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Discovery of the new *Coptotriche* species in China revealed two novel host-plant families and host-plant orders for Tischeriidae, a family of stenophagous, leaf-mining lepidopterans

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Abstract

The article describes three new species of *Coptotriche* Walsingham, 1890 from China and adjacent northern Vietnam: *C. camptotheca* Xu & Dai, **sp. nov.** feeding on *Camptotheca acuminata* Decne. (Nyssaceae); *C. turpinia* Xu & Dai, **sp. nov.** feeding on *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae); and *C. asiana* Diškus & Stonis, **sp. nov.** The latter appeared to be a narrow oligophagous species feeding on various *Symplocos* Jacq.: *S. sumuntia* Buch.-Ham. ex D. Don, *S. poilanei* Guill., and *Symplocos glauca* (Thunb.) Koidz. (Symplocaceae). Nyssaceae and Staphyleaceae are novel host-plant families of Tischeriidae. The new species are illustrated with photographs of adults, male and female genitalia, and leaf mines. The article also briefly discusses about the proportion of monophagous and oligophagous species of Tischeriidae.

Key words: leaf mines, Nyssaceae, Staphyleaceae, taxonomy, trumpet moths

Introduction

Describing new species seems to be one of the most fundamental tasks for the knowledge of biodiversity of our planet (Dubois 2011). Most of the species on Earth still await description. Closing this knowledge gap will require a renewed interest in exploration and taxonomy, and a continuing effort to catalog the existing biodiversity data in publicly available databases (Mora *et al.* 2011). However, the inventory of species diversity is often limited to the best-known groups of organisms and geographically is very uneven.

China, while vast and with a hugely diverse biota, is comparatively unexplored with respect to collection and study of Tischeriidae, especially in the provinces of the Oriental region. On the other hand, larvae of leaf mining Tischeriidae (or trumpet moths) are potential pests of wild and cultivated plants. They mine inside green tissues and produce leaf mines and can affect leaf photosynthesis and plant growth. For biological and morphological characterization of this family, we refer to the monographs by Braun (1972) and Puplesis & Diškus (2003) as well as the most recent papers (Diškus & Stonis 2015; Kobayashi *et al*. 2016; Xu *et al*. 2017; Stonis *et al.* 2019a, 2019b, 2020a, 2020b, 2020c, 2021; Stonis & Solis 2020).

The Tischeriid genus *Coptotriche* Walsingham, 1890 was restored to generic status by Puplesis & Diškus (2003). It is the largest genus in the family with about 60 species and the highest number of revealed host-plant species and families globally.

Though we expect Tischeriidae fauna to be very speciose and taxonomically diverse in China, prior to our study, only two species of *Coptotriche* were known from this country: *C. gaunacella* (Duponchel) and *C. japoniella* Puplesis & Diškus (Puplesis & Diškus 2003). *C. gaunacella* is one of the most common potential pests on plum trees in

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Europe, western Asia, and northern China (Puplesis & Diškus 2003; Kullander *et al*. 2011; Yu 2016). *C. japoniella* is a common leaf miner on *Eurya* (Theaceae) in East Asia, including Japan and central and southern China (Puplesis & Diškus 2003; Huang & Tan 2009; Oishi & Sato 2009).

In this paper, we describe three new species: *Coptotriche camptotheca* Xu & Dai, **sp. nov.** feeding on *Camptotheca acuminata* Decne. (Nyssaceae, Cornales, i.e. a novel host plant family and order); *C. turpinia* Xu & Dai, **sp. nov.** feeding on *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae, Crossosomatales, a novel host plant family and order); and *C. asiana* Diškus & Stonis, **sp. nov.** The latter appears to be a narrow oligophagous species feeding on various *Symplocos* Jacq.: *S. sumuntia* Buch.-Ham. ex D. Don, *S. poilanei* Guill., and *Symplocos glauca* (Thunb.) Koidz. (Symplocaceae).

Materials and methods

The description of the new species is based on the material deposited in the entomological collections of the Nanling Herbarium, Gannan Normal University, China (GNU). Some paratypes of *Coptotriche asiana* **sp. nov.** are also deposited at the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia (ZIN) and the Nature Research Centre, Vilnius, Lithuania (NRC).

The studied specimens were reared from mining larvae from July to October in 2012–2017 in Jiangxi, China, and in February of 2015 in the Lao Cai Province, northern Vietnam.

The adult external morphology of *C. camptotheca* **sp. nov.** and *C. turpinia* **sp. nov.** from China was examined with a Leica M-205C stereomicroscope and photographed with a Leica DFC-450 digital camera connected to a Leica M-205C stereomicroscope. The adults of *C. asiana* and the Vietnamese specimen of *C. turpinia* were measured and studied using Lomo stereoscopic microscopes MBS-10 and photographed using a Leica S6D stereoscopic microscope with an attached Leica DFC290 digital camera.

Dissections of genitalia of the material from China were produced under an Olympus SZX-7 stereomicroscope. Genital morphology was examined with an Olympus BX-53 microscope and photographed with an Olympus DP-26 digital camera connected to a Leica M-205C microscope. Genitalia of *C. asiana* and Vietnamese specimen of *C. turpinia* were studied and photographed with a Leica DM2500 microscope and a Leica DFC420 digital camera.

