



Diagnostics of *Manitischeria* gen. nov., an Old-World genus of leaf-mining Tischeriidae, composed of new species and species formerly in *Tischeria* Zeller

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Abstract

We describe a new genus, *Manitischeria* Diškus & Stonis, **gen. nov.**, and five new species: *Manitischeria selindica* Stonis & Diškus, **sp. nov.**, *M. namibiensis* Stonis & Diškus, **sp. nov.** from Africa, and *M. brachiata* Diškus & Stonis, **sp. nov.**, *M. symbolica* Diškus & Stonis, **sp. nov.**, and *M. baryshnikovae* Diškus & Stonis, **sp. nov.** from South East Asia. We discuss the diagnostics of *Manitischeria* **gen. nov.** composed of these new species and others transferred from *Tischeria* Zeller. Species are mostly trophically associated with Malvaceae, but also Rhamnaceae and Betulaceae. We list 18 currently known species of *Manitischeria* **gen. nov.**, including *M. ptarmica* (Meyrick), the type species, and provide 13 new combinations and the first documentation of genitalia of some, previously little-known species. New species are illustrated with photographs or drawings of the adults, genitalia, and the leaf mines when available. We briefly discuss the use of herbarium specimens to discover lepidopteran leaf mines, host plant, and distribution data.

Key words: fauna, leaf mines, new species, trumpet moths

Introduction

Tischeriidae, commonly known as trumpet moths, is a small lepidopteran family of leaf miners comprised of 160 described species worldwide (Stonis *et al.* 2019c, 2020b), including the five new species described here. Larvae of trumpet moths are obligatory leaf miners, i.e., all instars live, feed, and pupate inside plant leaves. Adults of Tischeriidae are medium small, with a wingspan ranging from 6.5 to 7.3 mm, but some tischeriids are smaller than average with a wingspan of only 4.1 mm, but some are larger than average with a wingspan of 11 mm (Stonis *et al.* 2021). Adults possess various distinctive diagnostic characters not discussed here, but extensively reviewed by Braun (1972) and Puplesis & Diškus (2003), and briefly listed by Stonis *et al.* (2018) and Stonis & Solis (2020).

Tischeriidae occur from tropical to temperate regions but are most abundant in the subtropics and tropics. The rich fauna of Tischeriidae was recently highlighted in a case from a tropical forest in Central America (Stonis *et al.* 2020a). On the other hand, the tischeriid fauna of South East Asia and East Asia are poorly surveyed (e.g., Stonis *et al.* 2014b; Kobayashi *et al.* 2016; Xu *et al.* 2017, 2018; Kim *et al.* 2019) and many new species in Asia await discovery. Recently two Tischeriidae species were reported from Korea (Kim *et al.* 2019). Prior to this study, *Dishkeya* Stonis, a New World endemic genus, was described bringing the total number of tischeriid genera (Stonis & Solis 2020) to five: *Tischeria* Zeller, 1839, *Coptotriche* Walsingham, 1890 (restored to generic status by Puplesis & Diškus 2003), *Astrotischeria* Puplesis & Diškus, 2003 (Puplesis & Diškus 2003); *Paratischeria* Diškus & Stonis, 2017 (Stonis *et al.* 2017), and *Dishkeya* Stonis, 2020 (Stonis & Solis 2020). A diagnostic scheme for differentiation of *Coptotriche*, *Astrotischeria*, and *Paratischeria* was provided by Xu *et al.* (2017);

and for differentiation of *Tischeria* and *Dishkeya* see Stonis & Solis (2020). A molecular phylogeny of the genera is under preparation and will be published separately (Stonis *et al.* in prep.).

Within the family, *Tischeria* represents a distinctive phylogenetic lineage at the generic rank. In the female genitalia it possesses an antrum, and in the male genitalia it is characterized by several characters. Notably, the lobes of the uncus are long and slender, the valva is slender and simple, without processes or lobes, the tegumen, at least anteriorly, is without a “frame-like” thickening, the juxta is distinctly separated from the phallus, and the phallus is wide and rounded basally (Stonis & Solis 2020).

Characteristics of some species, previously included in *Tischeria*, do not have the characters diagnostic for the genus. This group of species have a valva with a distinctive arm-like process, a juxta that is strongly connected with the phallus, and a tegumen with a frame-like thickening. Therefore, we erect a new genus for these species, *Manitischeria* **gen. nov.**, from Asia and Africa. Additionally, our unpublished molecular studies with mtDNA COI sequences confirm that there is a dichotomy between *Tischeria* and the new genus (Stonis *et al.* in prep.). The new genus is characterized by unique, derived characters (hypothesized apomorphies) listed in the diagnosis of the genus. The new genus was additionally supported by our discovery of five other, distinctive new species possessing the same derived generic characters.

We describe five new species, *Manitischeria selindica* Stonis & Diškus, **sp. nov.**, *M. namibiensis* Stonis & Diškus, **sp. nov.**, *M. brachiata* Diškus & Stonis, **sp. nov.**, *M. symbolica* Diškus & Stonis, **sp. nov.**, and *M. baryshnikovae* Diškus & Stonis, **sp. nov.** We designate a male lectotype and female paralectotype for *M. tyrocnistis* (Meyrick), a male lectotype and nine paralectotypes for *M. ptarmica* (Meyrick) and illustrate the genitalia of these species for the first time. We also provide the first photographic documentation of the little known East Asian *M. puplesisi* (Kozlov) and the South African *M. sparmanniae* (Puplesis & Diškus), and new distribution data for some species.

Material and methods

The dissections and the first documentation of *Manitischeria tyrocnistis* (Meyrick) and lectotype of *M. ptarmica* are based on material deposited at the Natural History Museum, London (NHMUK). For the first photographic documentation of the East Asian *Manitischeria puplesisi* (Kozlov), the holotype and one non-type specimen were borrowed from the Zoological Institute of the Russian Academy of Sciences, St. Petersburg (ZIN). The documentation of other African taxa, including the South African *M. sparmanniae* (Puplesis & Diškus), is based on the material deposited in the Zoological Museum, Natural History Museum of Denmark (ZMUC) and the Museum für Naturkunde, Berlin (MfN). Description of two new South African species is based on the material deposited in the Ditsong National Museum of Natural History, former Transvaal Museum of South Africa, Pretoria (TMSA). The descriptions of other new species are based on the material at the Lithuanian University of Educational Sciences, Vilnius, Lithuania (LEU, formerly abbreviated as VPU); this material, including the type series, in accordance with the agreement, will be transferred to ZIN due to the LEU closure.

The following protocols for Tischeriidae have been previously described: collecting and rearing of leaf mines by Stonis *et al.* (2018), and techniques of specimen dissection and genitalia mounts in Euparal by Stonis *et al.* (2014a). The descriptive terminology, with a few exceptions, follows Puplesis & Diškus (2003).

Permanent preparations on microscope slides were photographed and studied with a Leica DM2500 microscope and Leica DFC420 digital camera. Adults were measured and studied using Lomo stereoscopic microscopes MBS-10 and photographed using a Leica S6D stereoscopic microscope with attached a Leica DFC290 digital camera, except for Figs. 31–32 which were photographed using a Lomo MBS10 stereoscopic microscope and a temporarily attached Samsung Galaxy S7 cellular telephone with a camera.

Additionally, ca 1,000 plant specimens at the Herbarium of the Royal Botanic Gardens, Kew (U.K.) were surveyed for leaf mines of the *Zizyphus*-feeding *M. ptarmica*.

Description of a new genus, with a review of included species

Manitischeria Diškus & Stonis, gen. nov.

urn:lsid:zoobank.org:act:A9956778-8F3A-40C3-905B-D9291FF81237

(Figs. 1–36, 111)

Type species. *Manitischeria ptarmica* (Meyrick, 1908).

Diagnosis. External characters and wing venation characters are not informative or are insufficient for generic differentiation in most cases of Tischeriidae, including this new genus. In the male genitalia, species of the new genus are characterized by the presence of a long, lateral process of valva, an elaborate tegumen with thickened margins, a phallus with lateral extensions basally, and the elaborate or twisted joint of the tegumen with the vinculum; in the female genitalia the genus is characterized by a strongly developed antrum.

Description. *Adult.* Following the terminology provided by Stonis *et al.* 2021, most species are medium small with a wingspan of 6.1–8.3 mm, although one third of the species are small moths with a wingspan of 5.0–6.0 mm. The only exception is *M. ptarmica* which belongs to the category of very small moths, with some specimens recorded as small as 4.1 mm in wingspan (Stonis *et al.*, 2021). Head: frons smoothly scaled; frontal tuft overlapping the frons, comprised of long, slender, or relatively wide lamellar scales; collar comprised of slender or relatively wide lamellar scales; pecten present; antenna almost always slightly longer or significantly longer than one half the length of forewing. Forewing without a distinctive pattern, from yellowish ochre to pale grey, irregularly speckled with some darker scales, more abundantly in apical half of the forewing (Figs. 25–36); only occasionally the forewing is entirely dark, covered with dark brown scales; fringe line present, sometimes indistinctive, occasionally absent. Hindwing slender, brown-grey or pale brownish or ochreous cream, usually without androconia, but one species, *M. tyrocnistis* possesses dark brown androconial scales on apex of the generally pale hindwing of the males. Abdomen usually with distinctive long, or very long, anal tufts of piliform scales (Fig. 32).

Male genitalia. Capsule longer or much longer than wide. Uncus with two large long, or very long, lateral lobes, occasionally lobes are relatively shorter and wider. Socii membranous. Tegumen with a frame-like thickening (see Fig. 3). Valva slender or relatively wide basally, but almost always wider apically than basally, with a distinctive, usually long lateral process (Fig. 1); transtilla absent. Juxta present, strongly developed (usually much longer and wider than phallus) as a set of various large, horn-like processes (Figs. 49, 62, 77); except in *M. sparmanniae* horn-like processes are small and main body of juxta is almost rounded (Fig. 72). Anellus absent. Vinculum usually small, sometimes relatively large, with a basically triangular but variously modified ventral lobe. The joint of vinculum with tegumen is usually elaborate or twisted (see Fig. 3). Phallus short, slender, rod-like, basally with strongly developed lateral projections (Fig. 1).

Female genitalia. In comparison to other Tischeriidae, ovipositor lobes usually small, occasionally medium large, rounded, with peg-like setae; second pair of ovipositor lobes usually two times smaller. Anterior apophyses usually only slightly shorter than posterior apophyses; prela usually with three pairs of rod-like projections. Antrum strongly developed, long, distinctly thickened, and occasionally elaborate laterally (Fig. 106), sometimes also medially thickened (Fig. 56). Corpus bursae usually wide and short; pectinations indistinctive or as small and slender, weakly chitinized spines. Ductus spermathecae inconspicuous, with a small, plate-like vesicle and very little coils (maximum 3.5–4 in *M. kumatai* (Sato, Kobayashi & Hirowatari)) or without obvious coils, e.g., *M. ptarmica*.

Bionomics. Host plants are mostly Malvaceae (seven *Manitischeria* species), also Rhamnaceae (one species) and Betulaceae (one species). Host-plant relationships of the remaining nine *Manitischeria* species are unknown. Larvae mine leaves and produce blotch-like leaf mines (Figs. 11, 21–24); occasionally, being very slender and elongated, the leaf mine may look like a gallery (Figs. 15–18). Leaf mines are close to the leaf margin and mining larva bends or rolls a margin of the mined leaf before pupation (Figs. 5–11, 20, 23).

Distribution. Currently known from East, South East and South West Asia, and equatorial and southern Africa (Fig. 111).

Etymology. The genus name is derived from the combination of the Latin *manus* (an arm) referring to the long, arm-like process of the valva in the male genitalia and *Tischeria*, the genus from which the new taxon was transferred.

Remarks. Unpublished molecular data provides strong support for this new genus; it will be published separately with a molecular analysis of all Tischeriidae genera (Stonis *et al. in prep.*).

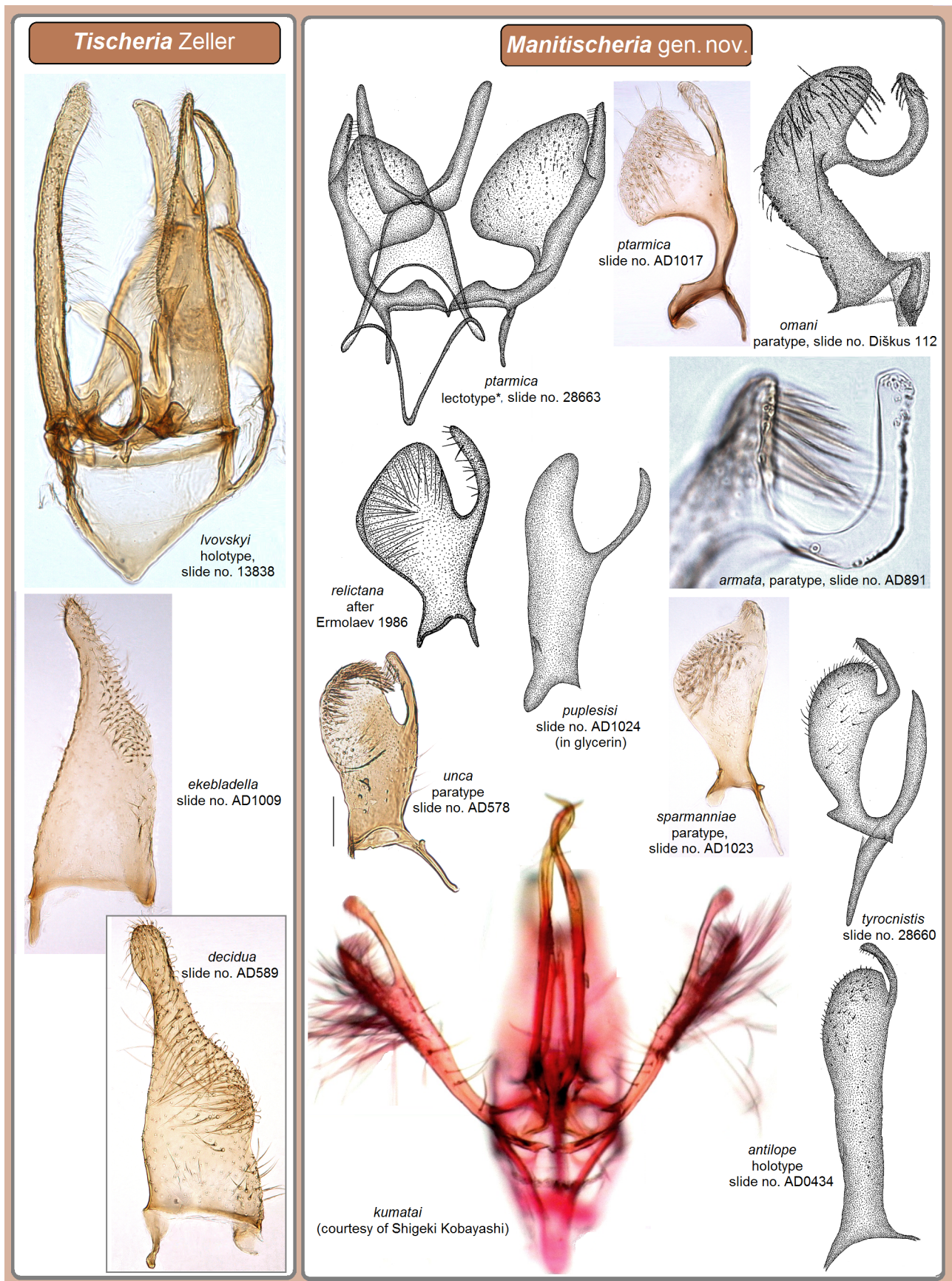


FIGURE 1. Diagnostics of *Tischeria* Zeller and *Manitischeria* Diškus & Stonis, **gen. nov.** based on characters of the valva (Note: morphological structures are drawn to different scales)

