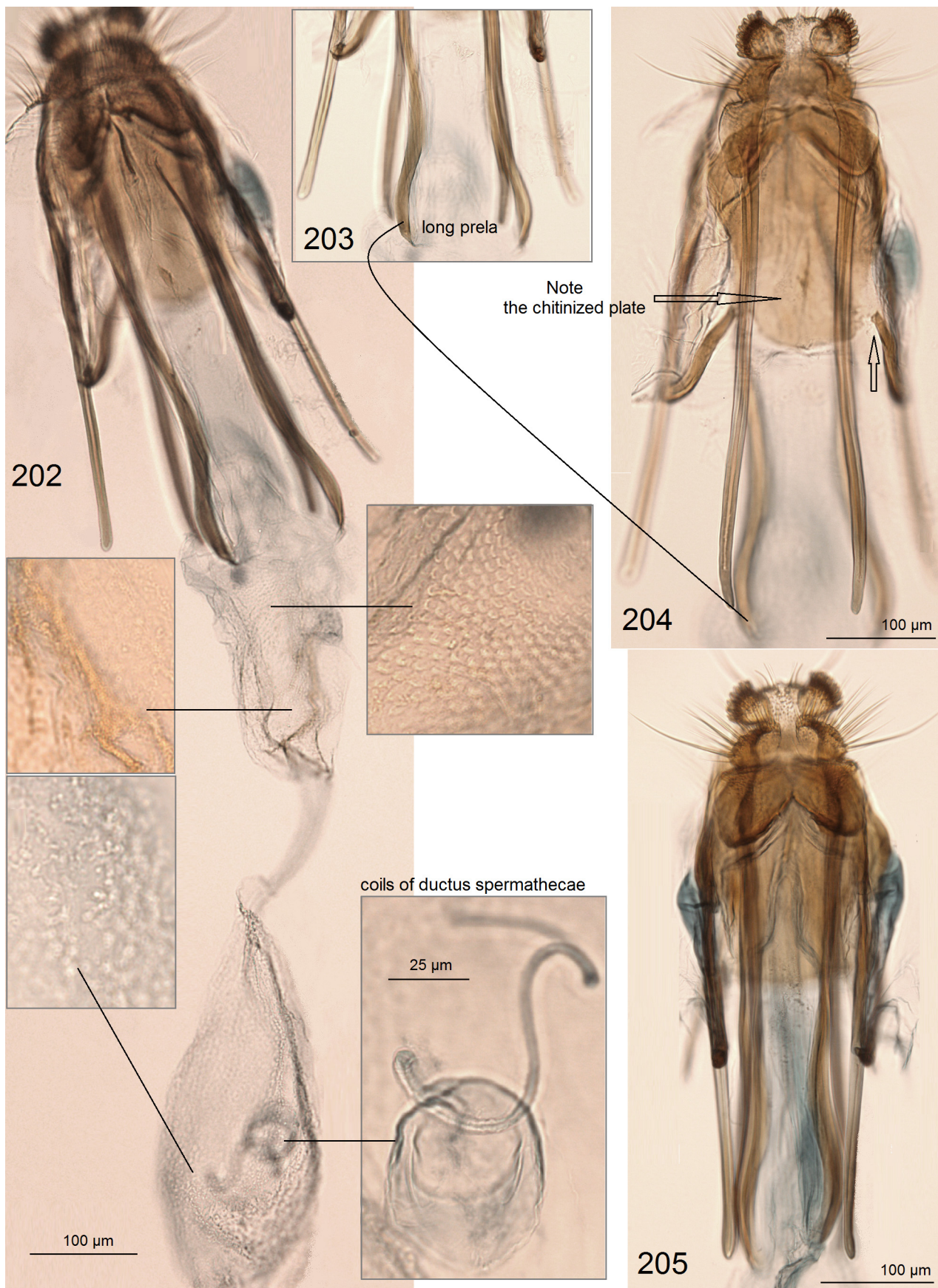
200



201

100 µm

FIGURES 196–201. Male genitalia of *Astrotischeria plagifera* (Meyrick, 1915), Vilcabamba, Ecuador (ZMUC). 196, 197, 199, 200, details of capsule with phallus removed, genitalia slide no. AD923; 198, 201, same, details of phallus.



FIGURES 202–205. Female genitalia of *Astrotischeria plagifera* (Meyrick, 1915), Vilcabamba, Ecuador (ZMUC). 202, general view, genitalia slide no. AD943; 203, 204, same, details of apophyses and prela; 205, same, genitalia slide no. AD942.



FIGURES 206–211. Bionomics of *Astrotischeria plagifera* (Meyrick, 1915). 206–208, 210, 211, host plant *Rhysolepis incana* (Pers.) H. Rob. & A.J. Moore, Asteraceae; 209, leaf mine, Vilcabamba, Ecuador, 4°17'42"S, 79°13'15"W, elevation 1950 m.



FIGURES 212–216. Leaf mines of *Astrotischeria plagifera* (Meyrick, 1915) on *Rhysolepis incana* (Pers.) H. Rob. & A.J. Moore, Vilcabamba, Ecuador, 4°17'42"S, 79°13'15"W, elevation 1950 m.

Diagnosis. The species belongs to the *Astrotischeria trilobata* group. The combination of a twisted apex of phallus, unique dorsal lobes of valva (see Fig. 15), distally furcate uncus in the male genitalia, and intense, multicoloured speckling of the forewing distinguishes *A. plagifera* from all other *Astrotischeria*, including other members of the *A. trilobata* group. The fact that it feeds on *Rhysolepis* also makes this species distinctive.

Male (Figs. 190, 191, 193–195). Forewing length: 3.4–4.2 mm; wingspan: 7.5–8.9 mm. Head: face pale grey to whitish cream; palpi grey, annulated with blackish brown scales; frontal tuft glossy, comprised of wide, either pale ochre-brown lamellar scales with cream tips, or of ochre cream lamellar scales; collar comprised of slender, fuscous-tipped lamellar scales; pecten distinct, cream, annulated with blackish brown scales; antenna distinctly longer than half the length of forewing; flagellum pale grey, annulated with blackish brown scales; sensillae relatively short, rather indistinct. Thorax greyish cream, densely speckled with pale brownish grey scales; tegula densely covered with brownish grey or grey-black scales. Forewing densely speckled with scales of different color: predominantly pale brownish grey and dark brown-grey, also black and orangish ochre scales; the ochre scales mostly scattered in irregular, indistinct patches; fringe formed by brownish cream, piliform scales, annulated with dark grey or pale ochre; fringe-line distinctive, formed by brownish black scales (or indistinct in the holotype); forewing underside brown-grey to pale brown, except slender pale ochre edges; no androconia. Hindwing grey on both upper and underside, without androconia; fringe grey to ochre-grey. Legs brownish cream, on upper side densely covered with blackish brown scales with little purple iridescence. Abdomen glossy, grey to blackish brown with little purple iridescence on both upper and underside, sometime with areas of cream scales on underside; genital plates large, yellowish to brownish cream, contrasting with the collar of abdomen; anal tufts rather long, distinctive, brownish cream.

Female (Fig. 192). Similar to male.

Male genitalia (Figs. 15, 196–201). Capsule about 640 µm long, 315 µm wide. Uncus (Figs. 196, 200) consisting of two distally furcate lateral lobes and one short, rounded median lobe (Fig. 199). Valva divided (Figs. 15, 196, 197): ventral lobe very slender (Fig. 197), about 410 µm long (excluding basal process); dorsal lobe distally slender, with a transverse, lobe-like process (Figs. 15, 196, 200); transtilla absent; basal process of valva long and slightly bent outwardly (Fig. 199). Anellus mostly membranous, thickened only laterally (Fig. 197), with a few setae on each side. Phallus (Fig. 201) about 620 µm long, apically bifurcated and twisted (Fig. 198), without spines.