The descriptive terminology, with a few exceptions, follows Puplesis & Diškus (2003). The identification of host plants was undertaken by experts in plant taxonomy (see Acknowledgements).

Descriptions of new species with records of novel host plants

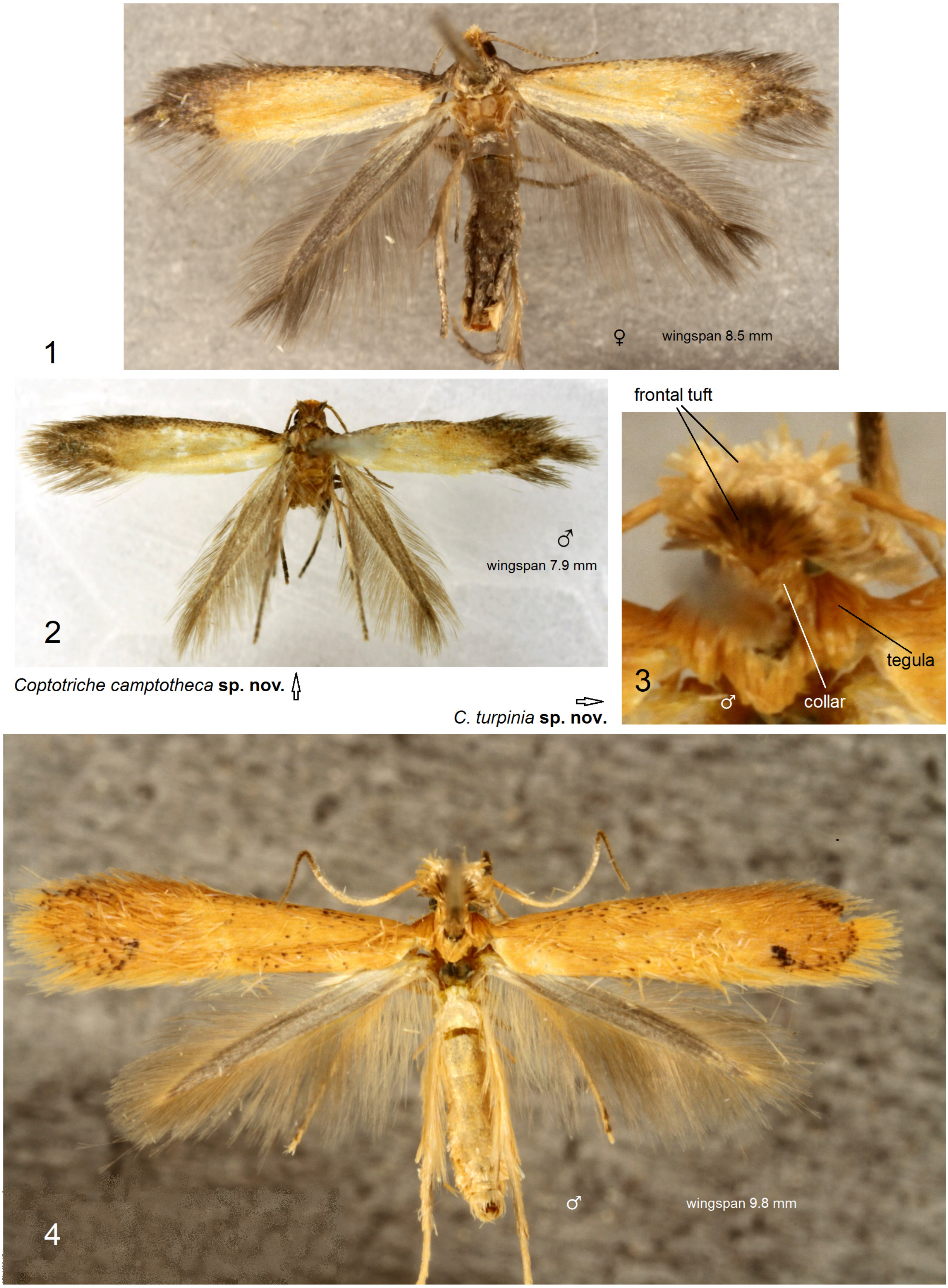
Coptotriche camptotheca Xu & Dai, sp. nov.

http://zoobank.org/NomenclaturalActs/B78B1D24-898A-450A-8AD9-B2EC657D1AC0
(Figs. 1, 2, 12–18, 49–55)