*—newly designated lectotype of *Manitischeria ptarmica* (Meyrick), a type species of the genus

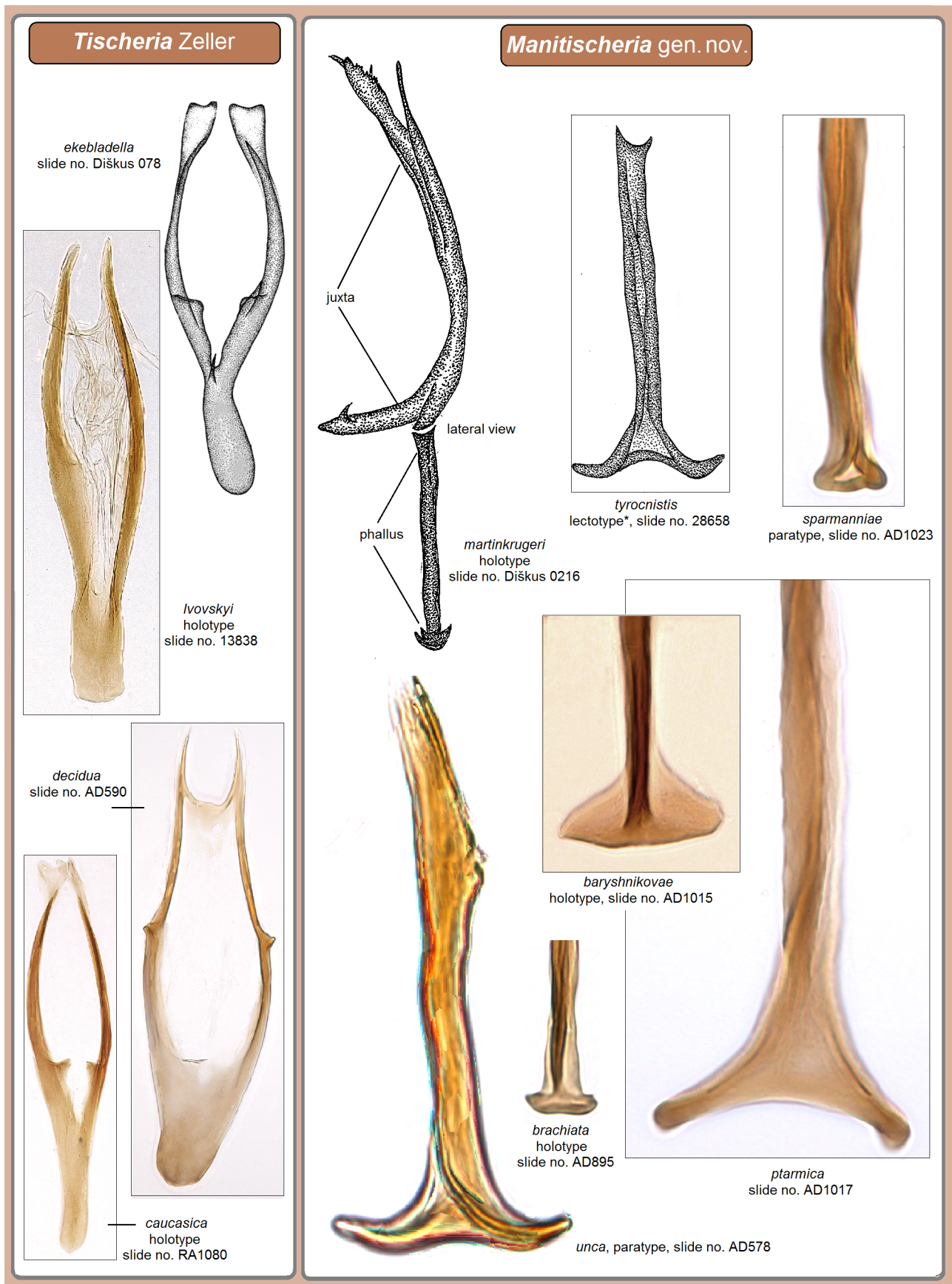


FIGURE 2. Diagnostics of *Tischeria* Zeller and *Manitischeria* Diškus & Stonis, **gen. nov.** based on characters of the phallus (Note: morphological structures are drawn to different scales)

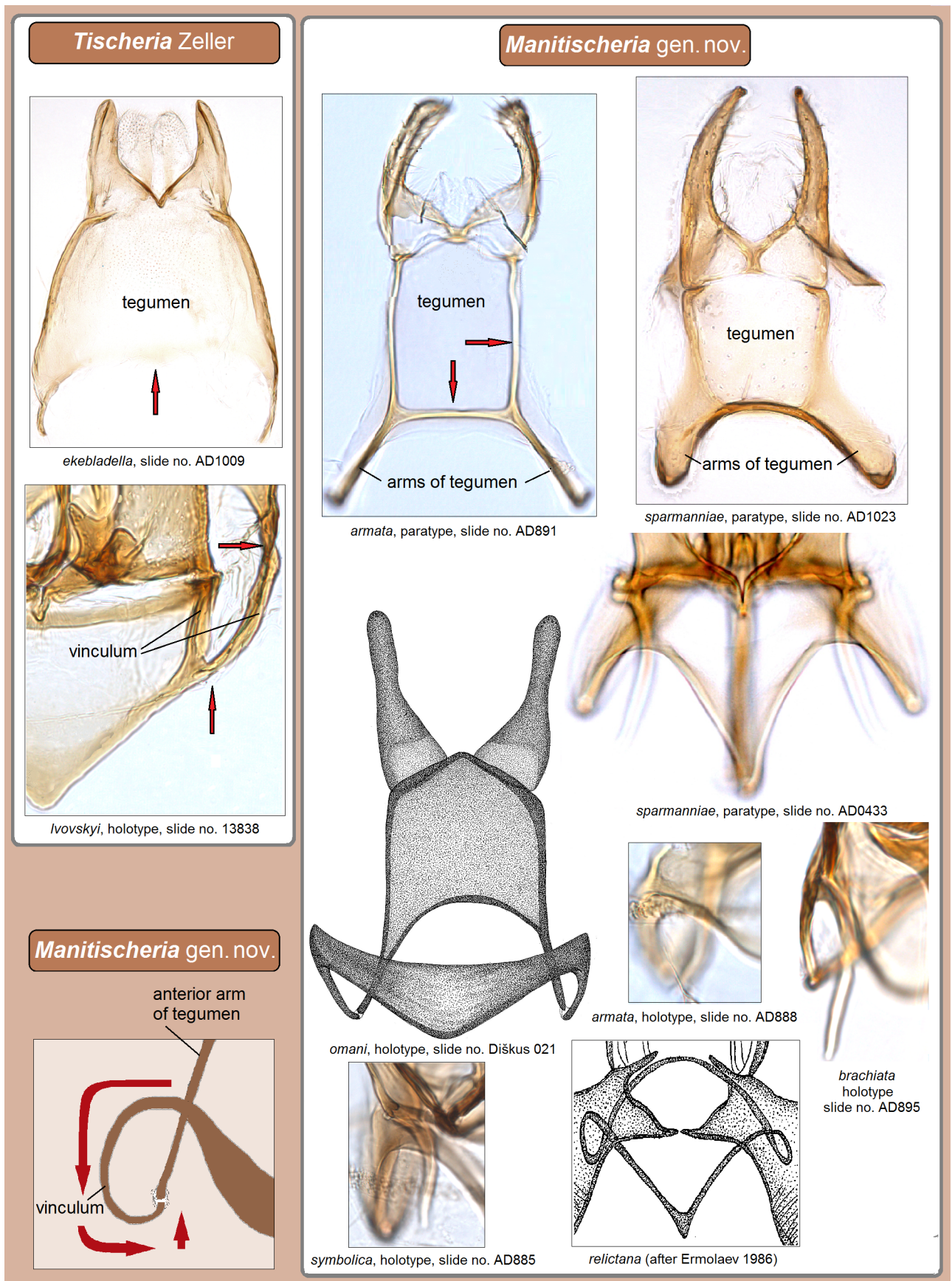


FIGURE 3. Diagnostics of *Tischeria* Zeller and *Manitischeria* Diškus & Stonis, **gen. nov.** based on characters of the tegumen and vinculum (Note: morphological structures are drawn to different scales)

1. *Manitischeria ptarmica* (Meyrick, 1908), comb. nov.

(Figs. 1, 2, 4–9, 33, 34, 37–45)

Tischeria ptarmica Meyrick, 1908: 399.

Tischeria ptarmica Meyrick, in van Nieuwerkerken 2010: 515–517.

Host plants. In India, *Ziziphus jujuba* Mill. (Meyrick 1908) and *Z. mauritiana* Lam. (Robinson *et al.* 2010); in the Arabian Peninsula, possibly *Z. spina-christi* (L.) Desf. (van Nieuwerkerken 2010); in Laos, *Ziziphus* sp. (resembling *Z. rugosa* Lam.), Rhamnaceae (Fig. 4).

Distribution. The species is possibly widespread in South West, South and South East Asia. Currently known from the Arabian Peninsula: UAE (van Nieuwerkerken 2010); Pakistan, Peshawar (new distribution data); India, Orissa: Puri (Meyrick 1908), Pusa, Surat, and Karwar (new distribution data); and Laos: Luang Prabang Province (new distribution data).

Material examined. 10 ♂ (lectotype and paralectotypes, **designated here**; seven without abdomen), INDIA: Odisha [Orissa], Puri, mining larvae on *Ziziphus jujuba* Mill., i.1908, E. Meyrick, genitalia slide no. 28663♂ (lectotype) (NHMUK); 1 ♂, N of Mumbai [Bombay], Surat, 26.iv.1919 (NHMUK) (new distribution data); 1 ♂, Karwar (also known as Kanara or Karnataka Coast), vi.1911 (without abdomen) (NHMUK) (new distribution data); 2 ♂, 1 ♀, Pusa, Rangji Coll., mining larvae on *Ziziphus jujuba*, 6.iii.1934, genitalia slide no. 28664 (NHMUK) (new distribution data).

1 ♂, PAKISTAN: Peshawar, 20–25.v.1916, Fletcher Coll. (presented by R.L.E. Ford 1949), genitalia slide 28820 (NHMUK) (new distribution data).

3 ♂, 1 ♀, LAOS: Luang Prabang Prov., Nong Khiaw, 20°32'48"N, 102°38'22"E, elevation 410 m, mining larvae on *Ziziphus* sp., 12.ii.2020, field card no. 5310, A. Diškus & M. Jocius, genitalia slide nos. AD1018♂, AD1019♂ (no pinned moth available, the adult, except for genitalia, completely consumed for molecular studies), AD1025♂ (ZIN); 2 ♂, 2 ♀, Vientiane Province, Vang Vieng, 18°56'01"N, 102°25'56"E, elevation 240 m, mining larvae on *Ziziphus rugosa* Lam., 3.ii.2020, field card no. 5310, A. Diškus & M. Jocius, genitalia slide nos. AD1017♂ (from adult in the pupal skin, no pinned moth is available), AD1020♂, AD1013♀, AD1016♀ (ZIN).

THAILAND. Herbarium samples with leaf mines of *M. ptarmica* collected in 21.xii.1969 from Fang, Chiang Mai province in northern Thailand (see Discussion).

Remarks. Here, we designate a lectotype and nine paralectotypes of *M. ptarmica*. The lectotype and paralectotypes are designated here to fix and stabilize the current concept of the name, labeled as in Material examined. Each specimen is supplied with individual round paper labels that clearly states the status of the specimen: red for the lectotype and yellow for paralectotypes.

The leaf mines of *M. ptarmica* are documented for the first time (see Figs. 4–9.) The male genitalia of the lectotype is provided in Fig. 1. For illustrations of the male and female genitalia from the Arabian Peninsula, see van Nieuwerkerken (2010); for the newly examined specimens from Laos, see Figs. 37–45.

Based on the study of many specimens from different localities, including a large series from Laos, we found that the juxta in *M. ptarmica* is always distinctly asymmetrical.

So far, *M. ptarmica* is the smallest known Tischeriidae worldwide. We measured our series from Laos: male forewing length 2.0–2.75 mm (n = 3, average mean = 2.5 mm); male wingspan 4.35–5.93 mm (n = 3, average mean = 5.40 mm); female forewing length 1.92–2.95 mm (n = 3, average mean = 2.55 mm); female wingspan 4.06–6.33 mm (n = 3, average mean = 5.47 mm) (Stonis *et al.* 2021). With a minimal wingspan of 4.06 mm, *T. ptarmica* is the smallest described species among the family, however, the maximum recorded wingspan of this species is longer than in another tiny species, *Coptotriche pulverea* Walsingham, 1897 (Stonis *et al.* 2021).

2. *Manitischeria zestica* (Meyrick, 1911), comb. nov.

Tischeria zestica Meyrick 1911: 238.

Tischeria zestica Meyrick, in Puplesis & Diškus 2003: 265–266.

Host plant. *Grewia occidentalis* L. Malvaceae (=Tiliaceae) (Puplesis & Diškus 2003).

Distribution. Republic of South Africa: Gauteng: Pretoria.

Remarks. The male lectotype and two female paralectotypes of *Manitisheria zestica* were designated, examined and illustrated by Puplesis & Diškus (2003): figs: 553 (adult), 564–567 (male genitalia), and fig. 599 (female genitalia).

3. *Manitisheria tyrocnistis* (Meyrick, 1934), comb. nov.
(Figs. 26, 46–51)

Tischeria tyrocnistis Meyrick 1934: 461–462.

Host plant. *Grewia tiliifolia* Vahl (Meyrick 1934), *G. biloba* G. Don (Robinson *et al.* 2010) (Malvaceae) (former Tiliaceae).

Distribution. India: Mumbai [Bombay] (Meyrick 1934), Indonesia: Java (Diškus & Puplesis 2003).

Material examined. 1 ♂, 1 ♀ (male lectotype and female paralectotype, **designated here**, see Remarks), INDIA: Mumbai [Bombay], i.1932, M. L. Maxwell (E. Meyrick Coll.), genitalia slide nos. 28658♂ (lectotype), 28659♀ (paralectotype) (NHMUK); 1 ♂, 1 ♀, same locality, 15.xii.32 (NHMUK); 1 ♀, same locality, 14.xii.32, genitalia slide no. 28660 (NHMUK); 1 ♂, 1 ♀, same locality, 12.i.33, genitalia slide no. 28660 (NHMUK); 1 ♂, 2 ♀, same locality, 18.xii.33, genitalia slide no. 28660 (NHMUK). 2 ♀ (one of them without abdomen), INDONESIA: Java, Telawa, vi.1935 (NHMUK).