Female genitalia (Figs. 202–205). Total length 1425–1510 µm. Ovipositor small, clothed with short, stout and darker ‘peg setae’. One pair of prela unusually long (Fig. 203). Ductus bursae slightly widened posteriorly, with scallop-like pectinations (Fig. 202). Corpus bursae small, elongated (Fig. 202), with indistinct pectination but without signum. Ductus spermathecae with about 2–3 coils (Fig. 202); utriculus absent or lost in slide preparation.

Bionomics (Figs. 206–216). Host plant: *Rhysolepis incana* (Pers.) H. Rob. & A.J. Moore, Asteraceae (Figs. 206–208, 210, 211). Mining larvae recorded from January. Leaf mine as an irregular blotch (Figs. 209, 212–216), with black-brown frass or with very little frass but epidermis stained brown, therefore old leaf mine may look brown. Larva pale yellowish green to pale yellow, with dark brownish green intestine and brown head (Figs. 213, 216). Adults known from February and June.

Distribution (Fig. 233). Known from the Ecuadorian Andes at an elevation of about 1400–2000 m (Figs. 245–247).

Remarks. Originally, the species was described from a few specimens collected from Huigra (a mountainous locality E of Guayaquil, Ecuador) but the host plant remained unknown. Only after a century this species was found occurring in abundance in other Andean locality, in southern Ecuador (Figs. 245–247), on distinctive, very brightly flowered plant of *Rhysolepis* (formerly *Viguiera*).

***Astrotischeria heliopsisella* (Chambers, 1875)**

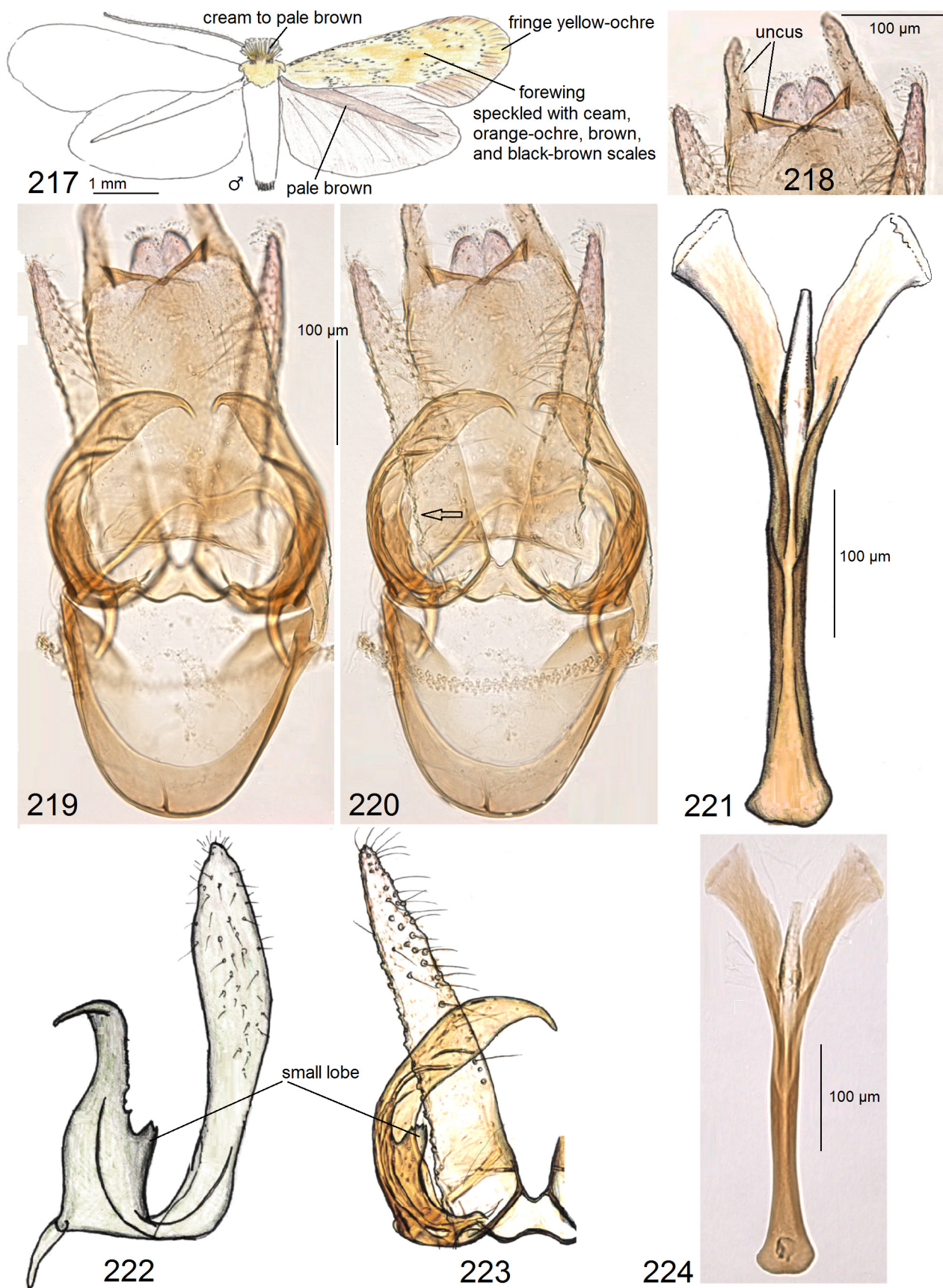
(Figs. 217–224, 233)

Tischeria heliopsisella Chambers, 1875: 113.

Tischeria heliopsisella Chambers, in Walsingham (1890: 325, 1891: 389); Forbes (1923: 147); Braun (1972: 75–77).

Astrotischeria heliopsisella (Chambers); Diškus & Puplesis (2003: 427).

Tischeria nolckenii Frey & Boll, 1876: 220, 1878: 257.



FIGURES 217–224. *Astrotischeria heliopsisella* (Chambers, 1875), Walsingham collection, 1871, on *Ambrosia* (BMNH). 217, male adult; 218, male genitalia, uncus, genitalia slide no. 28952; 219, 220, same, capsule with phallus removed; 221, 224, same, phallus; 222, 223, same, lateral view of valva. Note: also see Remarks in the text on *A. heliopsisella* (Chambers).

Material examined. 1 ♂, 2 ♀, USA, California, Mt. Shasta, Siskiyou, elevation about 1830 m, mining larva on *Ambrosia* sp. (Asteraceae), viii.1871, Lord Walshingham Collection, genitalia slide nos 28952♂, 28964♀ (BMNH).

Diagnosis. The species belongs to the *Astrotischeria trilobata* group. The combination of a very small second dorsal lobe of valva, unique phallus (see Fig. 221), and angular median lobes of uncus in the male genitalia distinguishes *A. heliopsisella* from all other *Astrotischeria*, including other members of the *A. trilobata* group. The fact that it feeds on *Ambrosia* and *Heliopsis* also makes this species distinctive.