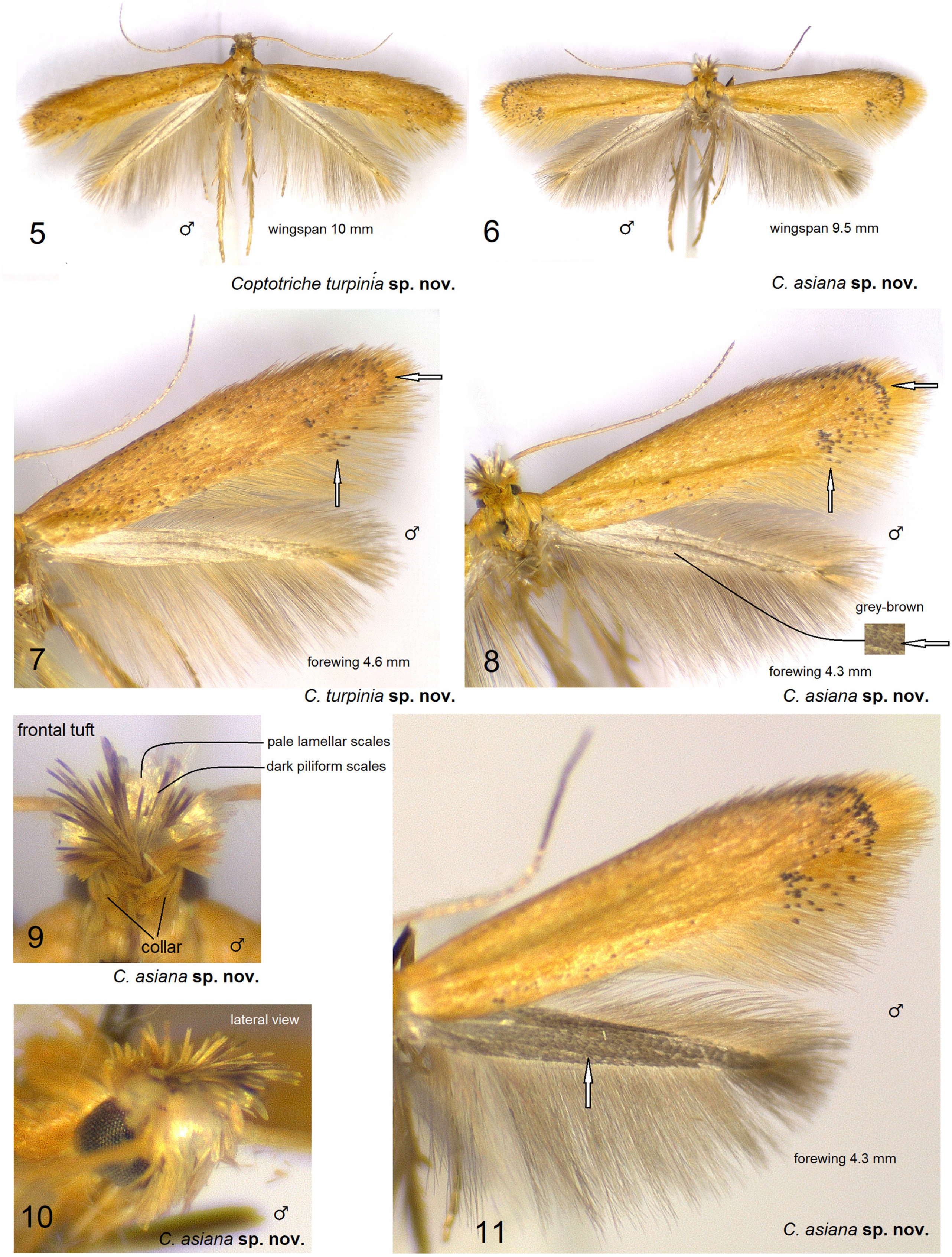
Type material. Holotype: 1 ♂, CHINA, Jiulianshan, Longnan County, Ganzhou City, Jiangxi Province, 24.585 N, 114.514 E, elevation 370 m, feeding larvae on *Camptotheca acuminata* Decne. (Nyssaceae), adults emerged 24–26.viii.2012, Jiasheng Xu, genitalia slide no. BX12094 ♂ (GNU). Paratypes: 1 ♀, same label data as holotype, genitalia slide no. BX12093♀ (GNU) and 1 ♂, 1 ♀, CHINA, Yunwushan, Guiding County, Qiannan Buyei and Miao Autonomous Prefecture, Guizhou Province), genitalia slide no. Liu0117 and Liu01160001 (GNU).

Diagnosis. External characters are not informative and insufficient for species differentiation in most cases of *Coptotriche* (or many other Tischeriidae), including this new species. In the male genitalia, the combination of a very slender phallus with a strongly widened apex (Fig. 17), distinctive spines on anellus (Fig. 14), and a rounded vinculum (Fig. 12) distinguish *C. camptotheca* **sp. nov.** from all other congeneric species. In the female genitalia, the distinctive spines on ductus spermathecae (Fig. 16) make this species unique. The host plant *Camptotheca acuminata* (Nyssaceae) also makes this species distinctive because there are no other species known to be feeding on Nyssaceae.