Remarks. Here, we designate a lectotype and paralectotype of *M. tyrocnistis*. The lectotype and paralectotype are designated here to fix and stabilize the current concept of the name, labeled as in Material examined. Each specimen is supplied with individual round paper labels that clearly states the status of the specimen: red for the lectotype and yellow for the paralectotype. The species is illustrated the first time, see Figs. 26, 46–51. Images are provided of the adult lectotype in Fig. 26; lectotype male genitalia in Figs. 46, 47, 49; paralectotype female genitalia in Fig. 51; additionally, we provide the phallus and right side of the juxta of a non-type specimen from India, slide 28660 (Figs. 48, 50).

4. *Manitisheria relictana* (Ermolaev, 1986), comb. nov.

Tischeria relictana Ermolaev 1986: 6–8.

Tischeria relictana Ermolaev, in Kobayashi *et al.* 2016: 138–140.

Host plants. *Betula ermanii* Cham., *B. grossa* Siebold & Zucc. (Betulaceae) (Kobayashi *et al.* 2016).

Distribution. Far East Russia: Sakhalin (Ermolaev 1986); Japan: Hokkaido, Honshu (Nagano and Nara Prefectures), and Shikoku (Tokushima Prefecture) (Kobayashi *et al.* 2016).

Remarks. The species has been illustrated: adult by Kobayashi *et al.* (2016): fig. 2 I, J, K, L; male genitalia by Ermolaev (1986): fig. 1 and Kobayashi *et al.* (2016): fig. 5 A, B; female genitalia by Kobayashi *et al.* (2016): fig. 5 C, D.

5. *Manitisheria puplesisi* (Kozlov, 1986), comb. nov.
(Figs. 27, 58–68)

Tischeria puplesisi Kozlov 1986: 24–25.

Host plant. Unknown.

Distribution. Far East Russia: Primorskiy Kray (Kozlov 1986).

Material examined. 1 ♂ (holotype), RUSSIA: Primorskiy Kray, Ussuriyskiy Rayon, Gornotayezhnoye, dendrarium, at light, 29.vi.1983, M. V. Kozlov, genitalia slide no. 13837♂ (ZIN); 1 ♂ (non-type specimen), 20 km SE Ussuriysk, Gornotayezhnoye, 43°41'38"N, 132°09'07"E, dendrarium, at light, 8.vii.1983, S. V. Seksyaeva [now Baryshnikova], genitalia slide no. AD1024♂ (ZIN).

Remarks. Here, upon our re-examination, we provide the first photographic documentation of the holotype

adult (Fig. 27) and its male genitalia (Figs. 58, 59), and male genitalia of a non-type specimen collected in the same locality as the holotype (Figs. 60–68).

6. *Manitischeria omani* (Puplesis & Diškus, 2003), comb. nov.

Tischeria omani Puplesis & Diškus 2003: 108–109.

Host plant. Unknown.

Distribution. Oman: Northern Region.

Remarks. The species was illustrated by Puplesis & Diškus (2003): figs. 203, 204 (adult), figs. 238–246 (male genitalia). Female is unknown.

7. *Manitischeria antilope* (Puplesis, Diškus & Mey, 2003), comb. nov.

Tischeria antilope Puplesis, Diškus & Mey, in Puplesis & Diškus 2003: 266–267.

Tischeria antilope Puplesis, Diškus & Mey, in Puplesis *et al.* 2004: 43, 45–47.

Host plant. Unknown.

Distribution. Southern Africa: Namibia.

Remarks. The species was illustrated by Puplesis & Diškus (2003): figs. 554, 555 (adult), figs. 568–571 (male genitalia) and by Puplesis *et al.* (2004): fig. 1 (adult), and figs. 5–8 (male genitalia). Female is unknown.

8. *Manitischeria sparrmanniae* (Puplesis & Diškus, 2003), comb. nov.

(Figs. 69–73)

Tischeria sparrmanniae Puplesis & Diškus 2003: 267–268.

Tischeria sparrmanniae Puplesis & Diškus, in Puplesis *et al.* 2004: 43, 45, 48, 49.

Host plant. *Sparrmannia ricinocarpa* (Eckl. & Zeyh.) Kuntze (Malvaceae).

Distribution. Republic of South Africa, Zimbabwe, Namibia.

Material examined. Paratypes: 2 ♂, NAMIBIA: Brandberg, Wasserfallfläche, elevation 1940 m, 20.iii.2001, W. Mey, genitalia slide nos. AD0433♂, AD1023♂ (ZIN).

Remarks. We provide the first photographic documentation of the male genitalia (Figs. 69–73). Two paratypes, previously deposited at LEU (=VPU), will be transferred to ZIN (see Material and Methods).

9. *Manitischeria martinkrugi* (Puplesis & Diškus, 2003), comb. nov.

Tischeria martinkrugi Puplesis & Diškus 2003: 268.

Tischeria martinkrugi Puplesis & Diškus, in Puplesis *et al.* 2004: 43.

Host plant. Unknown.

Distribution. Republic of South Africa: Mpumalanga: Skukuza.

Remarks. The species was illustrated by Puplesis & Diškus (2003): fig. 557 (adult), figs. 579–582 (male genitalia). Female is unknown.

10. *Manitischeria selindica* Stonis & Diškus, sp. nov.

urn:lsid:zoobank.org:act:25BD22B0-ECDC-4765-828F-1C1C996639AF

(Figs. 107, 108)

Tischeria species 0219, in Puplesis & Diškus 2003: 268–269; in Puplesis *et al.* 2004: 43.

Type material. Holotype: ♀, ZIMBABWE: Mt. Selinda, bred on *Triumfetta rhomboidea*, 28.iv.1956, Vari, genitalia slide no. Diškus 0219 (TMSA).

Diagnosis. Externally, *M. selindica* sp. nov. resembles another dark-coloured species, *M. relictana* (Ermolaev). In the female genitalia, the unique, strongly thickened H-shaped antrum (Fig. 108) distinguishes the new species from all known congeneric species, including the South African *M. namibiensis* sp. nov. and the East Asian *M. relictana*. It is expected that the latter may be related to *M. selindica* because they are the only species with a distinct H-shaped antrum with long posterior processes and both are dark-coloured (unusual colour for *Manitischeria*). However, the antrum of *M. relictana* is slender and posterior processes of the antrum are shorter than in *M. selindica* (for *M. relictana*, see Kobayashi *et al.* 2016: fig. 5 C, D). *Manitischeria selindica* is easily distinguishable from *M. namibiensis* by the short posterior processes of the H-shaped antrum and the dark colour of forewing.

Male. Unknown.

Female (Fig. 107). Forewing length: 2.5 mm; wingspan 5.5 mm (n = 1). Head: palpi cream; frons brown; frontal tuft and collar metallic brown; antenna greyish brown. Thorax and tegula glossy grey-brown. Forewing dark brown with some inconspicuous and irregular pale ochre shading; forewing underside dark brown; fringe pale brown. Hindwing brown, very slender; fringe pale brown. Forelegs and midlegs dark brown, hindlegs pale grey. Abdomen dark brown.

Female genitalia (Fig. 108). Ovipositor lobes very small, oval-shaped, with peg-like setae; second pair of ovipositor lobes twice as small. Anterior and posterior apophyses equal in length. Antrum strongly developed, H-shaped. Corpus bursae unknown (broken and lost, slide no. Diškus 0219).

Bionomics. Host plant is *Triumfetta rhomboidea* Jacq., Malvaceae (formerly Tiliaceae). Mine unknown. Adults occur in April.

Distribution. This species is known from the single locality of Mt. Selinda, Zimbabwe.

Etymology. This species is named after the famous area of exceptional beauty and rich tropical biodiversity, Mount Selinda in Zimbabwe, where it was discovered.

Remarks. The species was left unnamed, but documented, in Puplesis & Diškus (2003). Now that a generic position is evident, we name it for use in a future trophic analysis of the Tischeriidae.

11. *Manitischeria kuehnei* (Mey, 2010), comb. nov.

Tischeria kuehnei Mey, 2010: 337–338, 339.

Host plant. Unknown.

Distribution. Rwanda: South Kilongo.

Remarks. The species was illustrated by Mey (2010): figs. 1–3 (male genitalia). Female is unknown.

12. *Manitischeria unca* (Diškus & Stonis, 2014), comb. nov.

(Figs. 25, 52, 53, 55–57)

Tischeria unca Diškus & Stonis, in Stonis *et al.* 2014b: 144–148.

Host plant. Unknown.

Distribution. Far East Russia (Primorskiy Krai).

13. *Manitischeria kumatai* (Sato, Kobayashi & Hirowatari, 2016), comb. nov.

(Fig. 1)

Tischeria kumatai Sato, Kobayashi & Hirowatari, in Kobayashi *et al.* 2016: 136–138.

Host plant. *Tilia japonica* (Miq.) Simonk. (Malvaceae) (Kobayashi *et al.* 2016).

Distribution. Japan: Hokkaido and Honshu (Nagano Prefecture).

Remarks. The species was illustrated by Kobayashi *et al.* (2016): fig. 2 F, G (adult), fig. 4 A–G (male genitalia), fig. 4 H, I (female genitalia). The leaf mine was not illustrated, but it resembles the mine of *Coptotriche minuta* Diškus & Stonis according to Kobayashi *et al.* (2016).

14. *Manitischeria armata* (Stonis, Diškus & Mey, 2019), comb. nov.

(Figs. 28, 54)

Tischeria armata Stonis, Diškus & Mey, in Stonis *et al.* 2019a: 86, 89–93.

Host plant. Unknown.

Distribution. So far, the species is known from the Eastern Cape Province of South Africa only.

Remarks. The species was illustrated by Stonis *et al.* (2019a): fig. 1, 2 (adult), fig. 12–27 (male genitalia). Female is unknown.

15. *Manitischeria brachiata* Diškus & Stonis, sp. nov.

urn:lsid:zoobank.org:act:28515B35-2998-4D8A-8750-997BED4F3C12

(Figs. 13–18, 29–32, 74–84)

Type material. Holotype: ♂, CAMBODIA: Siem Reap Province, Siem Reap, 13°27'33"N, 103°52'01"E, elevation 40 m, feeding larvae 15.ii.2015, ex pupa ii.2015, field card no. 5187, A. Diškus, genitalia slide no. AD895♂ (ZIN).

Diagnosis. Externally, *M. brachiata* sp. nov. can be confused with other speckled Tischeriidae species. In the male genitalia, the unique, branched juxta (Fig. 77) distinguishes the new species from all known congeneric species.

Male (Figs. 29–32). Forewing length 2.8 mm; wingspan 6.0 mm (n = 1). Palpi cream; frons pale brown, distally and laterally cream; pecten grey-brown; frontal tuft brown, comprised of slender lamellar, cream-tipped scales; collar brownish cream; antenna longer than one half the length of forewing; flagellum brownish cream. Tegula and thorax ochre-cream. Forewing ochre cream, with two irregular and ill-defined patches of grey-black and black scales along costal margin and two spots along dorsum; fringe yellowish cream; fringe line present, comprised of brown-black scales; forewing underside grey-brown, without spots or androconia. Hindwing grey-brown on upper side and underside; fringe dark grey-brown. Legs covered with dark brown scales on upper side, brown cream on underside. Abdomen dark brown on upper side, grey-brown on underside; genital plates cream to brown; anal tufts cream, long.

Female. Unknown.

Male genitalia (Figs. 74–84) with capsule 305 µm long, 170 µm wide. Uncus comprised of two long lobes (Figs. 78–80). Diaphragm with an inner bulge (Figs. 81, 82, 84). Valva sinuous (Fig. 74); lateral arm with a group of pectens distally (Figs. 79, 83). Juxta with median and lateral branches (Figs. 75, 77). Vinculum with a median, triangular, distally rounded ventral lobe (Figs. 74, 75, 79). Phallus (Figs. 74, 75, 79) with long, lateral arms apically.

Bionomics (Figs. 13–18). Host plant is *Helicteres* Pluk. Ex L. sp., Malvaceae (Figs. 13, 14). Larvae mine leaves in February. Larva greenish grey, with a dark brown head. The mine (Figs. 15–18) is a sinuous, gradually widening gallery, with some greenish grey frass only at the beginning (Fig. 16). Adults occur in late February.

Distribution. This species is known from the single locality in Cambodia, Siem Reap Province, at elevation 40 m, but the host plant has a much wider distribution.

Etymology. The species name is derived from the Latin *brachiatus* (branched), for the strongly branched juxta in the male genitalia.

16. *Manitischeria symbolica* Diškus & Stonis, sp. nov.

urn:lsid:zoobank.org:act:A2C29D53-3192-49A4-807A-B262B010DABA

(Figs. 10–12, 36, 85–95)

Type material. Holotype: ♂, VIETNAM: Lao Cai Province, Sapa, 22°19'19"N, 103°49'31"E, elevation 1260 m, feeding larvae 19.ii.2015, ex pupa iii.2015, field card no. 5190, A. Diškus, genitalia slide no. AD885♂ (ZIN).

Diagnosis. Externally, *M. symbolica* sp. nov. can be confused with other sparsely speckled Tischeriidae species, including the most similar *M. baryshnikovae* sp. nov., described below. In the male genitalia, the unique, elaborate juxta (Figs. 91–94) distinguishes the new species from all known congeneric species.

Male (Fig. 36). Forewing length 3.8 mm; wingspan 8.3 mm (n = 1). Palpi and pecten bright yellowish ochre; frons ochre cream; frontal tuft ochre cream, glossy, comprised of slender lamellar scales; collar yellowish ochre; antenna longer than one half the length of forewing; flagellum pale ochre cream, irregularly annulated with brown scales; basally flagellum bright yellow-ochre; sensillae very fine, short, inconspicuous. Tegula and thorax concolourous with forewing. Forewing pale yellowish ochre, sparsely irrorated with dark brown scales, with most of brown scales along costa in apical half of the wing; fringe yellow-ochre; fringe line indistinctive; forewing underside dark ochre-brown, without spots or androconia. Hindwing brownish cream to grey depending on angle of view; on underside, hindwing grey-brown; fringe pale yellowish brown. Legs ochre cream, on upper side and laterally densely speckled with blackish brown scales. Abdomen grey, with some blue and purple iridescence on upper side, densely speckled with dark brown scales on underside; genital plates yellowish cream; anal tufts long, cream to brown.

Female. Unknown.

Male genitalia (Figs. 85–95) with capsule 720 µm long, 300 µm wide. Uncus comprised of two long lobes (Figs. 86, 89, 95). Valva slender at the basal half (Figs. 89, 90), with inner, spine-like process (Fig. 95); lateral arm prominent (Fig. 90). Juxta with straight median and sinuous, elaborate lateral branches (Figs. 89, 91–94). Vinculum with a long, median, distally truncated ventral lobe (Figs. 87–89). Phallus (Figs. 85, 87–89) without lateral arms apically (Fig. 91).

Bionomics (Figs. 10–12). Host plant is unknown (probably Malvaceae, unidentified) (Fig. 12). Larvae mine leaves in February. Larva yellowish grey, with a dark brown head. The mine (Figs. 10, 11) is an irregular blotch, usually near leaf margin; upon development, larva bends the leaf margin (Fig. 10). Exit hole on the leaf underside. Adults occur in late March.

Distribution. This species is known from the single locality in northern Vietnam, Lao Cai Province (Sapa), at elevation of 1260 m.