Male (Fig. 217). Forewing length about 4.0 mm; wingspan about 8.6 mm. Head: face and palpi ochre cream; frontal tuft comprised of wide, cream lamellar scales and, centrally, slender lamellar pale brown scales; collar comprised of wide, white cream lamellar scales; antenna distinctly longer than half the length of forewing; flagellum ochre cream with some dark brown scales; sensillae long, distinctive. Thorax and tegula ochre cream, with a few pale brown scales; Forewing relatively wide, cream, sparsely speckled with pale brown, brown, black-brown and orange-yellow scales; the dark scales form irregular, oblique, stripe-like patches; fringe yellow-ochre on termen, pale brown on costa and tornus; fringe-line distinct; forewing underside brown, without androconia. Hindwing slender, pale brown (at certain angle of view grey) on both upper and underside, without androconia; fringe pale brown. Legs ochre cream, speckled with dark grey-brown scales on upper side. Abdomen grey-brown on upper side, brownish cream on underside; anal tuft distinct, brownish cream, comprised of piliform and, laterally, slender lamellar scales.

Female. Similar to male.

Male genitalia (Figs. 218–224). Capsule about 660 µm long, 250–280 µm wide. Uncus consisting of two long lateral lobes and very short, angular median lobes (Fig. 218). Valva divided (Figs. 222, 223): ventral lobe slender and straight (Figs. 219, 220), about 370–390 µm long, 60 µm wide; dorsal lobe very large, curved inwardly (Figs. 219, 220), with a short, lobe-like outgrow (Figs. 222, 223); transtilla absent; basal process of valva relatively short (Figs. 219, 222). Anellus weakly developed, indistinct in slide no. 28952 (BMNH), but well-developed and illustrated in Braun 1972: Fig. 92. Phallus (Figs. 221, 224) about 400 µm long, distally widely bifurcated, without spines (Fig. 221).

Female genitalia. Illustrated in Braun (1972: Fig. 138).

Bionomics. Host plants: *Heliopsis helianthoides* (L.) Sweet, *Ambrosia* spp. (including *A. trifida* L.) (Asteraceae). Leaf mine blotch-like (illustrated in Braun 1972: Fig. 48). Larvae of the earlier generation mine in June, later generation in late August—early September; adults known from late March–May and June–August (Braun 1972).

Distribution (Fig. 233). The species occurs in USA (Ohio, New Jersey, Kentucky, Texas, California) (see Remarks).

Remarks. In this paper, we add a new distribution record for *A. heliopsisella* in mountainous East Coast of the USA (Fig. 233) on the basis of our studied and illustrated specimen from California (Figs. 218–224), reared on *Ambrosia*. The studied specimen (slide no. 28952 BMNH) slightly differs from the A. Braun's drawing of the specimen from Ohio (Braun 1972: Fig. 92), also reared also on *Ambrosia*, in the wider apical lobes of phallus, wider dorsal lobe of valva, shape of median lobes of uncus, and the basally slender valva (unfortunately, anellus is missing in slide no. 28952, therefore it is not possible to compare it with A. Braun's drawing). We assume that these differences are probably a result of different illustration techniques, or possibly also geographical variation in the genitalia. At this stage of knowledge we refrain from describing a new species and, therefore, treat *A. heliopsisella* as a slightly variable species distributed across the USA, from the East Coast to the mountains of California.

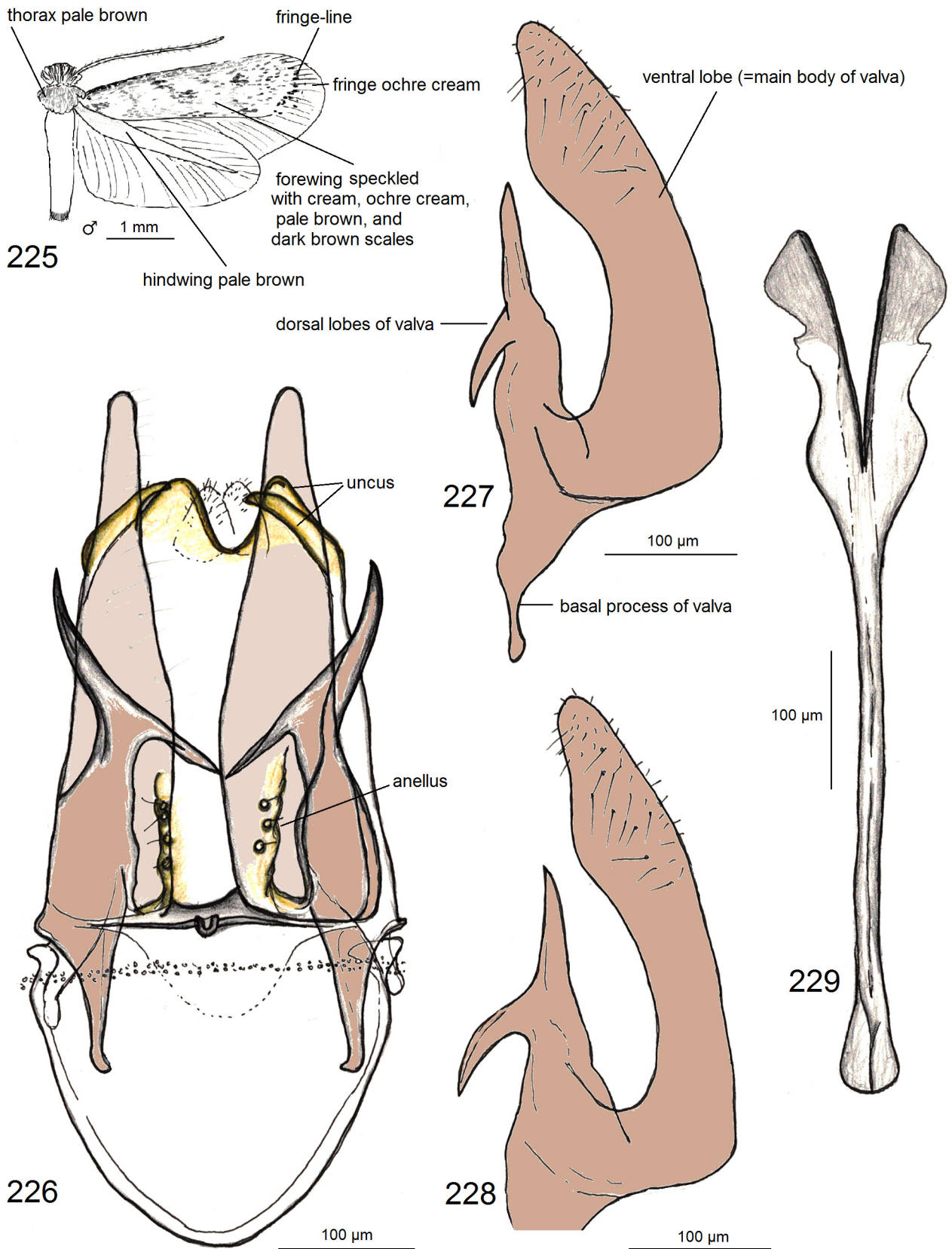
***Astrotischeria ambrosiaeella* (Chambers, 1875)** (Figs. 14, 225–229, 233)

Tischeria ambrosiaeella Chambers, 1875: 112, 113.