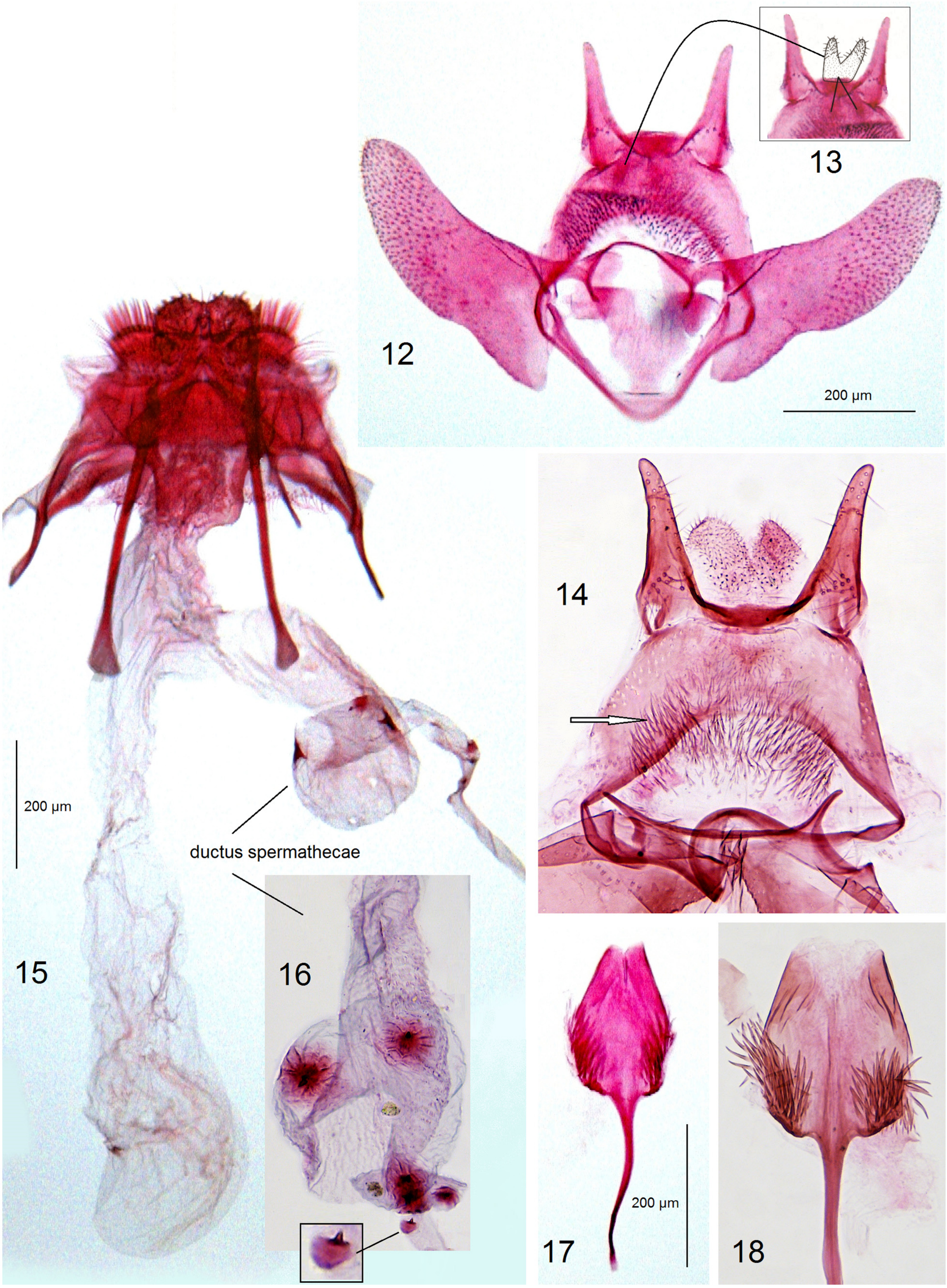
Male (Fig. 2). Forewing length about 3.6 mm, wingspan 7.9 mm (n = 1). Head: frons, palpi and pecten glossy cream to fuscous; frontal tuft comprised of slender lamellar scales, brown, distally cream; collar glossy cream; antenna slightly longer than one half of the length of forewing; flagellum dark brown on upper side, pale ochre on underside;



FIGURES 1–4. Adults of new *Coptotriche* species. 1, *C. camptotheca* Xu & Dai, **sp. nov.**, female paratype, Jiangxi Province, China; 2, same, another female paratype (GNU); 3, 4, *C. turpinia* Xu & Dai, **sp. nov.**, male holotype, Jiangxi Province, China (GNU)



FIGURES 5–11. Adults of new *Coptotriche* species. 5, 7, *C. turpinia* Xu & Dai, **sp. nov.**, male paratype, Lao Cai Province, Vietnam (ZIN); 6, 8–11, *C. asiana* Diškus & Stonis, **sp. nov.**, male paratype, Lao Cai Province, Vietnam (ZIN)



FIGURES 12–18. Genitalia of *Coptotriche camptotheca* Xu & Dai, **sp. nov.** 12, 13, male genitalia, paratype, slide no. BX12094. 14, same, another paratype, slide no. Liu0117; 15, female genitalia, paratype, slide no. BH12093; 16, same, another paratype, slide no. Liu01160001; 17, male genitalia, phallus, paratype, slide no. BX12094; 18, same, another paratype, slide no. Liu0117 (GNU)

sensilla long. Thorax: ochre to ochre-brown; tegula ochre-brown. Forewing greyish yellow-ochre, densely speckled with black-brown scales along costal margin and apically; fringe yellowish grey to dark brown, without fringe line; forewing underside dark grey-brown. Hindwing dark grey-brown on upper side and underside; fringe yellowish brown. Legs ochreous cream to brownish cream, densely covered with greyish brown to black-grey scales on upper side. Abdomen glossy, ochre to dark brown on upper side and underside; anal plates large, dark brown-grey.

Female (Fig. 1). Forewing length 3.3–3.8 mm, wingspan 7.7–8.5 mm (n = 2). Antenna half the length of forewing; flagellum without visible sensilla. Forewing stronger speckled with black-brown scales on tornus than in male. Hindwing and fringe grey. Otherwise, as in male.