Etymology. The species name is derived from the Ancient Greek *symbolus* (a symbol, seal, logo), based on the elaborate juxta in the male genitalia, which resembles a logo in European folk traditions with two crisscrossed horse heads attached to a house gable (as in the Raiffeisen Bank).

17. *Manitischeria baryshnikovae* Diškus & Stonis, sp. nov.

urn:lsid:zoobank.org:act:7A67D90F-BB3B-4B49-8E01-ABE9AE27814C

(Figs. 19–24, 35, 96–106)

Type material. Holotype: ♂, LAOS: Luang Prabang Prov., Nong Khiaw, 20°33'07"N, 102°36'21"E, elevation 1070 m, from feeding larvae 10.ii.2020, A. Diškus & M. Jocius, genitalia slide no. AD1015♂ (ZIN). Paratype: 1 ♀ same label data as holotype, genitalia slide no. AD1014♀ (ZIN).

Diagnosis. Externally, *M. baryshnikovae* sp. nov. can be confused with other sparsely speckled Tischeriidae species, including the most similar *M. symbolica* sp. nov., described above. In the male genitalia, the presence of two large, curved, dorsal lobes of the juxta (Fig. 100) and a short uncus distinguish the new species from all known congeneric species. In the female genitalia, *M. baryshnikovae* is characterized by the unique, laterally elaborate antrum (Fig. 106), however, females of most other *Manitischeria* are unknown.

Male (Fig. 35). Forewing length 3.2 mm; wingspan 6.6 mm (n = 1). Palpi and frons cream; pecten brownish cream; frontal tuft and collar ochre cream, distally cream, comprised of slender lamellar scales; antenna slightly longer than one half the length of forewing; flagellum brownish cream to cream, irregularly annulated with brown

scales; sensillae very fine, relatively short, but visible. Tegula and thorax concolourous with forewing. Forewing pale yellowish ochre, irrorated with blackish brown and pale grey scales, with most of blackish brown scales in apical third of the wing; fringe yellow-ochre; fringe line indistinctive; forewing underside pale brown-grey, without spots or androconia. Hindwing cream to brownish cream depending on angle of view; hindwing underside pale grey-brown; fringe brownish cream. Legs ochre cream, on upper side and laterally densely speckled with blackish brown scales. Abdomen yellow-ochre to ochre-brown; genital plates grey cream; anal tufts long, very distinctive, ochre-yellow or yellow-brown depending on angle of view.

Female. Forewing length 3.2 mm; wingspan 6.6 mm (n = 1). Scaling as in male, but flagellum not annulated with brown scales; fringe line of forewing distinctive, comprised of blackish brown scales; dark scales form four inconspicuous, ill-defined spots on forewing apex. Otherwise, as in male.

Male genitalia (Figs. 96–104). Capsule 470 µm long, 275 µm wide. Uncus comprised of two short, basally wide lobes (Figs. 101, 104). Valva (Figs. 98, 100) slender in basal half, with a prominent inner arm. Juxta comprised of ventral and dorsal elements; ventrally with a pair of pointed, curved, spine-like processes (Figs. 97, 100, 103), dorsally with a pair of very large, inwardly bent lobes (Figs. 96, 100, 102, 104). Vinculum with a very short dorsal lobe (Fig. 99). Phallus (Figs. 97, 104) deeply divided apically (Fig. 97).

Female genitalia (Figs. 105, 106) 1015 µm long. Ovipositor lobes relatively small, rounded, with peg-like setae (Fig. 105); second pair of ovipositor lobes twice smaller. Anterior apophyses slightly shorter than posterior apophyses (Fig. 106); prela with three pairs of rod-like projections and a pair of lobe-like projections; the latter is mostly membranous (Fig. 105). Antrum thickened and elaborate laterally (Fig. 106). Corpus bursae wide, but short (Fig. 106); pectinations indistinctive. Ductus spermathecae inconspicuous.

Bionomics (Figs. 19–24). Host plant is *Helicteres* Pluk. ex L. sp., Malvaceae (Fig. 19). Larvae mine leaves in February. Larva is yellowish grey with a dark green intestine and brown head. The mine is irregularly shaped, blotch-like (Figs. 21–24), with very little or without frass. Adults occur in March.

Distribution. This species is known from a single locality in Laos, Luang Prabang Province, at elevation of about 1100 m, but the host plant has a much wider distribution.

Etymology. The species is named in honour of our great colleague and friend Dr. Svetlana V. Baryshnikova (Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia) in recognition of over 40-years research in the field of leaf mining Lepidoptera.

18. *Manitischeria namibiensis* Stonis & Diškus, sp. nov.

urn:lsid:zoobank.org:act: CBC74DE2-9B57-4328-A5A6-F44A682EAD20

(Figs. 109, 110)

Tischeria species 6547, in Puplesis & Diškus 2003: 270; in Puplesis *et al.* 2004: 43.

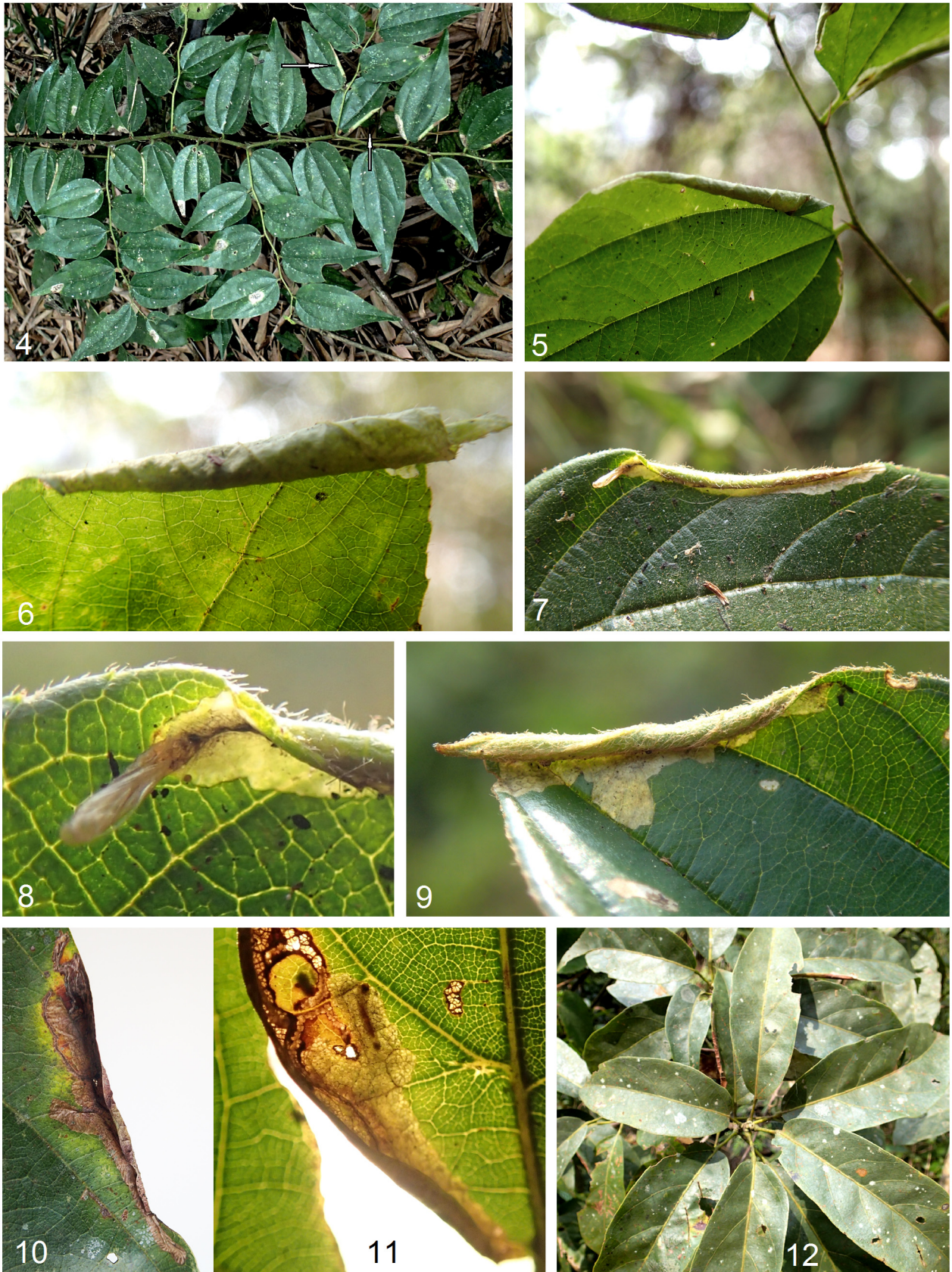
Type material. Holotype: ♀, NAMIBIA: Abachaus, xii.1946, Hobohm, genitalia slide no. 6547 (TMSA).

Diagnosis. Externally, *M. namibiensis* sp. nov. can be confused with other sparsely speckled Tischeriidae species. In the female genitalia, the unique, H-shaped antrum with very short posterior processes (Fig. 110) distinguishes the new species from all known congeneric species, including *M. zimbabwienis* sp. nov. It is expected that *M. namibiensis* may be related to *M. selindica* because they are the only African species with a H-shaped antrum. However, the antrum of *M. namibiensis* has very short posterior processes, and adult scaling is not dark (dark brown in *M. selindica*).

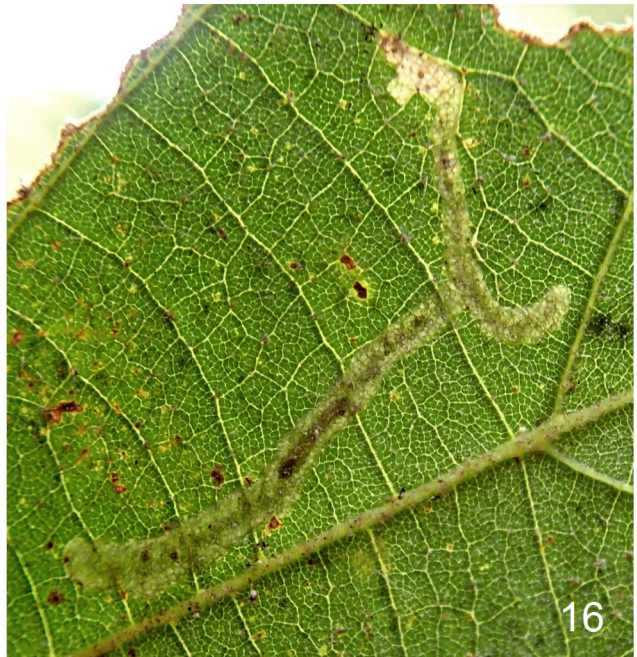
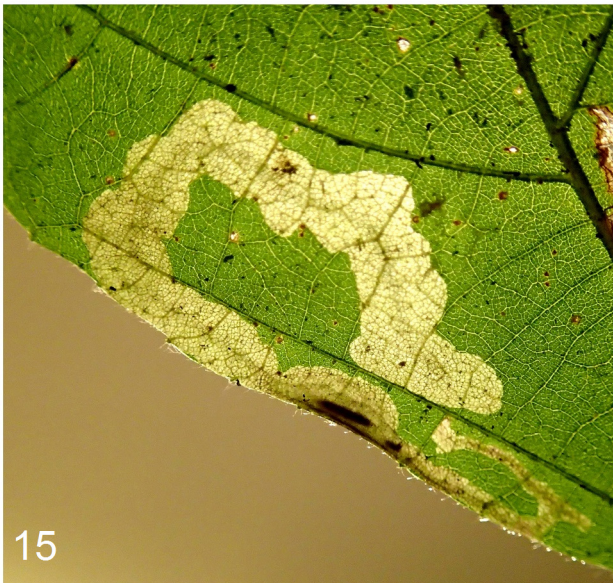
Male. Unknown.

Female (Fig. 109). Forewing length: 2.7 mm; wingspan 6.1 mm (n = 1). Head: palpi and frons cream; frontal tuft and collar golden cream; antenna cream, indistinctly annulated with pale brown scales in basal part. Thorax and tegula golden cream. Forewing whitish cream sparsely speckled with some dark brown scales and with some irregular yellowish shading; forewing underside ochre-brown; fringe cream. Hindwing cream; fringe golden cream. Legs brownish cream.

Female genitalia (Fig. 110). Ovipositor lobes medium small, with peg-like setae; second pair of ovipositor lobes two to three times smaller. Anterior apophyses slightly shorter than posterior apophyses. Antrum H-shaped, strongly thickened, with very short posterior processes. Corpus bursae unknown (lost, slide no. 6547).



FIGURES 4–12. Bionomics of *Manitischeria* spp. 4–9, *M. ptarmica* (Meyrick), leaf mines on host plant *Zizyphus* sp. (**the first documentation**), Laos (**new distribution data**); 10–12, *M. symbolica* **sp. nov.**, leaf mines and unidentified host plant (expected to be Malvaceae), Vietnam



FIGURES 13–18. Bionomics of *Manitischeria brachiata* Diškus & Stonis, **sp. nov.** 13, habitat, elevation 40 m, Siem Reap, Cambodia; 14, unidentified host plant of Helicteroideae Meisn., Malvaceae; 15–18, leaf mines

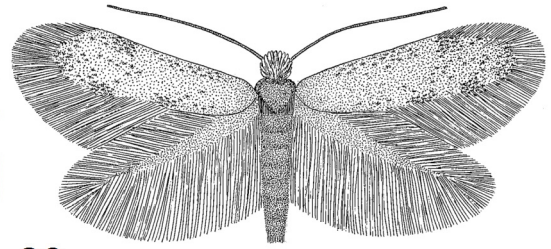


FIGURES 19–24. Bionomics of *Manitscheria baryshnikovae* Diškus & Stonis, **sp. nov.** 19, host plant *Helicteres* sp., Helicteroideae Meisn., Malvaceae; 20–24, leaf mines