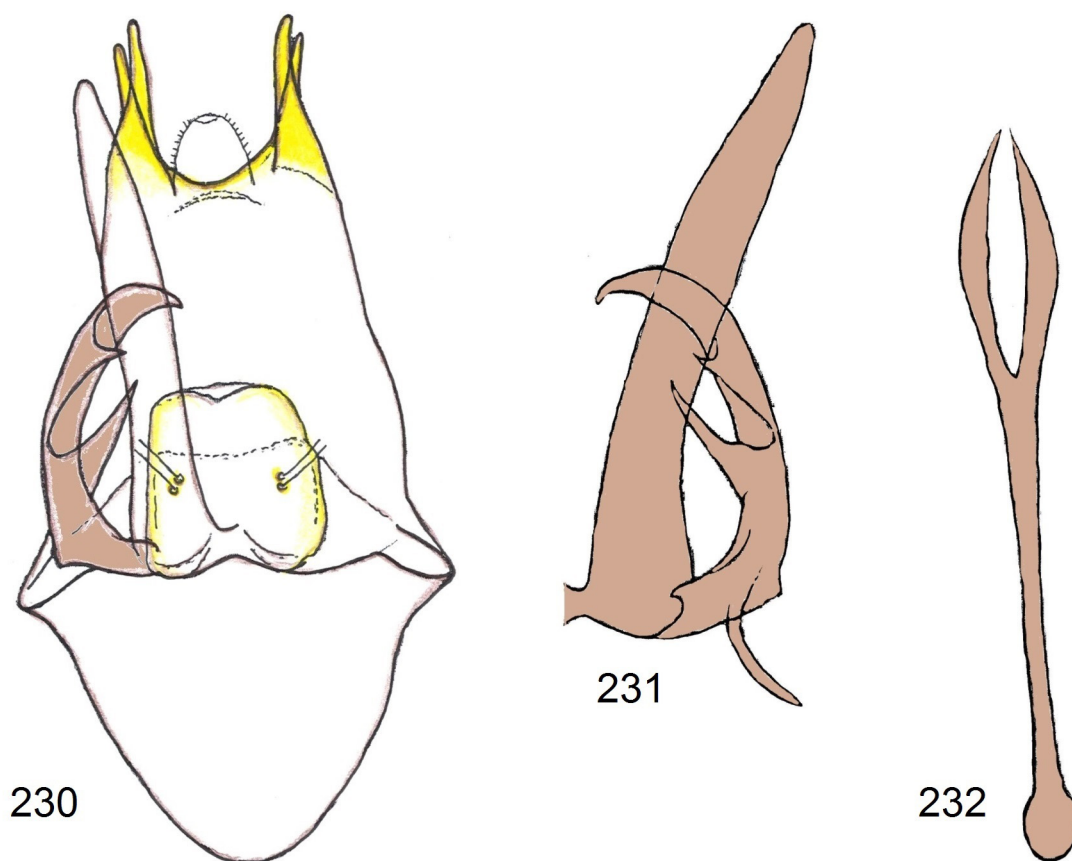
Tischeria ambrosiaeella Chambers, in Forbes (1923: 147); Braun (1972: 77–79).

Tischeria ambrosiella Walsingham, 1890: 325. Misspelling.

Astrotischeria ambrosiaeella (Chambers); Diškus & Puplesis (2003: 427).



FIGURES 225–229. *Astrotischeria ambrosiaeella* (Chambers, 1875), Kirkwood, St. Louis, on *Ambrosia trifida*, 13.ix.1886, Walsingham collection (BMNH). 225, male adult; 226, male genitalia with phallus removed, genitalia slide no. 28951; 227, 228, same, lateral view of valva; 229, same, phallus.



FIGURES 230–232. *Astrotischeria occidentalis* (Braun, 1972), male genitalia (after Braun 1972, modified). 230, capsule with phallus and right valva removed; 231, right valva; 232, phallus.

Material examined. 1 ♂, 1 ♀, USA: Missouri, Kirkwood, St. Louis, mining larvae on *Ambrosia trifida* (Asteraceae), 13.ix.1886, ex. pupa 9.i.1890, Lord Walshingham Collection (BMNH); 1 ♂, 1 ♀, same label but without host-plant data, [leg. Miss Murtfeldt], Lord Walshingham Collection, genitalia slide nos 28951♂, 28962♀ (BMNH).

Diagnosis. The species belongs to the *Astrotischeria trilobata* group. The combination of the very distinctive, unique, horn-shaped dorsal lobes of valva (see Figs. 226–228), unique shape of the phallus (see Fig. 229), and a rather large but short uncus in the male genitalia distinguishes *A. ambrosiaeella* from all other *Astrotischeria*, including other members of the *A. trilobata* group. The fact that it feeds on *Ambrosia* also makes this species rather distinctive.

Male (Fig. 225). Forewing about 3.5–3.6 mm; wingspan about 7.5–7.7 mm. For a description see Braun 1972: 77, 78.

Female. Similar to male.

Male genitalia (Figs. 226–229). Described in Braun 1972: 78.

Female genitalia. Described and illustrated in Braun 1972: 78, Fig. 39 (only apophyses and prela).

Bionomics. Host plants: *Ambrosia trifida* L., *A. artemisiifolia* L., also possibly *A. psilostachya* DC. (Braun 1972). Leaf mine is an irregular, elongated blotch, usually between two veins (illustrated in Braun 1972: Fig. 49). Larvae recorded from July, September and October; adults from August–November (Braun 1972: 78).

Distribution (Fig. 233). USA (Pennsylvania, Ohio, Kentucky, Missouri, California).

Astrotischeria occidentalis (Braun, 1872)

(Figs. 13, 230–232, 233)

Tischeria occidentalis Braun, 1872: 73–75

Astrotischeria occidentalis (Braun); Diškus & Puplesis (2003: 428).

Diagnosis. The species belongs to the *Astrotischeria trilobata* group. The combination of the very slender and long lobes of uncus, and the unique dorsal lobes of valva in the male genitalia (see Fig. 13) distinguishes *A. occidentalis* from all other *Astrotischeria*, including other members of the *A. trilobata* group. The fact that it feeds on *Aster* also makes this species distinctive.

Male. Wingspan about 7–8 mm. For a description see Braun 1972: 73, 74.

Male genitalia (Figs. 13, 230–232). Described in Braun 1972: 74.

Female genitalia. Apophyses illustrated by Braun 1972: Fig. 137.

Bionomics. Host plant: *Aster* sp., Asteraceae.

Distribution (Fig. 233). USA (Wyoming: Grand Teton National Park).

Discussion

Species groups are fully informal units. For diagnostic purposes, species groups are widely in use, e.g., in the Nepticulidae (see Stonis *et al.* 2013, 2016b, 2017b, 2018) and Elachistidae (see e.g. Kaila 2011, 2015, Kaila *et al.* 2015). Previously there were no species groups designated in the genus *Astrotischeria*. In this paper, the *A. trilobata* group is designated purely for diagnostic purposes. Despite the striking transformation of the valva into a three-lobed structure, the group still could be paraphyletic. Unusually for the group (and the genus) one species, *A. onae* sp. nov., possesses a bilobed uncus with rather long lateral lobes. In all other species of the *A. trilobata* group the uncus is rather short, four-lobed and comprises two slender, lateral lobes, and two short, rounded, median lobes; the latter may be merged together. Valval dorsal lobes (also in the shape of a horn-like process) are differently developed and, therefore, they could be non-homologous (e.g. compare *A. furcata* in Figs. 16, 17 and *A. onae* in Figs. 18, 19). We also noticed some differences in the female genitalia: a chitinized plate of prela can be present or absent, processes of prela are greatly extended or not extended, ductus spermathecae are with different number of small or large coils. Although it is desirable to have monophyletic species groups, this is not a requirement for informal entities. Therefore, the current designation of the *trilobata* group, even if paraphyletic, does not contradict with the diagnostic purpose of the group.

Two of the treated species of the *A. trilobata* group appeared to be oligophagous: *Astrotischeria selvica* feeding on *Sphagneticola*, *Synedrella* and *Tilesia*, and *A. heliopsiella* feeding on *Heliopsis* and *Ambrosia*. Five other species, each with a single host plant known, could be monophagous. However, we expect that further research and discovery of more host plants may reveal that oligophagy is more common among the species of the *A. trilobata* group than currently known.