Male genitalia (Figs. 12–14, 17, 18). Capsule about 550 μm long. Uncus with two long lateral lobes. Socii membranous, distinctive (Figs. 13, 14). Tegumen short, with long lateral arms (Fig. 14). Valva about 445 μm long, gradually narrowing towards apex but rounded distally (Fig. 12). Transtilla with a short and very slender transverse bar and medium-short sublateral processes. Vinculum rounded anteriorly. Anellus membranous, covered with distinctive spines (Fig. 14). Phallus about 500 μm long (Fig. 17), very slender, with a strongly extended tulip-shaped apex and two short, lateral bands of spines.

Female genitalia (Figs. 15, 16). Total length about 1450 μm. Ovipositor lobes large, clothed with short, modified, peg-like setae. Second pair of lobes almost equal to the main ovipositor lobes. Anterior apophyses significantly shorter than posterior apophyses; the latter widened distally. Prela comprised of three pairs of rod-like projections. Vestibulum without antrum, slightly thickened laterally. Ductus bursae considerably narrower than corpus bursae, without spines. Corpus bursae membranous, without spines or signa. Ductus spermathecae wide in proximal part, with distinctive spines (Fig. 16).

Bionomics (Figs. 49–55). The host plant is *Camptotheca acuminata* Decne. (Nyssaceae), an evergreen tree (Fig. 50). Larvae mine leaves in August. The first to second larval instars produce a small, irregular, white blotch-like mine (Fig. 51); with the growth of the larvae, the mine expands into a long blotch-like mine (Figs. 54, 55). There is usually one mine per a leaf (Figs. 52, 53, 55). Pupation inside of the mine. Adults fly in late August and possibly September. Otherwise, biology is unknown.

Distribution. Currently known from the two localities in the Jiulianshan Mountains (China: Jiangxi Province) and the Yunwushan Mountains (China: Guizhou Province) at elevation of ca. 400 m along roadsides in the montane subtropical broadleaf evergreen forest (Fig. 49).

Etymology. The new species is named after the host plant, *Camptotheca* Decne.

Coptotriche turpinia Xu & Dai, sp. nov.

http://zoobank.org/NomenclaturalActs/B7F19F95-1D51-4D54-9FC5-ABAB470C622A
(Figs. 3–5, 7, 19–28, 56–61)

Type material. Holotype: 1 ♂, CHINA, Wuzhifeng, Shangyou County, Ganzhou City, Jiangxi Province, 25.987 N, 114.195 E, elevation 394 m, feeding larvae on *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae), adults emerged 30.vi.2014, Jiasheng Xu, genitalia slide no. BX15012♂ (GNU). Paratypes (7 ♂): 6 ♂, same label data as holotype, genitalia slide no. Liu0087001♂ (GNU); 1 ♂, VIETNAM, Lao Cai Province, 15 km NW Sa Pa, 22°21'3"N, 103°46'16"E, elevation ca. 1910 m, from feeding larva 21.ii.2015, ex pupa iii.2015, field card no. 5198, A. Diškus, genitalia slide no. AD1056♂ (ZIN).

Diagnosis. Externally, *C. turpinia* **sp. nov.** is most similar to *C. asiana* **sp. nov.** (described below). From the latter, *C. turpinia* usually differs in the less distinctive dark marking of the forewing and the paler hindwing; however, some specimens of *C. turpinia* may be undistinguishable from *C. asiana*. In the male genitalia, the combination of a short distal process of the vinculum (Figs. 19, 20, 27), sinuous valva (Figs. 19, 20, 24), distinctive posterior excavations of vinculum (Fig. 25), and distinctly short tegumen (Figs. 19, 26) distinguish the new species from the most similar Japanese *C. symplocosella* Kobayashi & Hirowatari (see Kobayashi *et al*. 2016) and *C. asiana*. The host plant *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae) also makes this species distinctive because there are no other species feeding on *Turpinia* Vent.

Male (Figs. 4–6). Forewing length 3.9–4.6 mm, wingspan 8.9–10.0 mm (n = 8). Head: frons, palpi and pecten ochreous cream to glossy whitish cream; frontal tuft comprised of lamellar scales, cream white to ochreous yellow, grey-brown basally; collar glossy, ochreous cream to ochreous yellow, comprised of slender lamellar scales; antenna significantly longer than one half of the length of forewing; flagellum ochre-yellow to ochreous cream, with about 37 segments; sensilla whitish cream, very fine, rather indistinctive. Thorax: ochreous cream to ochreous yellow, distally usually brown; tegula ochreous cream usually with some ochre scales or entirely ochreous yellow. Forewing ochreous cream to ocherous yellow, with some sparsely distributed brown-black or black scales which apically form a rather indistinctive C-shaped streak and small, irregular, rather indistinctive spot on tornus; fringe ochreous grey to ocherous yellow, without fringe line; forewing underside densely speckled with grey-brown or ochre-brown scales, except a large area below the fold. Hindwing pale grey to blackish grey on upper side and underside; fringe ochre glossy, pale grey or ochre-grey to blackish gray. Legs pale ochre to ochre-yellow, usually darkened with black-grey scales on upper side. Abdomen pale ochre to yellowish grey on upper side and underside; genital segments large, pale brown to yellowish cream; anal tuft dorsal, long, pale ochre-yellow to pale brown.

Female. Unknown.