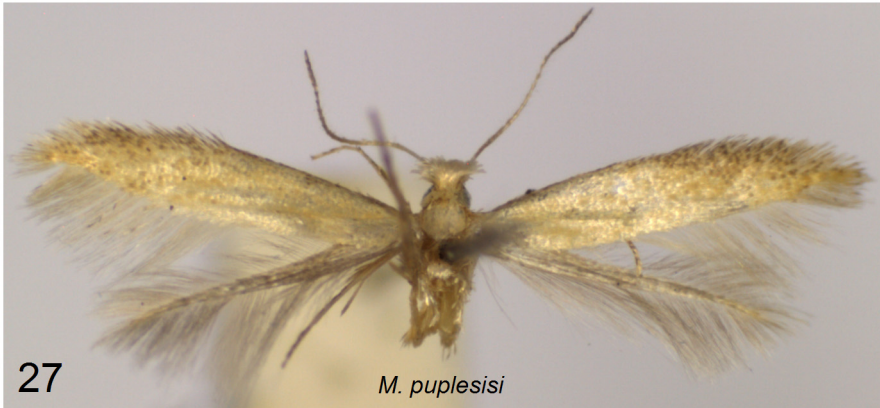
25

Manitischeria unca



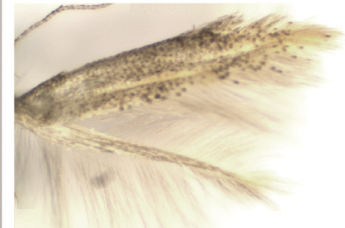
26

M. tyrocnistis



27

M. puplesisi



28

M. armata



31

M. brachiata sp. nov.



M. brachiata sp. nov.

29



antennal
sensillae trichodea

30

M. brachiata sp. nov.

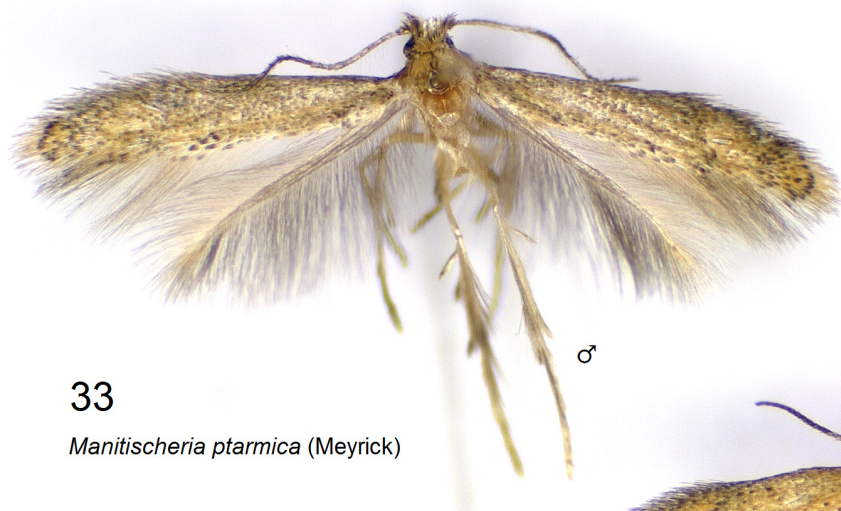


32

M. brachiata sp. nov.

anal tufts

FIGURES 25–32. Adults of *Manitischeria* spp. 25, *M. unca* (Diškus & Stonis), paratype; 26, *M. tyrocnistis* (Meyrick), lectotype (**first documentation**); 27, *M. puplesisi* (Kozlov), holotype (**first documentation**); 28, *M. armata* (Diškus & Stonis), holotype; 29–32, *M. brachiata* Diškus & Stonis, **sp. nov.**, holotype



33

Manitscheria ptarmica (Meyrick)

♂



34

M. ptarmica (Meyrick)

♂



35

M. baryshnikovae sp. nov.
(holotype)

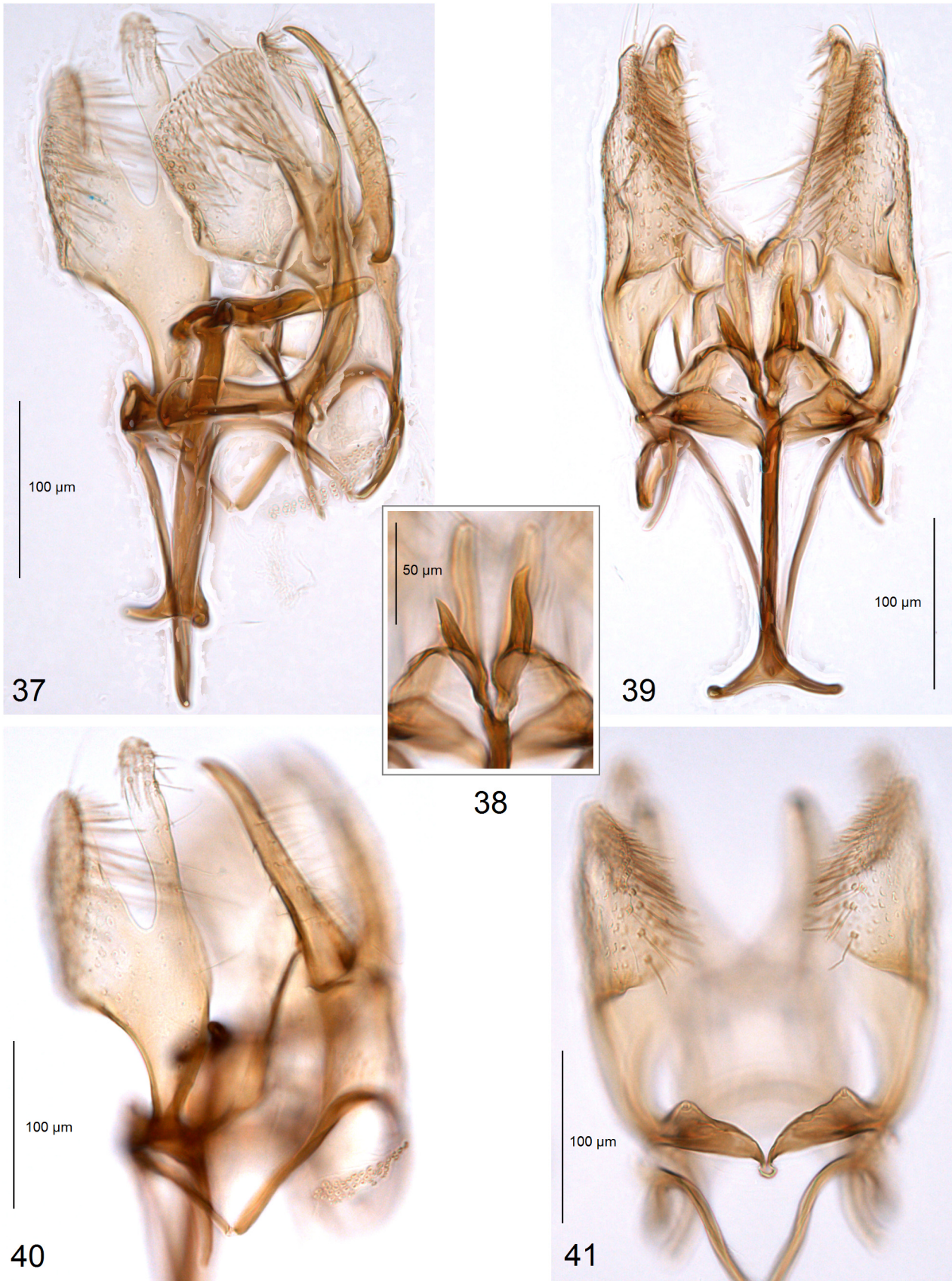
♂



36 *M. symbolica* sp. nov.
(holotype)

♂

FIGURES 33–36. Adults of *Manitscheria* spp. 33, 34, *M. ptarmica* (Meyrick), Laos (**new distribution data**); 35, *M. baryshnikovae* Diškus & Stonis, **sp. nov.**, Laos, holotype; 36, *M. symbolica* Diškus & Stonis, **sp. nov.**, Vietnam, holotype (Note: *M. ptarmica* is the smallest known Tischeriidae worldwide with recorded minimal wingspan in specimens from Laos: 4.35 mm in males, 4.06 in females)



FIGURES 37–41. Male genitalia of *Manitischeria ptarmica* (Meyrick), Laos (**new distribution data**); 37, slide no. AD1020, lateral view of capsule; 38, slide no. AD1019, ventral view of juxta; 39, slide no. AD1025, ventral view of capsule; 40, slide no. AD1020, lateral view of capsule; 41, slide no. AD1018, ventral view of capsule with phallus removed (ZIN)



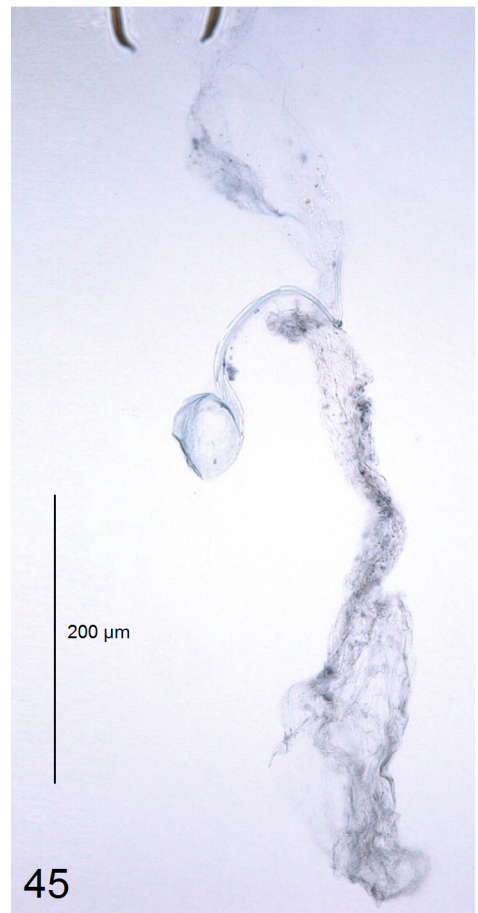
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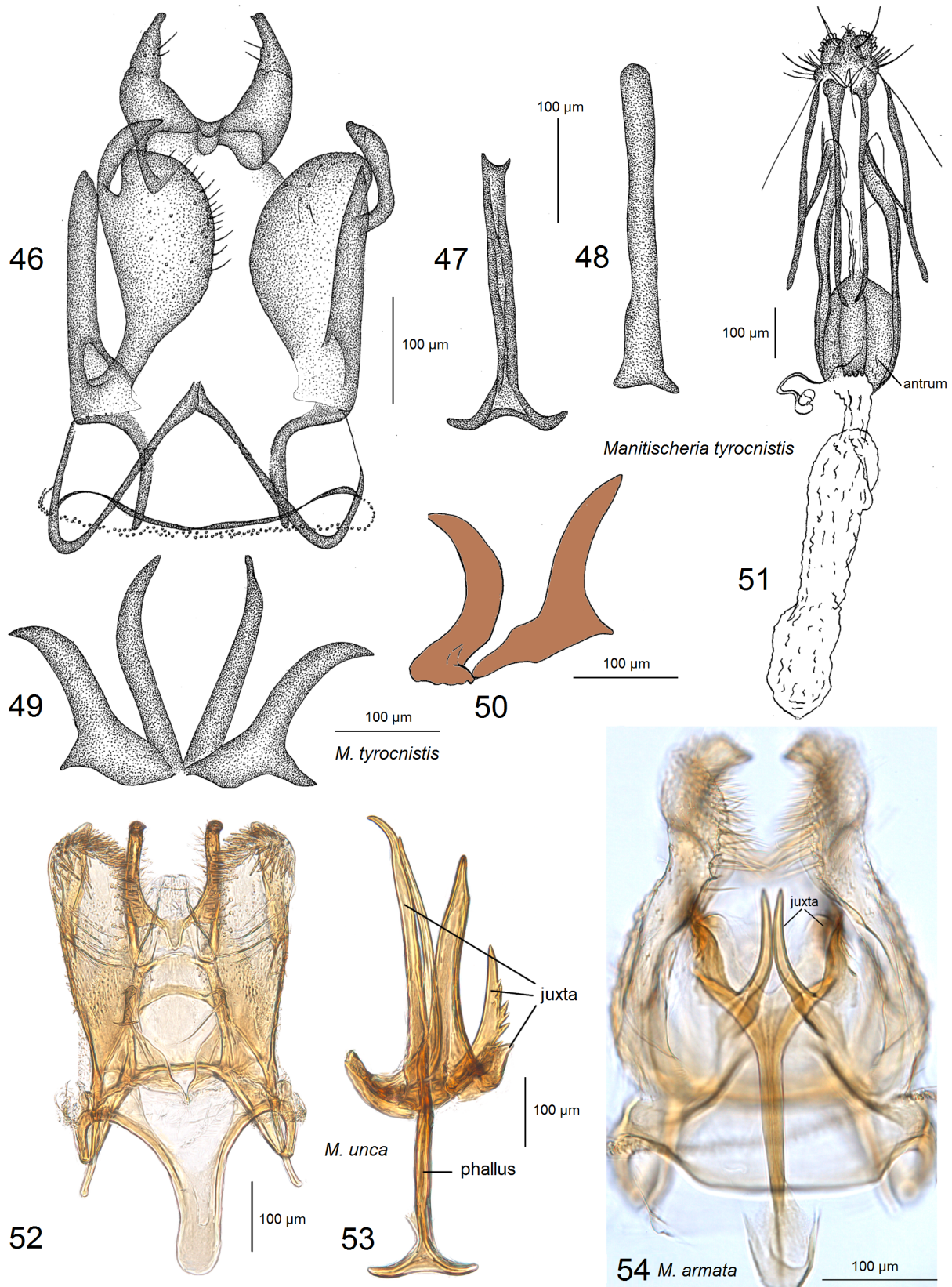


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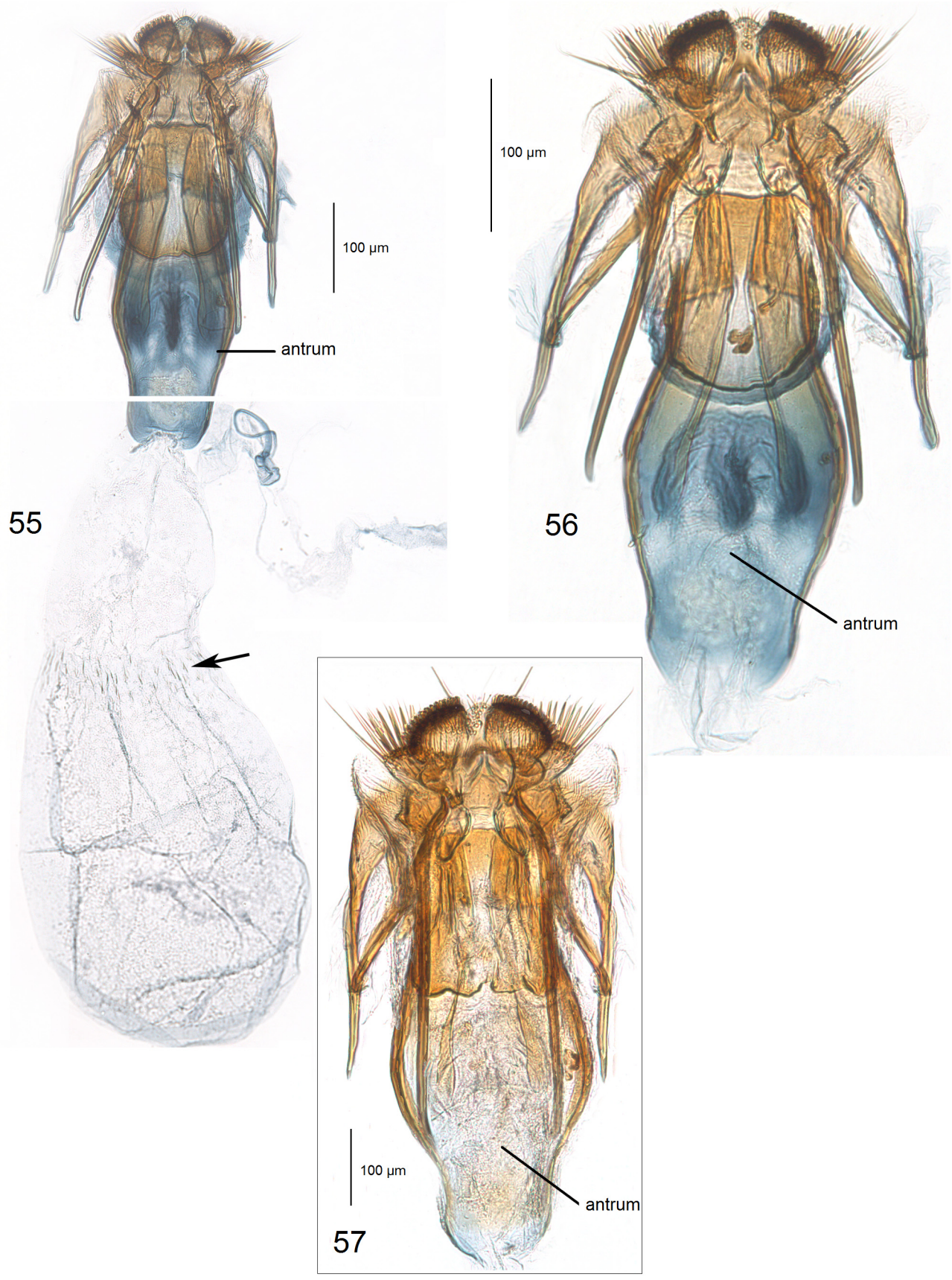