Globally, Tischeriidae are already recognized to feed on eighteen plant families from Rosids and Asterids (Fig. 249). Almost all studied *Astrotischeria* species, except for *A. omissa* (Braun), feed only on Asteraceae. So far, no Asteraceae-feeding Tischeriidae are known outside of the Americas but there they are diverse, making the American Tischeriidae fauna rather unique. Seven out of eleven species of the *A. trilobata* group were reared from host plants belonging to Asteraceae; we assume that all species of the group feed on Asteraceae because feeding on Asteraceae is so characteristic for the genus in general.

The species of the *A. trilobata* group feed exclusively on three tribes of Asteroidea: Eupatorieae, Heliantheae and Astereae. Most of the species are associated with Heliantheae (Fig. 250). Likewise, this plant tribe also hosts the majority of other *Astrotischeria* species, both described ones, as well as species in preparation for description (Stonis & Diškus, unpublished).

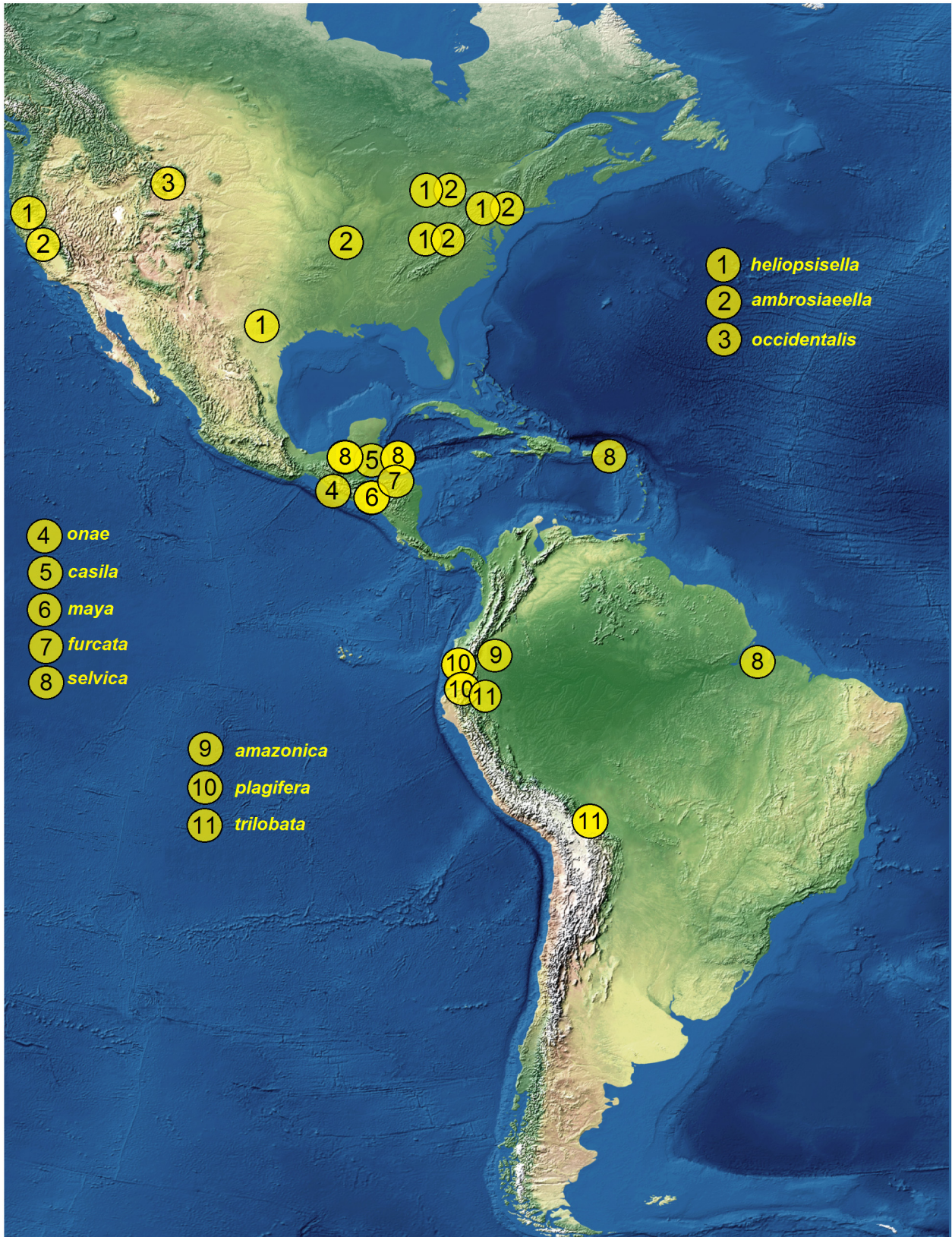


FIGURE 233. Distribution map. Currently known species of the *Astrotischeria trilobata* group. (Map base—courtesy of Tom Patterson, the United States National Park Service in Harpers Ferry, West Virginia, USA). Note: also see Remarks in the text on *A. heliopsisella* (Chambers).



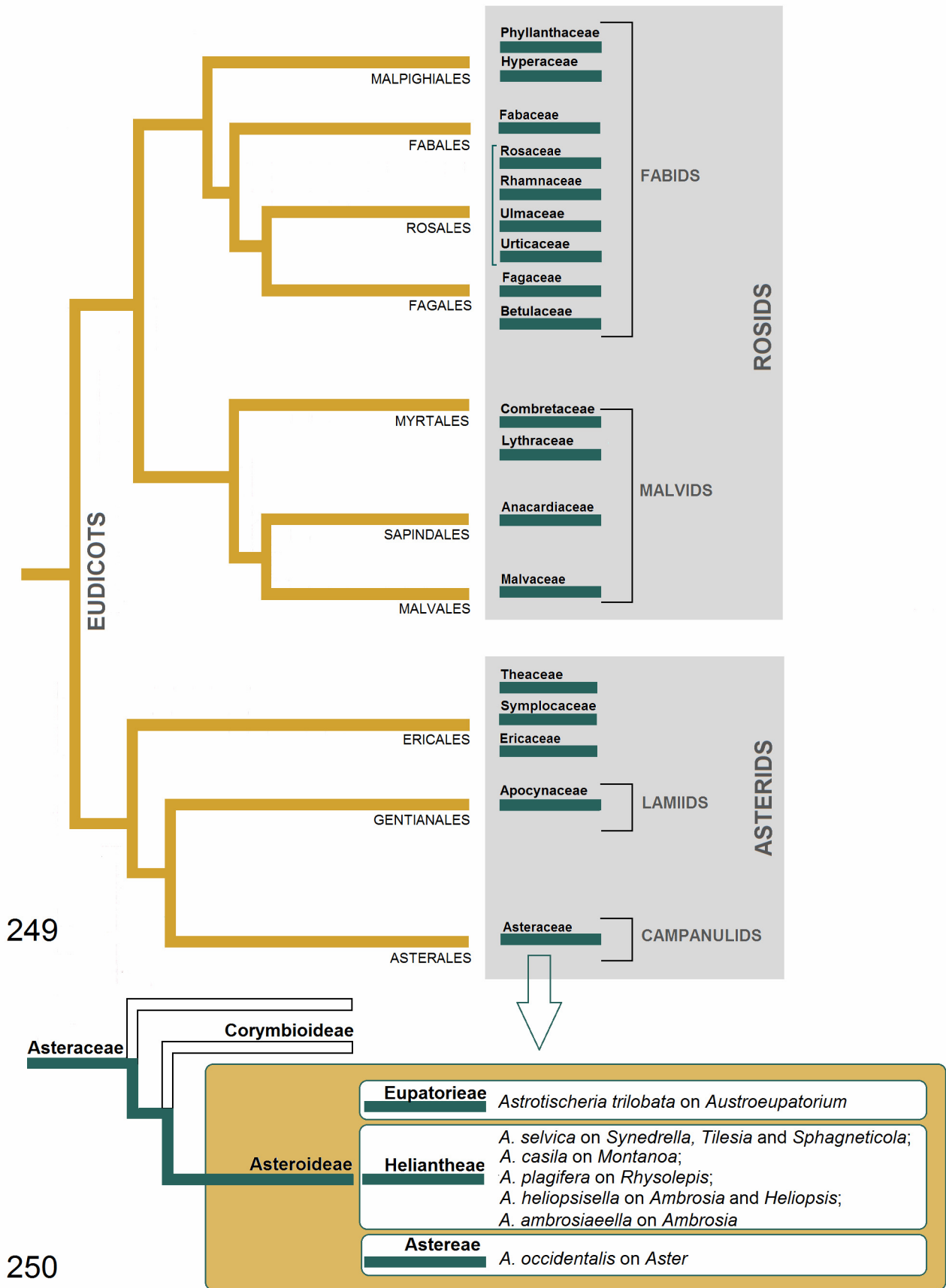
FIGURES 234–238. Habitats of *Astrotischeria* species. 234, 235, *A. maya* Diškus & Stonis, **sp. nov.**, Copán Archaeological Site Ruinas, Honduras, 14°50'13"N, 89°08'37"W, elevation ca. 620 m; 236, *A. selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.**, Tikal National Park, Guatemala, 17°13'28"N, 89°37'10"W, elevation 290 m; 237, 238, *A. selvica* Diškus, Carvalho-Filho & Stonis, **sp. nov.** and *A. casila* Diškus & Stonis, **sp. nov.**, Las Cuevas, Belize, 16°43'58"S, 88°59'06"W, elevation 580 m. Fig. 237—courtesy of Las cuevas Biological Station and Alex Monro, the Royal Botanic Gardens, Kew, London).