Male genitalia (Figs. 19–28). Capsule 490–550 µm long. Uncus with two long lateral lobes. Socii membranous, distinctive (Figs. 19, 23). Tegumen distinctly short (Fig. 26), with long lateral arms (Figs. 19, 20, 26). Valva 405–500 µm long, wide (Fig. 19) and slightly sinuous (Figs. 19, 24). Transtilla with medium-short sublateral processes (Fig. 23) and a short transverse bar; the latter may be relatively wide (Fig. 23). Vinculum rounded (Fig. 19) or with a very small process anteriorly (Figs. 20, 27). Anellus indistinctive, membranous. Phallus 650–710 µm (occasionally 940 µm) long (Figs. 21, 25), very slender, with a strongly extended tulip-shaped apex and two long lateral bands of spines.

Bionomics (Figs. 56–61). The host plant is *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae), an evergreen tree (Figs. 56, 58). Larvae mine leaves from December until early May of the subsequent year (*C. turpinia* seems to be hibernating in the larval stage). Morphology (shape and colour) of leaf mines change in the course of their development (Figs. 57–61). There are usually 2–5 mines per leaf (Figs. 58, 59). Mature larva is pale grey, 9.0–10.0 mm long. Pupation in a nidus at the end of the mine. Exit slit on upper side of the leaf, close to the end of the leaf mine.

Distribution. The new species is known from China (Jiangxi Province) and northern Vietnam (Lao Cai Province).

Etymology. The new species is named after the host plant, *Turpinia* Vent.

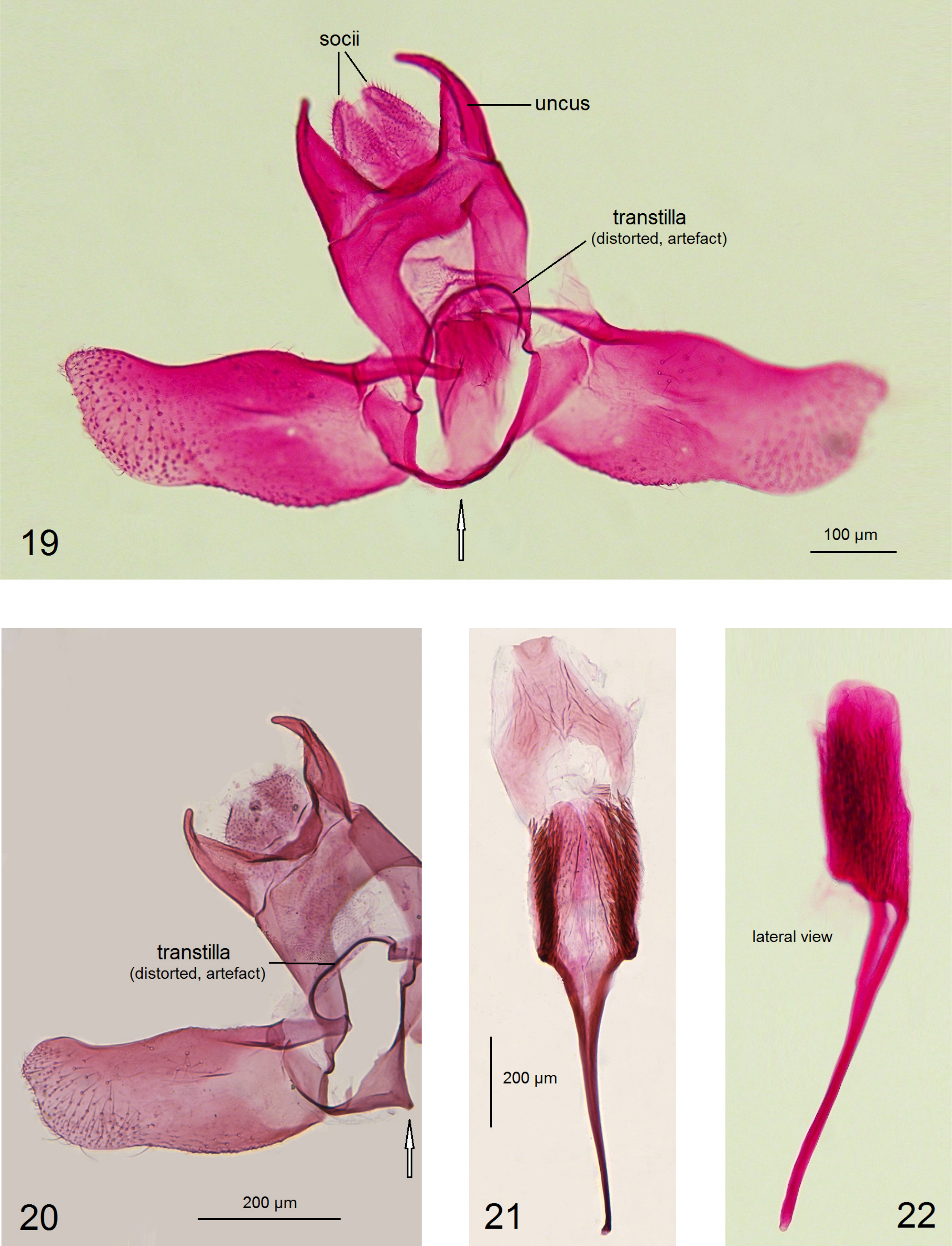
Coptotriche asiana Diškus & Stonis, sp. nov.