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FIGURES 42–45. Female genitalia of *Manitscheria ptarmica* (Meyrick), Laos (**new distribution data**); 42, 43, slide no. AD1013, apophyses and prela; 44, slide no. AD1016, antrum; 45, slide no. AD1013, bursa copulatrix (ZIN)



FIGURES 46–54. Genitalia of *Manitischeria* spp.; 46, *M. tyrocnistis*, lectotype, slide no. 28658 (NHMUK), male genitalia (**first documentation**), capsule with phallus removed; 47, same, phallus; 48, same, non-type specimen, India, slide no. 28660 (NHMUK); 49, same, juxta, lectotype, slide no. 28658 (NHMUK); 50, same, right part of juxta, non-type specimen, India, slide no. 28660 (NHMUK); 51, same, paralectotype, female genitalia (**first documentation**), slide no. 28659 (NHMUK); 52, 53, *M. unca*, holotype, male genitalia, slide no. AD577 (ZIN); 54, *M. armata*, holotype, male genitalia, slide no. AD888 (TMSA)



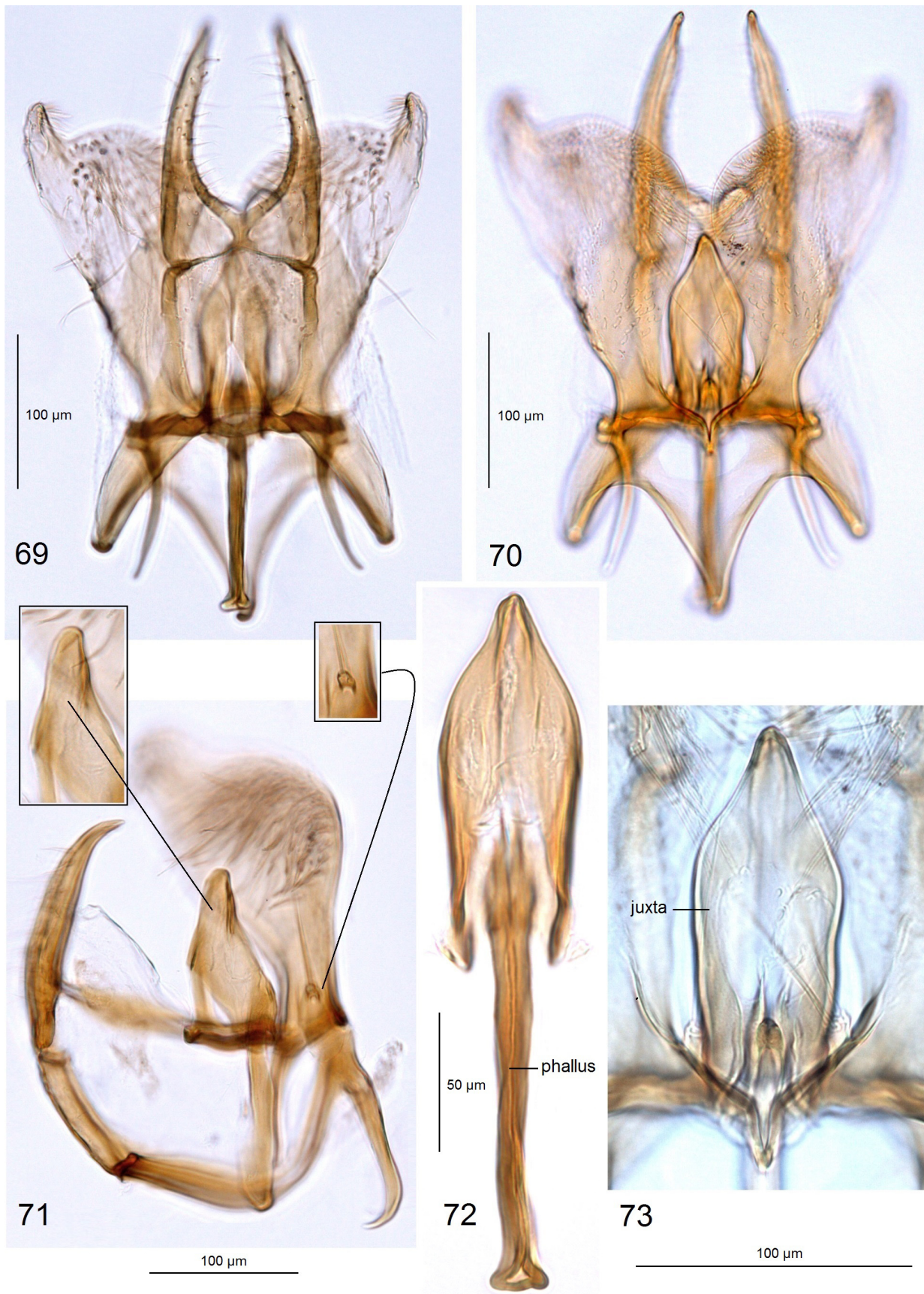
FIGURES 55–57. Female genitalia of *Manitischeria unca* (Diškus & Stonis); 55, general view, paratype, slide no. AD585 (ZIN); 56, ovipositor lobes, apophyses, prella, and antrum, paratype, slide no. AD586 (ZIN); 57, same, paratype, slide no. AD584 (ZIN)



FIGURES 58–62. Male genitalia of *Manitischeria puplesisi* (Kozlov); 58, 59, holotype (**first photographic documentation**), slide no. 13837 (ZIN); 60, non-type specimen, slide no. AD1024 (ZIN), valvae; 61, 62, same, phallus and juxta



FIGURES 63–68. Male genitalia of *Manitischeria puplesisi* (Kozlov) (**first photographic documentation**); 63, non-type specimen, slide no. AD1024, in Euparal before dissection apart, lateral view; 64, same, ventral view; 65, same, focused on juxta; 66, same, focused on uncus and tegumen, 67, same, focused on vinculum and basal part of valvae; 68, same, focused on basal part of valvae (ZIN)



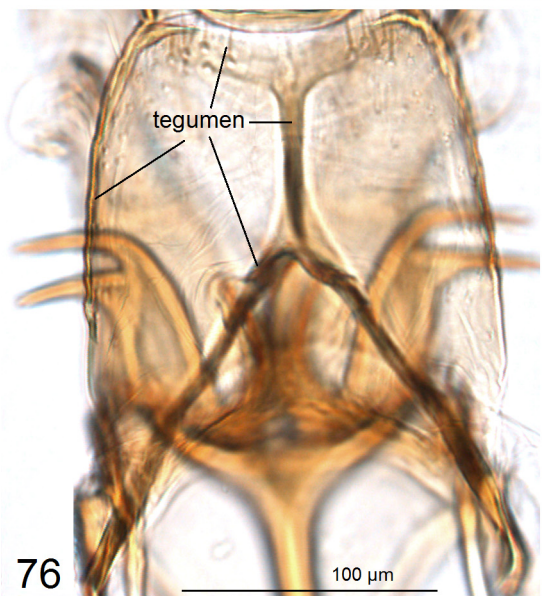
FIGURES 69–73. Male genitalia of *Manitischeria sparmanniae* (Puplesis & Diškus) (**first photographic documentation**); 69, paratype, slide no. AD0433 (ZIN), ventral view, focused on uncus, tegumen and phallus; 70, same, focused on juxta and vinculum; 71, paratype, slide no. AD1023 (ZIN), lateral view; 72, same, phallus; 73, paratype, slide no. AD0433 (ZIN), juxta



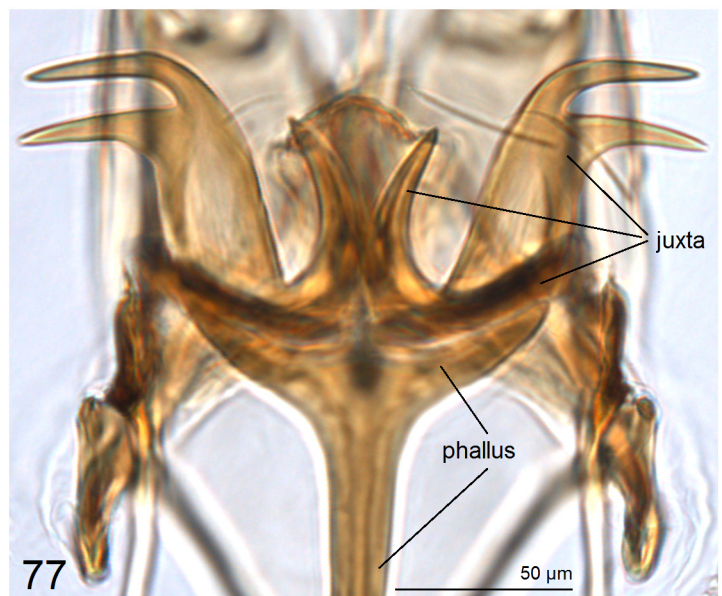
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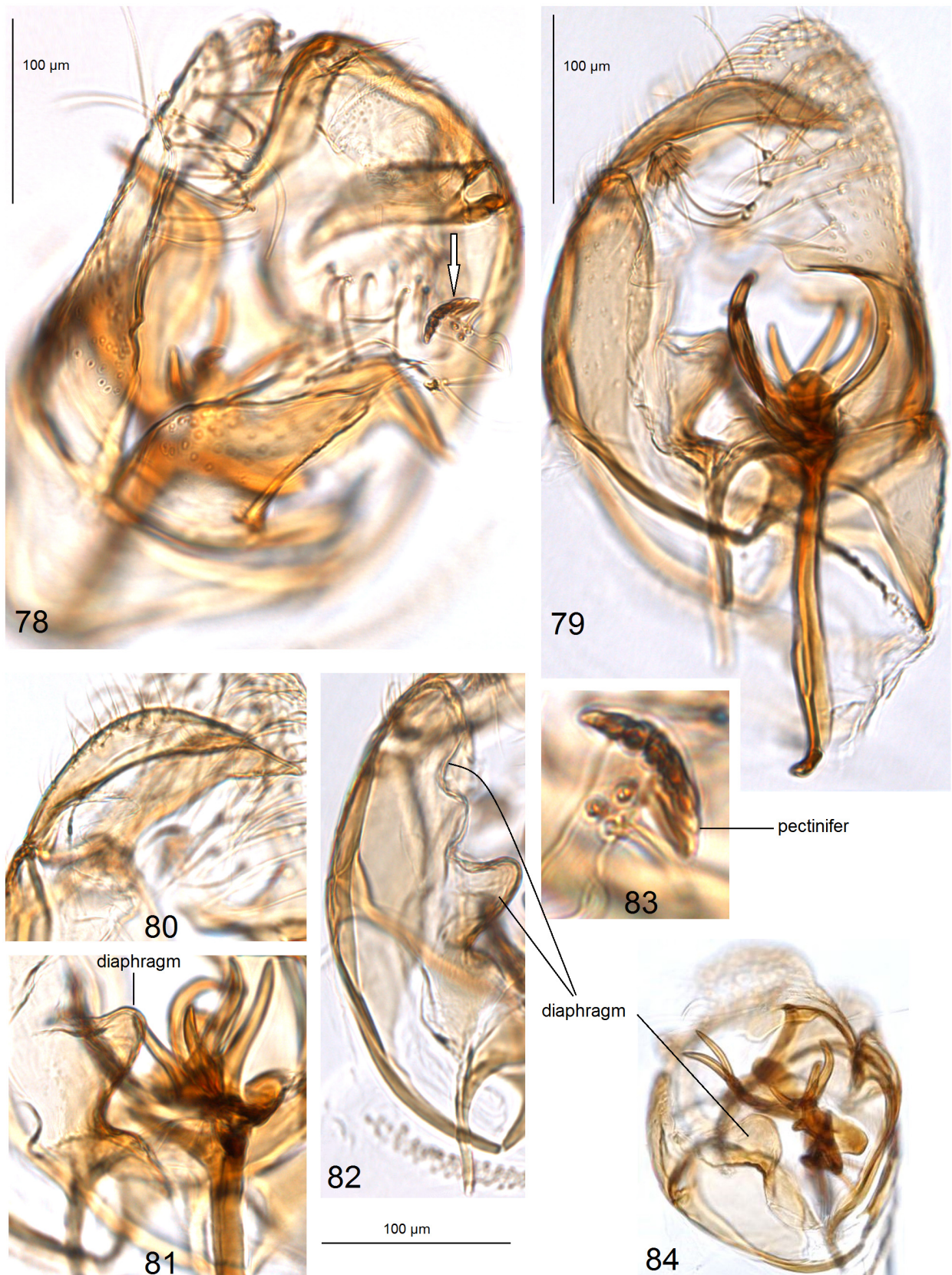