FIGURES 239–244. Habitats of *Astrotischeria* species. 239, 240, *A. furcata* Stonis & Diškus, **sp. nov.**, Las Cuevas, Belize, 16°43'58"S, 88°59'06"W, elevation 590 m; 241–244, *A. amazonica* Diškus & Stonis, **sp. nov.**, Misahualli, Ecuador, 1°01'28"S, 77°40'02"W, elevation 440 m (244—collector Arūnas Diškus, 2007).



FIGURES 245–248. Habitats of *Astrotischeria* species. 245–247, *A. trilobata* Diškus & Stonis, **sp. nov.** and *A. plagifera* (Meyrick, 1915), Vilcabamba, Ecuador, 4 °16'06"S, 79 °10'40"W, elevation 1990 m; 248, *A. trilobata* Diškus & Stonis, **sp. nov.**, Coroico, Bolivia, 16 °11'54"S, 67°43'13"W, elevation 1650 m.



FIGURES 249–250. Host-plant clades engaged by Tischeriidae. 249, clades of Eudicots engaged by the family Tischeriidae; 250, trophic specialization of the species of the *Astrotischeria trilobata* group.

Recent studies of another leaf-mining family, Nepticulidae, reveal that Asteraceae also hosts the greatest diversity of leaf-mining species of *Stigmella* in South America. It should, however, be noted that the Asteraceae-feeding Nepticulidae are extremely poorly known from all other regions of the world, except South America (Stonis *et al.* 2018). It is unknown why some *Stigmella* (Nepticulidae) and *Astrotischeria* (including the *A. trilobata* group) have been so successful on Asteraceae in the New World. Possibly this pattern is somehow tied to the origin or extraordinary diversity of Asteraceae in the western hemisphere: the earliest fossils confidently assigned to Asteraceae suggest a South American-Antarctica origin of this plant family (Barreda *et al.* 2010, 2012). However, the species of the *A. trilobata* group (or remaining *Astrotischeria*) are highly apomorphic to compare with the majority of Tischeriidae; they are also associated with the most derived host plants within Asteraceae, not with the basal lineages.

Recent studies of Asteraceae richness and taxonomic diversity show that Central and South America have the highest number of genera and species (Katinas *et al.* 2007). The Asteraceae flora of South America contains about 6316 species, North America about 5404 (Panero & Crozier 2016), Mesoamerica alone 1375 species in 255 genera; for tropical America as a region, there are about 8040 Asteraceae species belonging to 580 genera (Prunski & Sancho 2004). Indeed, the Americas is a vast region with an extraordinary diversity of host plants and habitats suitable for the Tischeriidae. It is interesting that some Asteraceae tribes which are the most preferred by *Astrotischeria* species, like Heliantheae or Eupatorieae, are largely found in the Neotropics and mostly represented by native species (Prunski & Sancho 2004).

Earlier it was hypothesized that Tischeriidae are probably more speciose in Central America than anywhere else in world (Puplesis & Diškus 2003). This statement is now further supported by the addition of our currently described species, and also because large, currently undescribed Tischeriidae material recently collected by us in Central America awaits publication.

Acknowledgements

We are indebted to Prof. Liliana Katinas (División Plantas Vasculares, Museo de La Plata, La Plata, Argentina), Dr. Pedro Lage Viana (Belém, Brazil), Dr. Nixon Cumbicus Torres (Departamento de Ciencias Naturales, Universidad Técnica Particular de Loja, Ecuador), and Caroline Whitefoord (The Natural History Museum, London) for identification of the host plants. We are also grateful to Dr. David C. Lees (BMNH) for the loan of the material. Dr. Arūnas Diškus thanks Modestas Jocius (Vilnius, Lithuania) for his kind assistance in investigating the Tischeriidae fauna of the Neotropics. This study was supported in part by the Research Foundation of the Lithuanian University of Educational Sciences (2018).

References

- Barreda, V.D., Palazzesi, L., Katinas, L., Crisci, J.V., Tellería, M.C., Bremer, K., Passalia, M.G., Bechis, F. & Corsolini, R. (2012) An extinct Eocene taxon of the daisy family (Asteraceae): evolutionary, ecological, and biogeographical implications. *Annals of Botany*, 109, 127–134.
<https://doi.org/10.1093/aob/mcr240>
- Barreda, V.D., Palazzesi, L., Tellería, M.C., Katinas, L., Crisci, J.V., Bremer, K., Passalia, M.G., Corsolini, R., Rodríguez Brizuela, R. & Bechis, F. (2010) Eocene Patagonia fossils of the daisy family. *Science*, 329 (5999), 1621.
<https://doi.org/10.1126/science.1193108>
- Bourquin, F. (1962) Microlepidopteros nuevos con sus biologías. *Revista de la Sociedad Entomológica Argentina*, 23, 31–46.
- Braun, A.F. (1927) Descriptions of new Microlepidoptera. *Transactions of the American Entomological Society*, 53 (3), 191–199.
- Braun, A.F. (1972) Tischeriidae of America North of Mexico (Microlepidoptera). *Memoirs of the American Entomological Society*, 28, 1–148.
- Bua, A., Usai, D., Donadu, M.G., Delgado Ospina, J., Paparella, A., Chaves-Lopez, C., Serio, A., Rossi, C., Zanetti, S. & Molicotti, P. (2017) Antimicrobial activity of *Austroeupatorium inulaefolium* (H.B.K.) against intracellular and extracellular organisms. *Natural Product Research*. [published online]
<https://doi.org/10.1080/14786419.2017.1385014>
- Chambers, V.T. (1875) Tineina of the Central United States. *The Cincinnati Quarterly Journal of Science*, 2 (2), 97–121.
- Davis, D.R. (1999) The Monotrysiian Heteroneura. In: Kristensen, N.P. (Ed.), *Lepidoptera: Moths and Butterflies*. Vol. 1.