http://zoobank.org/NomenclaturalActs/D53FA683-FDEA-4710-97DB-73B79D02E66E
(Figs. 7–11, 29–48, 62–79)

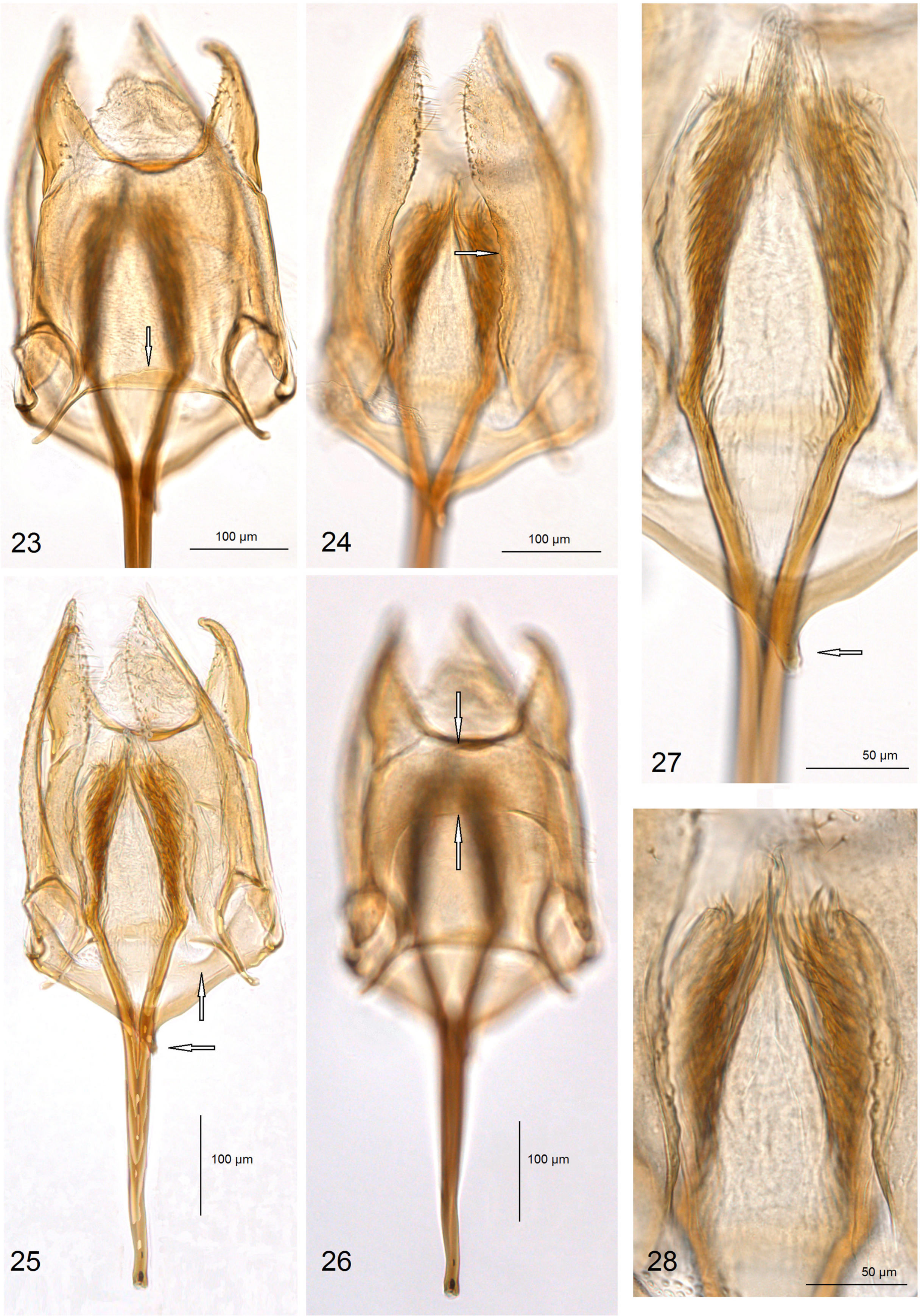
Type material. Holotype: ♂, VIETNAM, Lao Cai Province, 15 km NW of Sa Pa, 22°20’58”N, 103°46’16”E, elevation ca. 1920 m, mining larva on *Symplocos sumuntia* Buch.-Ham. ex D. Don (Symplocaceae), 20.ii.2015, ex pupa iii.2015, field card no. 5191, A. Diškus, genitalia slide no. AD1044 (ZIN). Paratypes (13 ♂, 5 ♀): 6 ♂, 2 ♀, same label data as holotype, genitalia slides nos. AD1043♂ (from adult in pupal exuviae), AD1041♀ (ZIN); 5 ♂, 3 ♀, 15 km NW of Sa Pa, 22°20’53” N, 103°46’15” E, elevation ca. 1910 m, mining larvae on *Symplocos poilanei* Guill. (Symplocaceae), 20.ii.2015, ex pupa iii.2015, field card no. 5193, A. Diškus, genitalia slides nos. AD1057♂, AD1053♀ (GNU); 2 ♂, 15 km NW of Sa Pa, 22°21’2”N, 103°46’17”E, elevation 1920 m, mining larva on *Symplocos glauca* (Thunb.) Koidz. (Symplocaceae), 21.ii.2015, ex pupa iii.2015, field card no. 5197, A. Diškus, genitalia slides. nos AD944♂ (from adult in pupal exuviae), AD1054♂ (NRC).