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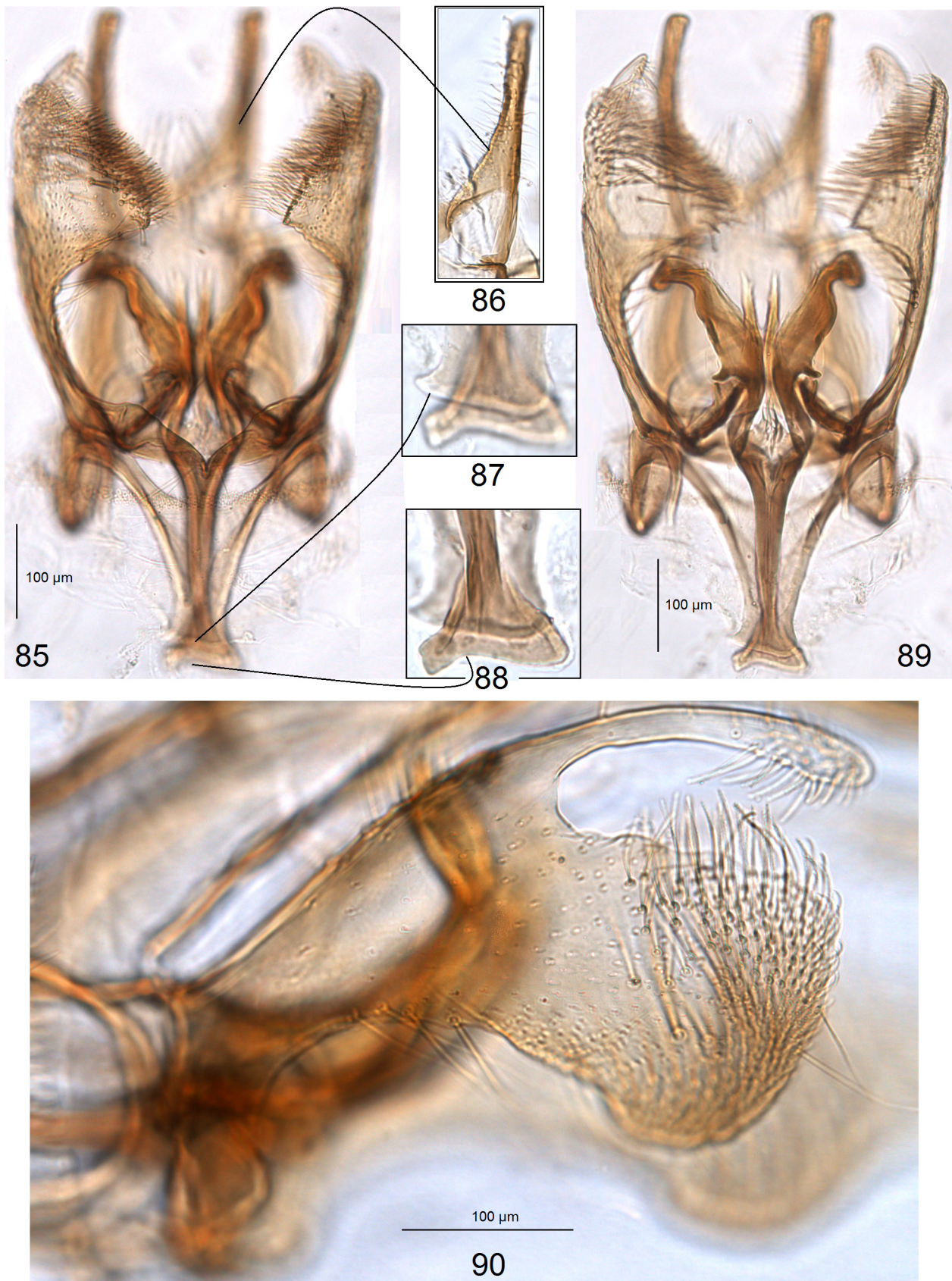


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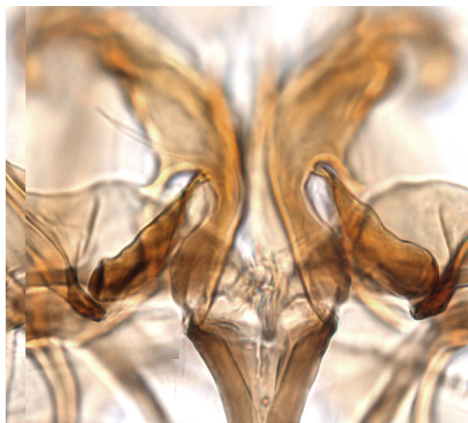
FIGURES 74–77. Male genitalia of *Manitischeria brachiata* Diškus & Stonis, **sp. nov.**: 74, holotype, slide no. AD895 (ZIN), general view, focused on valvae and phallus; 75, same, focused on uncus, juxta, and phallus; 76, same, tegumen; 77, same, juxta



FIGURES 78–84. Male genitalia of *Manitischeria brachiata* Diškus & Stonis, **sp. nov.**; 78, holotype, temporary mount in Euparal of slide no. AD895 (ZIN), caudal view; 79, same, lateral view of genitalia; 80, same, lateral view of uncus; 81, same, lateral view of diaphragm and juxta; 82, same, lateral view of diaphragm; 83, same, apex of lateral process of valva with pectinifer; 84, same, caudo-lateral view of genitalia

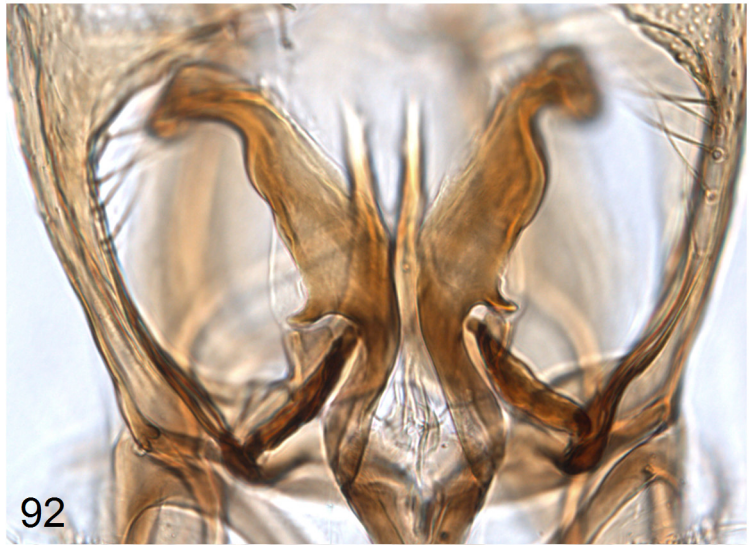


FIGURES 85–90. Male genitalia of *Manitscheria symbolica* Diškus & Stonis, **sp. nov.**; 85, holotype, slide no. AD885 (ZIN), general view, focused on valva; 86, same, uncus; 87, 88, same, basal part of vinculum and phallus; 89, same, general view of genitalia, focused on juxta and phallus; 90, same, temporary mount in Euparal of slide no. AD885 (ZIN), lateral view of valva



91

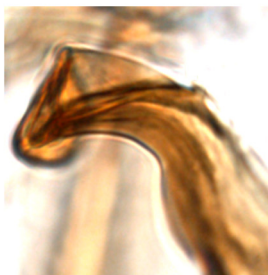
100 μ m



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93



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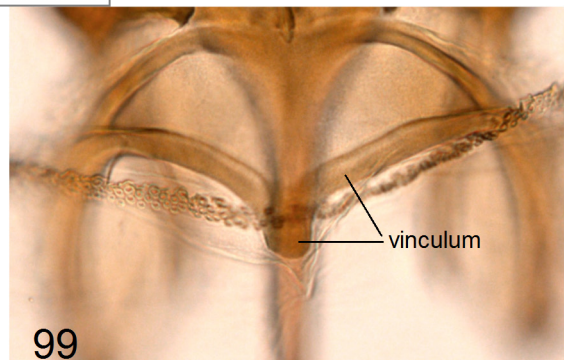
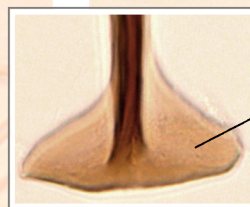
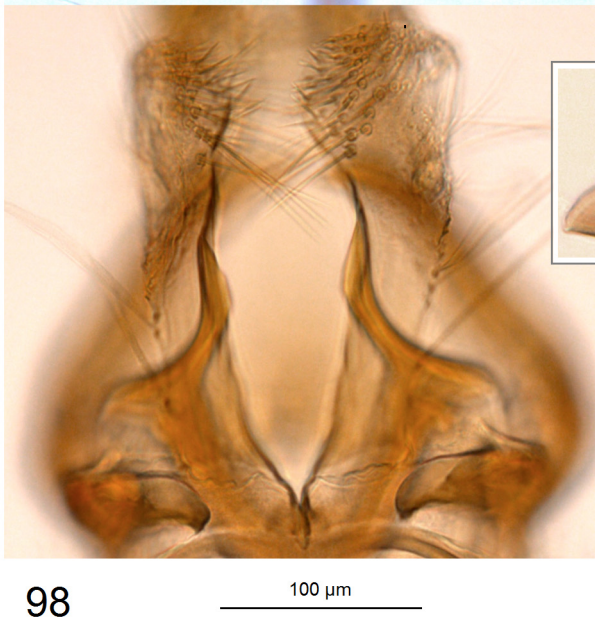
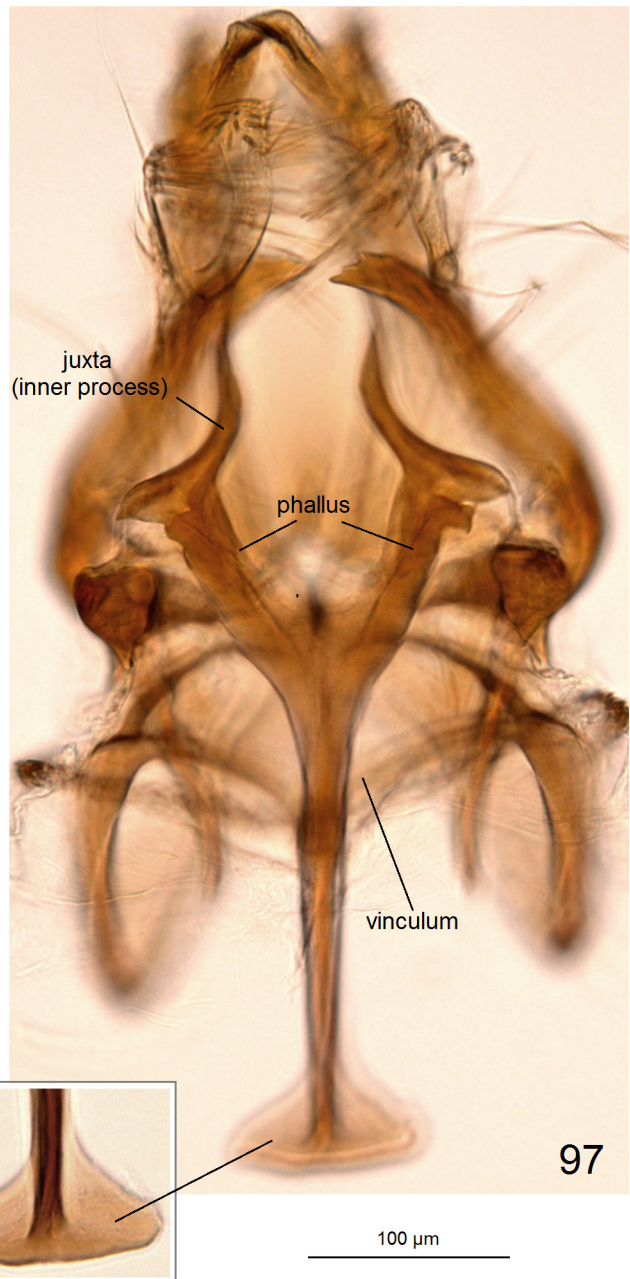
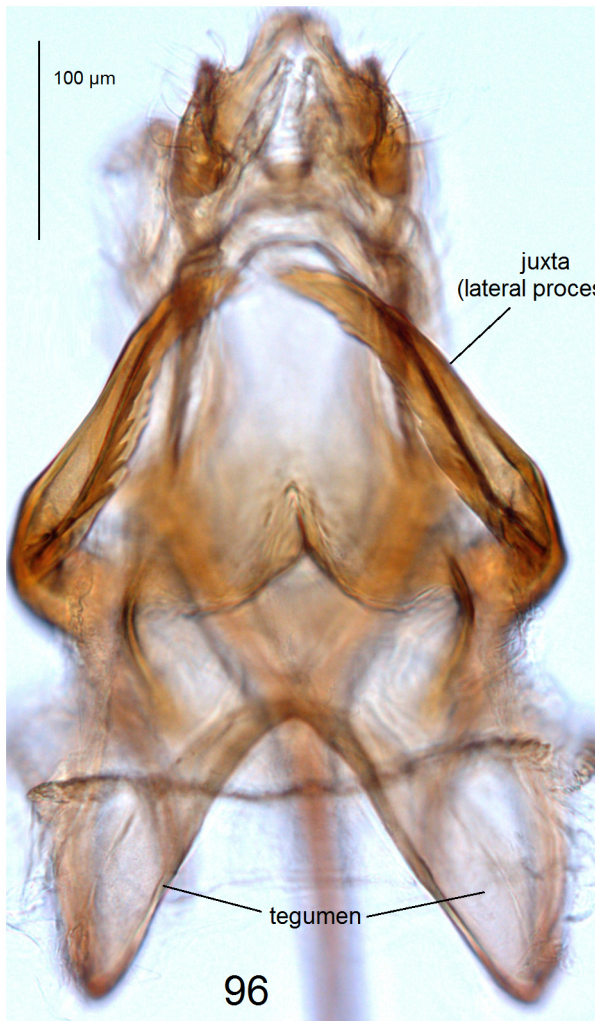


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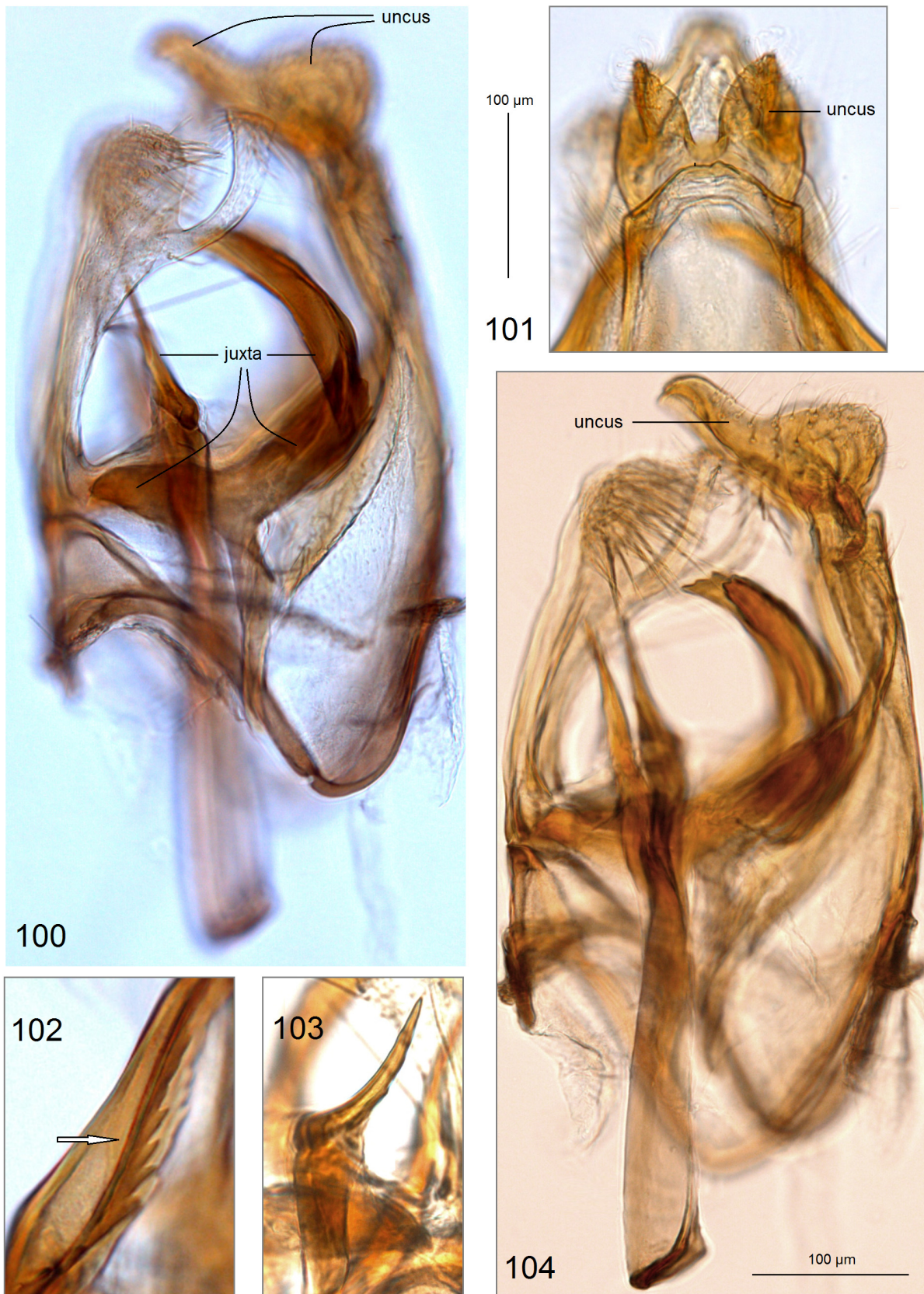
100 μ m