- Evolution, Systematics, and Biogeography. *Handbuch der Zoologie/Handbook of Zoology. IV/35*. Walter de Gruyter, Berlin and New York, pp. 65–90.
- Diškus, A. & Puplesis, R. (2003) Catalogue of the world Nepticuloidea & Tischerioidea. In: Puplesis, R. & Diškus, A. (Eds.), *The Nepticuloidea & Tischerioidea (Lepidoptera)—a global review, with strategic regional revisions. Monograph*. Lututė, Kaunas, pp. 318–436.
- Diškus, A. & Stonis, J.R. (2012) *Leaf-mining insects of Lithuania. The Nepticulidae (Lepidoptera): taxonomy, chorological composition and trophic relationships. Monograph*. Lututė Publishers, Kaunas, 220 pp. [in Lithuanian]
- Diškus, A. & Stonis, J.R. (2015) *Astrotischeria neotropicana* sp. nov.—a leaf-miner on *Sida*, Malvaceae, currently with the broadest distribution range in the Neotropics (Lepidoptera, Tischeriidae). *Zootaxa*, 4039 (3), 456–466.
- Diškus, A., Stonis, J.R. & Cumbicus Torres, N. (2014) First discovery of leaf-mining Nepticulidae and Tischeriidae (Lepidoptera) associated with the Chilean endemic genus *Podanthus* Lag. (Asteraceae) as a host-plant. In: Stonis, J.R., Hill, S.R., Diškus, A. & Auškalnis, T. (Eds.), *Selected abstracts and papers of the First Baltic International Conference on Field Entomology and Faunistics*. Edukologija Publishers, Vilnius, pp. 30–31.
- Forbes, W.T.M. (1923) *Lepidoptera of New York and neighboring states: primitive forms, Microlepidoptera, pyraloids, bombyces*. Cornell University. Agricultural Experiment Station, Ithaca, New York, 729 pp.
- Frey, H. & Boll, J. (1876) Einige Tineen aus Texas. *Entomologischen Zeitung herausgegeben von dem entomologischen Vereine zu Stettiner*, 37 (4–6), 209–228.
- Frey, H. & Boll, J. (1878) Tineen aus Texas. *Entomologischen Zeitung herausgegeben von dem entomologischen Vereine zu Stettiner*, 39 (7–9), 249–279.
- Heppner, J.B. (2008) Trumpet leafminer moths (Lepidoptera: Tischeriidae). In: Capinera, J.L. (Ed.), *Encyclopedia of Entomology*. Springer, Dordrecht. [published online]
https://doi.org/10.1007/978-1-4020-6359-6_2575
- Huang, G.-H. & Tan, J.-C. (2009) New records of a genus and a species of the family Tischeriidae (Lepidoptera) from China. *Entomotaxonomia*, 31 (1), 58–61.
- Kaila, L. (2011) Elachistine moths of Australia (Lepidoptera: Gelechioidea: Elachistidae). *Monographs on Australian Lepidoptera. Vol 11*. CSIRO Publishing, Melbourne, x + 443 pp.
- Kaila, L. (2015) The *Elachista dispunctella* (Duponchel) complex (Lepidoptera, Elachistidae) revisited, with exceptional level of synonymy. *Zootaxa*, 3980 (3), 301–358.
<https://doi.org/10.11646/zootaxa.3980.3.1>
- Kaila, L., Baran, T. & Mutanen, M. (2015) A revision of the *Elachista dispilella* complex (Lepidoptera: Gelechioidea: Elachistidae). *Zootaxa*, 3963 (4), 517–560.
<https://doi.org/10.11646/zootaxa.3963.4.3>
- Katinas, L., Gutiérrez, D.G., Grossi, M.A. & Crisci, J.V. (2007) Panorama de la familia Asteraceae (= Compositae) en la República Argentina. *Boletín de la Sociedad Argentina de Botánica*, 42 (1–2), 113–129.
- Karsholt, O. & Nieuwerkerken, van E.J. (2013) Fauna Europaea: Tischeriidae. In: Karsholt, O. & Nieuwerkerken, van E.J. (Eds.), *Fauna Europaea: Lepidoptera, Moths*. Fauna Europaea, Version 2.6.2. Available from: <http://www.faunaeur.org/> (accessed 5 February 2018)
- Kobayashi, S., Sato, H., Hirano, N., Yamada, K. & Hirowatari, T. (2016) A review of the Japanese species of the family Tischeriidae (Lepidoptera). *ZooKeys*, 601, 127–151.
<https://doi.org/10.3897/zookeys.601.7782>
- Koçak, A.Ö. & Kemal, M. (2012) List of the hitherto recorded pterygot taxa of Turkey (Insecta) (Temporary report of the Entomofauna Project of Turkey-10). *Centre for Entomological Studies Ankara, Memoirs*, 6, i–iv + 1–1649, 1 fig. Available from: <https://archive.org/details/CentreForEntomologicalStudiesAnkaraMemoirs6> (accessed 5 February 2018)
- Kurz, M.A. & Embacher, G. (2016) Die Scythrididae und Tischeriidae (Lepidoptera) des Bundeslandes Salzburg, Österreich. *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen*, 68, 39–43.
- Kuznetsov, V.I. (1994) Sem. Tischeriidae—odnotsvetnye moli-minery. In: Kuznetsov, V.I. (Ed.), *Insects and mites—pests of agricultural plants. Lepidoptera. 3 (1)*. Nauka Publishers, St. Petersburg, pp. 23–25. [in Russian]
- Landry, B. & Roque-Albelo, L. (2004) First report of Tischeriidae (Lepidoptera) on the Galapagos Islands, Ecuador, with descriptions of two new endemic species. *Revue suisse de Zoologie*, 111 (3), 599–609.
<https://doi.org/10.5962/bhl.part.80255>
- Laštuvka, A. & Laštuvka, Z. (2015) New records of Lepidoptera from the Iberian Peninsula for 2015 (Insecta: Lepidoptera). *SHILAP Revista de Lepidopterologia*, 43 (172), 633–644. Available from: <http://www.redalyc.org/pdf/455/45543699008.pdf> (accessed 31 August 2018)
- Lees, D.C. & Stonis, J.R. (2007) The first record of Tischeriidae (Insecta: Lepidoptera) from Madagascar, with description of *Coptotriche avelona* sp. n. and an update distributional checklist of Afrotropical Tischeriidae. *Zootaxa*, 1645, 35–45.
- Lewis, O.T., Memmott, J., LaSalle, J., Lyal, C.H., Whitefoord, C. Godfray, H.C.J. (2002) Structure of a diverse tropical forest insect–parasitoid community. *Journal of Animal Ecology*, 71, 855–873.
<https://doi.org/10.1046/j.1365-2656.2002.00651.x>
- Mey, W. (2010) Two new species of Tischeriidae from East Africa (Lepidoptera, Tischerioidea). *Esperiana Memoir*, 5, 337–340.
- Meyrick, E. (1908) New Microlepidoptera from India and Burma. *Records of the Indian Museum*, 2 (4), 395–400.