invisible in lateral view,
see Fig. 90

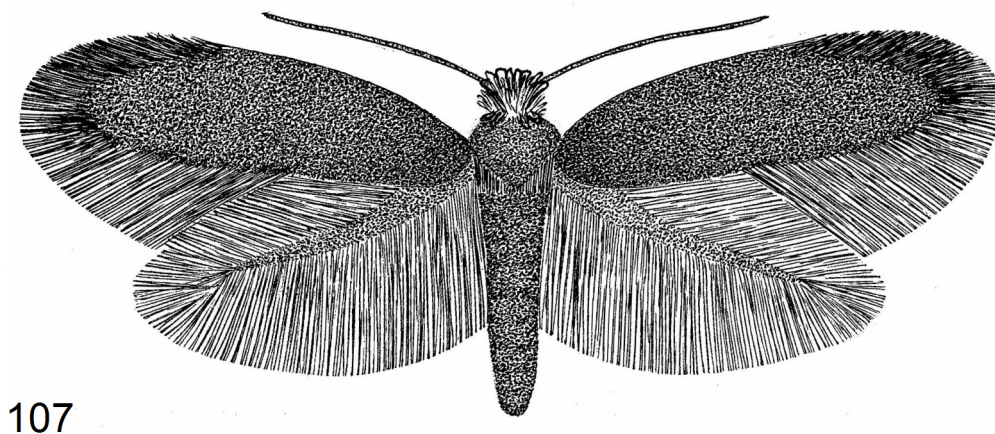
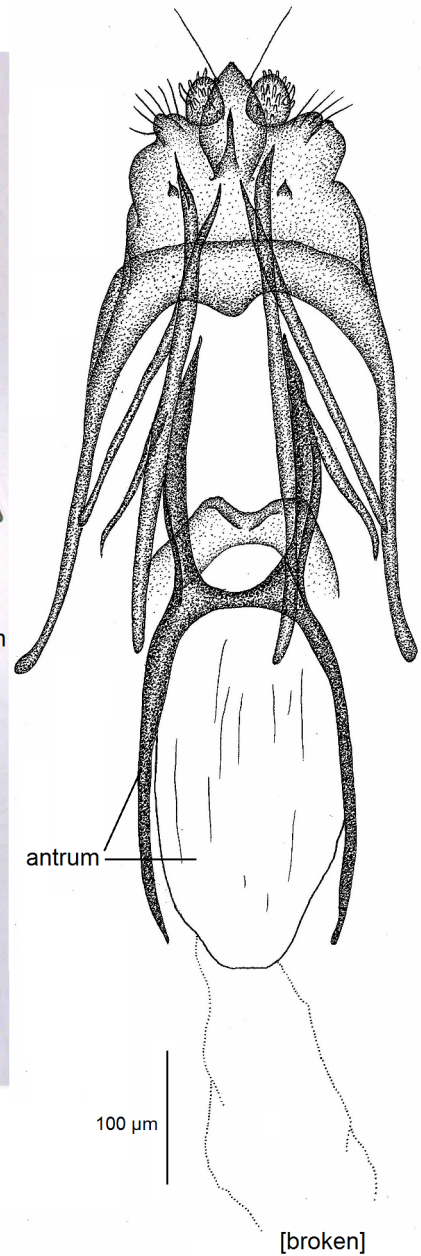
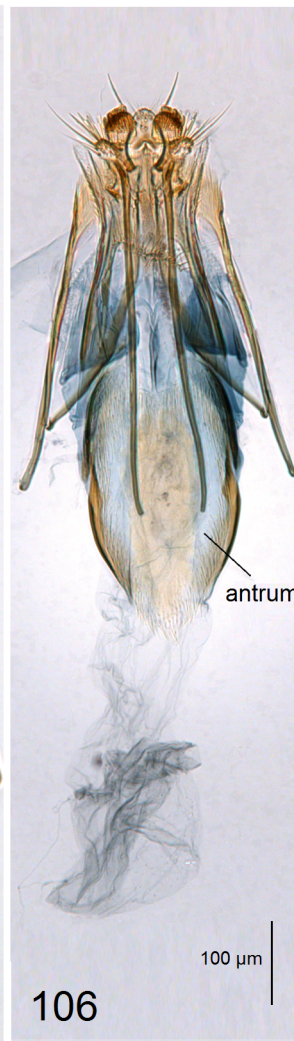
FIGURES 91–95. Male genitalia of *Manitischeria symbolica* Diškus & Stonis, **sp. nov.**; 91–94, holotype, slide no. AD885 (ZIN), details of juxta; 95, same, details of valva with inner process



FIGURES 96–99. Male genitalia of *Manitscheria baryshnikovae* Diškus & Stonis, **sp. nov.**; 96, holotype, slide no. AD1015 (ZIN), general view, focused on lateral processes of juxta and tegumen; 97, same, focused on inner processes of juxta and phallus; 98, same, valvae; 99, same, vinculum



FIGURES 100–104. Male genitalia of *Manitischeria baryshnikovae* Diškus & Stonis, **sp. nov.**; 100, holotype, slide no. AD1015 (ZIN), lateral view, focused on valva, lateral processes of juxta, tegumen, and vinculum; 101, same, uncus; 102, same, fragment on lateral process of juxta; 103, same, fragment of inner process of juxta; 104, same, lateral view of genitalia, focused on phallus and uncus



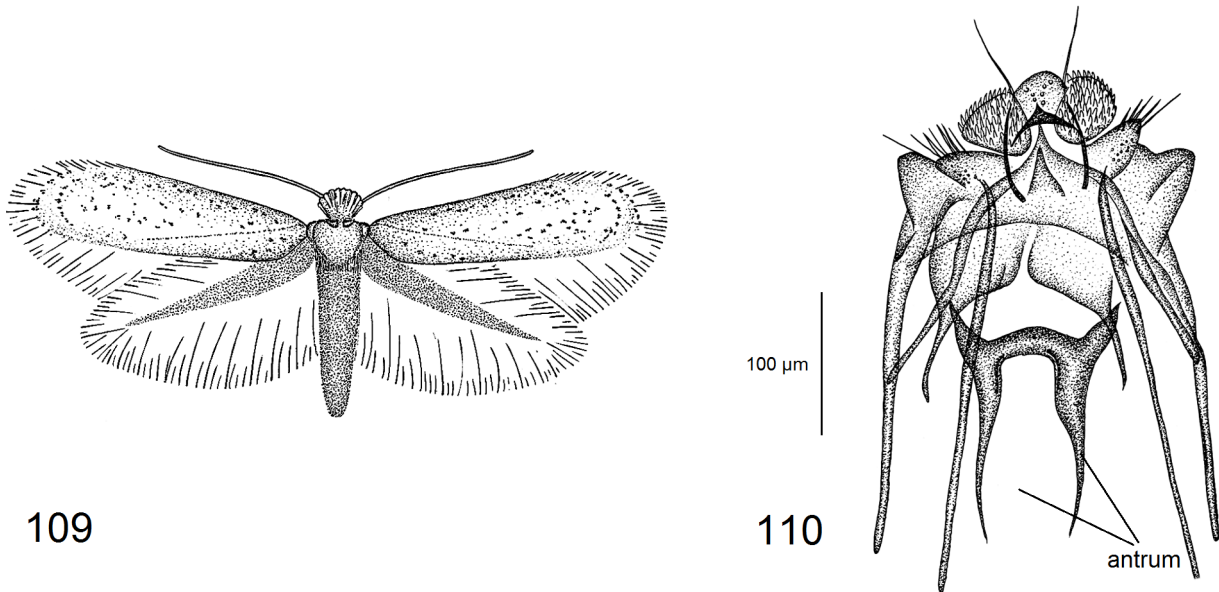
FIGURES 105–108. *Manitischeria* spp. 105, *M. baryshnikovae* Diškus & Stonis, **sp. nov.**, female genitalia, ovipositor lobes, apophyses, prela, and antrum, paratype, slide no. AD1014 (ZIN); 106, same, general view; 107, *M. selindica* Stonis & Diškus, **sp. nov.**, female adult, holotype (TMSA); 108, same, female genitalia, slide no. Diškus 0219 (TMSA)

Bionomics. Host plant is unknown. Adults occur in December.

Distribution. This species is known from the single locality of Abachaus, Namibia.

Etymology. This species is named after Namibia, the only country where it is known to occur.

Remarks. The species was left unnamed, but documented, in Puplesis & Diškus (2003). We name it now that its generic position is known.



FIGURES 109, 110. *Manitischeria namibiensis* Stonis & Diškus, **sp. nov.**; 109, female adult, holotype; 110, female genitalia, slide no. 6547 (TMSA)

Discussion

Trophic associations with plant families may reveal important data about taxonomic diversity and patterns, and the evolution of host use in Tischeriidae (e.g., Powell *et al.* 1999). Some Tischeriidae show great selectivity in their food choice (Stonis *et al.* 2019b, 2020b), but species can be either monophagous or oligophagous and feed on certain plant species or a few species of closely related host-plant genera (Stonis *et al.* 2018). In some cases, hypotheses about species host use can be determined at the genus level. For example, Asteraceae is a host plant family exclusive to the endemic American *Astrotischeria* Puplesis & Diškus (Diškus & Puplesis 2003). On the other hand, some plant families, such as the Malvaceae, are host to many species in different and phylogenetically distant genera.

Although host plant data are not commonly available, we found that visual study of herbarium specimens may yield additional data on insect-plant interactions, diversity, and their geographical distribution. *Manitischeria ptarmica* mines leaves of various *Ziziphus* species; the leaf mine was documented for the first time in this paper (Figs. 4–9). The combination of the host plant, *Ziziphus*, and the bent or rolled up margin of the mined leaf, is very specific data. Therefore, we examined *Ziziphus* herbarium specimens at the Royal Botanic Gardens, Kew, U.K. for *M. ptarmica* leaf mines. We visually searched about 1,000 herbarium specimens and discovered *M. ptarmica* leaf mines in one herbarium sheet from Thailand with the label: “C. F. Van Beusekom & C. Phengkklai 2644, 21 December, 1969, N. Thailand, prov. Chiang Mai, Fang, 20° N, 99°20' E, alt. ca 550 m, hot springs and surrounding evergreen forest.” Herbarium specimen sheets are a practical, and uniquely applicable, method for the discovery of lepidopteran leaf mines and associated data (also see Lees *et al.* 2011; Kirichenko *et al.* 2018).

Manitischeria species are associated with three plant families, Malvaceae, Betulaceae, and Rhamnaceae. The Malvaceae is the major host of *Manitischeria* because seven of the nine species with host plant data feed on this family, and two other species feed on Rhamnaceae and Betulaceae, respectively. All three host-plant families fall within the Rosid clade of the eudicot major angiosperm subgrouping. Within the Rosids, the Rhamnaceae and Betulaceae belong to the eudicot I grouping or Fabids, and the Malvaceae belong to the eudicot II or Malvid grouping (Angiosperm Phylogeny Group 2016). In this paper, we transferred *Manitischeria* from *Tischeria* whose hosts are

mostly Fagaceae, that is also part of the Fabid clade of the eudicot I grouping, with the exception of two American *Tischeria* species that utilize the Fabid Rhamnaceae.

Currently, *Manitischeria* species occur in the Old World (Fig. 111); including four species from East Asia (eastern Palearctic). Most of the species occur in the Palaeotropical region, which includes the Oriental region or tropical Asia and the Afrotropical region, most of Africa, excluding the Sahara and the Mediterranean coast.



FIGURE 111. Currently known distribution of *Manitischeria* species (map base, courtesy of T. Patterson, USA; modified). 1, *Manitischeria ptarmica* (Meyrick); 2, *Manitischeria zestica* (Meyrick); 3, *Manitischeria tyrocnistis* (Meyrick); 4, *Manitischeria relictana* (Ermolaev); 5, *Manitischeria puplesisi* (Kozlov); 6, *Manitischeria omani* (Puplesis & Diškus); 7, *Manitischeria antilope* (Puplesis, Diškus & Mey); 8, *Manitischeria sparmanniae* (Puplesis & Diškus); 9, *Manitischeria martinkrugi* (Puplesis & Diškus); 10, *Manitischeria selindica* Stonis & Diškus, **sp. nov.**; 11, *Manitischeria kuehnei* (Mey); 12, *Manitischeria unca* (Diškus & Stonis); 13, *Manitischeria kumatai* (Sato, Kobayashi & Hirowatari); 14, *Manitischeria armata* (Stonis, Diškus & Mey); 15, *Manitischeria brachiata* Diškus & Stonis, **sp. nov.**; 16, *Manitischeria symbolica* Diškus & Stonis, **sp. nov.**; 17, *Manitischeria baryshnikovae* Diškus & Stonis, **sp. nov.**; 18, *Manitischeria namibienis* Stonis & Diškus, **sp. nov.** *—This record is solely based on the leaf mines discovered in the Herbarium of the Royal Botanic Gardens, Kew, U.K. (see Discussion)

The majority of *Manitischeria* species are known only from their single, type localities due to insufficient sampling efforts. However, this study found that *M. ptarmica*, originally described from India by Meyrick (1908) and most recently discovered in the Emirates (van Nieukerken 2010), possesses a much broader distribution from the Arabian Peninsula to South East Asia; we report it from Pakistan and Laos for the first time. We discovered it has a greater distribution within India and also occurs in Mumbai, Karwar, and Pusa. We found that *M. ptarmica*, the type species, and *M. tyrocnistis* (see Fig. 111), have the broadest distributions among *Manitischeria* species.

Although *M. ptarmica* specimens from our morphological studies of the type series from India, specimens collected in Pakistan and Laos, and comparison to the documented material from the Arabian Peninsula (van Nieukerken 2010) showed a slight variation in the shape of the phallus and vinculum, we did not split the species into subspecies or separate species. That said, our unpublished and preliminary analysis with the mitochondrial COI gene revealed significant differences between the specimens from the Arabian Peninsula and Laos, and may indicate cryptic species within *M. ptarmica* that will be addressed in a subsequent publication (Stonis *et al. in prep.*).

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Contributions to the research

Contributions to this research are as follows: JRS: concept and design of research, diagnostics of new genus and new species, manuscript writing, and preparation of the illustrations; AD: field work and laboratory dissections of all treated species, discussion on diagnostics of *Manitischeria* and its species, photography of the holotype of *M. puplesisi*; MAS: manuscript writing, elaboration of the concept, and discussion of the results; AM: identification of the host plants, search for leaf mines of *M. ptarmica* on *Ziziphus* spp. in the Herbarium of the Royal Botanic Gardens, Kew, U.K., expertise and contribution to botanical issues.

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