- Meyrick, E. (1911) Descriptions of Transvaal Micro-Lepidoptera. *Annals of the Transvaal Museum*, 2 (4), 218–240.
- Meyrick, E. (1915a) *Exotic Microlepidoptera*, 1 (12), 353–384.
- Meyrick, E. (1915b) Descriptions of South American Micro-Lepidoptera. *The Transactions of the Entomological Society of London*, 48 (2), 201–256.
- Meyrick, E. (1934) *Exotic Microlepidoptera*. 4 (15). Printed by Taylor and Francis, London, 32 pp. [pp 449–480]
- Meyrick, E. (1936) *Exotic Microlepidoptera*. 5 (2). Printed by Taylor and Francis, London, 32 pp. [pp. 33–64]
- Navickaitė, A., Diškus, A., Stonis, J.R. & Dobrynina, V. (2011) Taxonomic catalogue of the world Nepticuloidea and Tischerioidea (Lepidoptera) described by members of the Biosystematics Research Group (Lithuania) up to 2009. *Acta Zoologica Lituanica*, 21 (2), 113–132.
<https://doi.org/10.2478/v10043-011-0014-2>
- Nieukerken, van E.J. (2010) Order Lepidoptera, family Tischeriidae. In: Harten, van A. (Ed.), *Arthropod fauna of the United Arab Emirates. Vol. 3. Dar Al Ummah, Abu Dhabi*, pp. 515–518.
- Panero, J.L. & Crozier, B.S. (2016) Macroevolutionary dynamics in the early diversification of Asteraceae. *Molecular Phylogenetics and Evolution*, 99, 116–132.
<https://doi.org/10.1016/j.ympev.2016.03.007>
- Prunski, J.F. & Sancho, G. (2004) Asteraceae or Compositae (Aster or Sunflower Family). In: Smith, N., Mori, S.A., Henderson, A., Stevenson, D.W. & Heald, S.V. (Eds.), *Flowering Plants of the Neotropics*. Princeton University Press, Princeton, pp. 33–39.
- Puplesis, R. (1994) *The Nepticulidae of Eastern Europe and Asia: western, central and eastern parts*. Backhuys Publishers, Leiden, 291 pp., figs. 840.
- Puplesis, R. & Diškus, A. (2003) *The Nepticuloidea & Tischerioidea (Lepidoptera)—a global review, with strategic regional revisions*. Monograph. Lututė, Kaunas, 512 pp., figs 612.
- Puplesis, R. & Diškus, A. (2005) Checklist of African Tischeriidae (Insecta: Lepidoptera) with a Redescription of the Formerly Neglected *Tischeria urticicolella* from Equatorial Africa. *Zoological Science*, 22 (9), 1051–1055.
<https://doi.org/10.2108/zsj.22.1051>
- Puplesis, R., Diškus, A. & Mey, W. (2004) Tischeriidae. In: Mey, W. (Ed.), *The Lepidoptera of the Brandberg Massif in Namibia. Esperiana Memoir, Berlin*, 1, pp. 39–51.
- Puplesis, R. & Robinson, G.S. (2000) A review of the Central and South American Nepticulidae (Lepidoptera) with special reference to Belize. *Bulletin of the Natural History Museum, London, Entomology*, 69 (1), 1–114.
- Sato, H. (2011) Tischeriidae. In: Komai, F., Yoshiyasu, Y., Nasu, Y. & Saito, T. (Eds.), *A guide to the Lepidoptera of Japan*. Tokai University Press, pp. 128, 559, figs II-14.3A, B.
- Sinev, S.Yu. (2008) Tischeriidae. In: Sinev, S. Yu. (Ed.), *Catalogue of the Lepidoptera of Russia*. KMK Scientific Press., St. Petersburg, Moscow, pp. 27.
- Stonis, J.R. & Diškus, A. (2007) Distribution of *Tischeria gouaniae* sp. n. from the tropical forest of Belize—an exotic new addition to the American fauna of *Tischeria* (Insecta: Lepidoptera: Tischeriidae). *Zoological Science*, 24 (12), 1286–1291.
<https://doi.org/10.2108/zsj.24.1286>
- Stonis, J.R. & Diškus, A. (2008) Checklist of American *Coptotriche* (Insecta: Lepidoptera: Tischeriidae) with descriptions of two new species from the tropical forest of Belize (Central America). *Zoological Science*, 25 (1), 99–106.
<https://doi.org/10.2108/zsj.25.99>
- Stonis, J.R., Diškus, A., Katinas, L. & Solis, M.A. (2018) Asteraceae: host to the greatest diversity of leaf-mining Nepticulidae (Lepidoptera) in South America? *Proceedings of the Entomological Society of Washington*. [in press]
- Stonis, J.R., Diškus, A., Paulavičiūtė, B. & Monro, A.K. (2017a) Urticaceae-feeders from the family Tischeriidae: descriptions of two new species and new genus *Paratischeria* gen. nov. *Biologija*, 63 (1), 1–22.
- Stonis, J.R., Diškus, A., Remeikis, A. & Cumbicus Torres, N. (2016a) First description of leaf-mining Nepticulidae and Tischeriidae (Insecta, Lepidoptera) feeding on the Chilean endemic plant genus *Podanthus* Lag. (Asteraceae). *Zootaxa*, 4061 (2), 119–130.
<https://doi.org/10.11646/zootaxa.4061.2.2>
- Stonis, J.R., Diškus, A., Remeikis, A., Gerulaitis, V. & Karsholt, O. (2016b) Leaf-mining Nepticulidae (Lepidoptera) from record high altitudes: documenting an entire new fauna in the Andean páramo and puna. Monograph. *Zootaxa*, 4181 (1), 1–94.
<https://doi.org/10.11646/zootaxa.4181.1.1>
- Stonis, J.R., Diškus, A., Remeikis, A., Karsholt, O. & Cumbicus Torres, N. (2017b) Illustrated review of the leaf-mining Nepticulidae of the central Andes (Peru and Bolivia). Monograph. *Zootaxa*, 4257 (1), 1–70.
<https://doi.org/10.11646/zootaxa.4257.1.1>
- Stonis, J.R., Diškus, A., Remeikis, A., Navickaitė, A. & Rocienė, A. (2013) Description of new species of oak leaf-miners (Lepidoptera: Nepticulidae), with notes on the species groups of *Stigmella* Schrank associated with *Quercus* as a host-plant. *Zootaxa*, 3737 (3), 201–222.
- Stonis, J.R., Diškus, A., Rocienė, A., Sruoga, V. & Davis, D.R. (2014) New and little known *Coptotriche* and *Tischeria* species (Lepidoptera: Tischeriidae) from Primorskiy Krai, Russian Far East. *Zootaxa*, 3884 (2), 141–155.
<https://doi.org/10.11646/zootaxa.3884.2.3151>
- Stonis, J.R., Diškus, A. & Sruoga, V. (2008) Redescription of *Coptotriche pulvereae* (Walsingham)—an unusual species of the

- American Tischeriidae fauna (Insecta: Lepidoptera). *Acta Zoologica Lituanica*, 18 (3), 169–173.
<https://doi.org/10.2478/v10043-008-0023-y>
- Walsingham, Lord. (1890) Steps towards a revision of Chambers's index, with notes and descriptions of new species. *Insect life*, 2 (10), 322–326.
- Xu, J., Dai, X., Liao, C., Diškus, A. & Stonis, J.R. (2018) Discovery of Ulmaceae-feeding Tischeriidae (Lepidoptera, Tischerioidea), *Tischeria ulmella* sp. nov., and the first report of the *Quercus*-feeding *T. naraensis* Sato in China. *Zootaxa*, 4399 (3), 361–370.
<https://doi.org/10.11646/zootaxa.4399.3.6>
- Xu, J., Dai, X., Liu, P., Bai, H., Diškus, A. & Stonis, J.R. (2017) First report on *Paratischeria* from Asia (Lepidoptera: Tischeriidae). *Zootaxa*, 4350 (2), 331–344.
<https://doi.org/10.11646/zootaxa.4350.2.8>
- Zeller, P.C. (1839) Versuch einer naturgemässen Eintheilung der Schaben, Tinea. *Isis*, 32 (3), 167–224.