Diagnosis. Externally, *C. asiana* **sp. nov.** is most similar to *C. turpinia* **sp. nov.** (described above). From the latter, *C. asiana* often differs in the very distinctive dark marking of the forewing and the dark hindwing; however, some specimens of *C. asiana* may be undistinguishable from *C. turpinia*. In the male genitalia, the combination of a long distal process of the vinculum (Figs. 36, 39), strongly excavated valva (Figs. 36, 37, 42), and a long, anteriorly distinctly thickened tegumen (Fig. 38) distinguish this new species from the most similar *C. symplocosella* Kobayashi & Hirowatari (see Kobayashi *et al*. 2016) and *C. turpinia*. The host plant genus *Symplocos* is shared only with the Japanese *C. symplocosella*, but the latter possesses different genitalia with a short vinculum and slender valva.

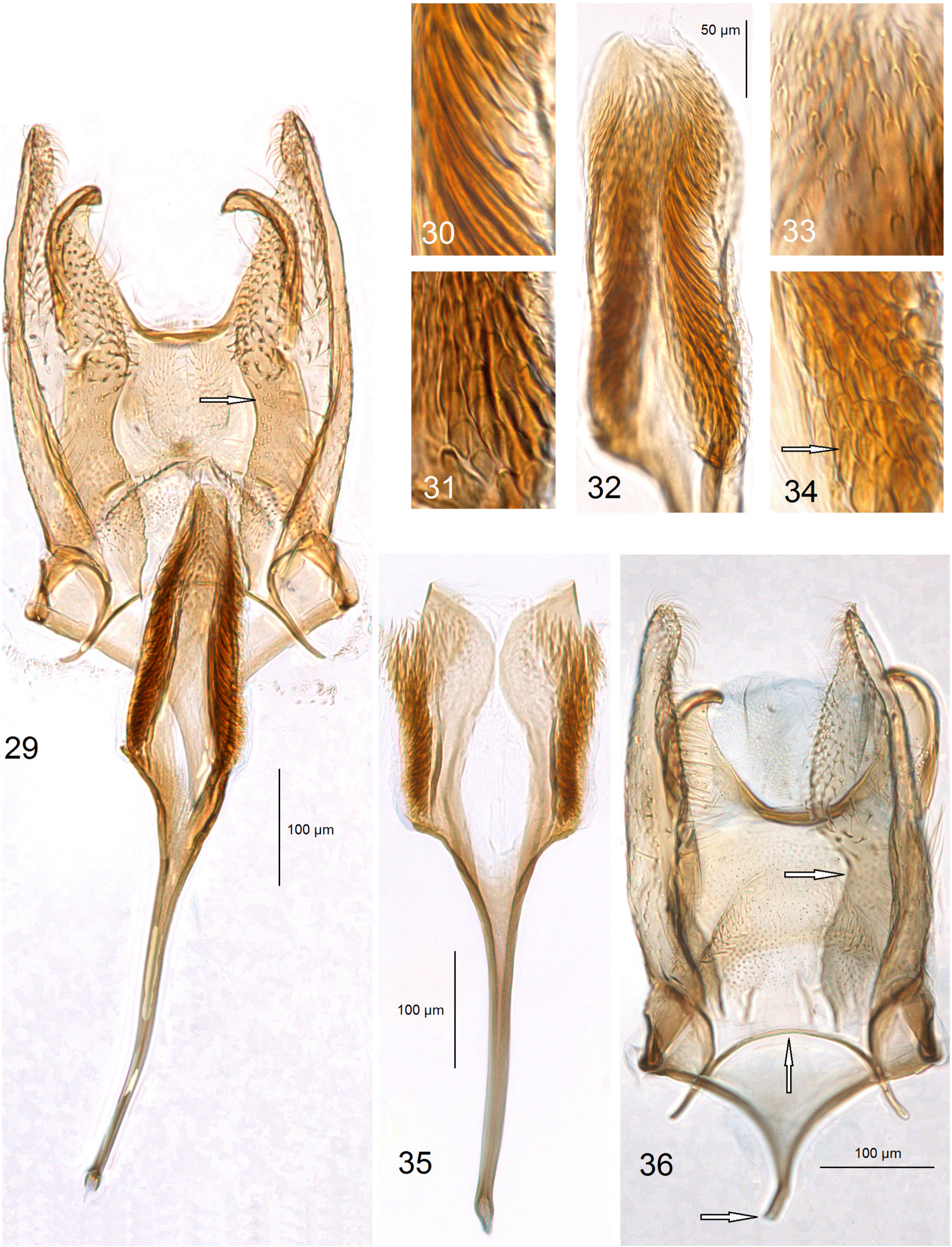
Male (Figs. 8–11). Forewing length 4.1–4.5 mm, wingspan 9.0–9.8 mm (n = 10). Head: frons, palpi and pecten glossy yellowish cream; frontal tuft comprised of yellowish cream lamellar scales and grey, long, piliform-like scales (Figs. 9, 10); collar ochreous yellow; antenna significantly longer than one half of the length of forewing; flagellum ochre-yellow; sensilla whitish cream, very fine, rather indistinctive. Thorax: ochreous yellow, sometimes



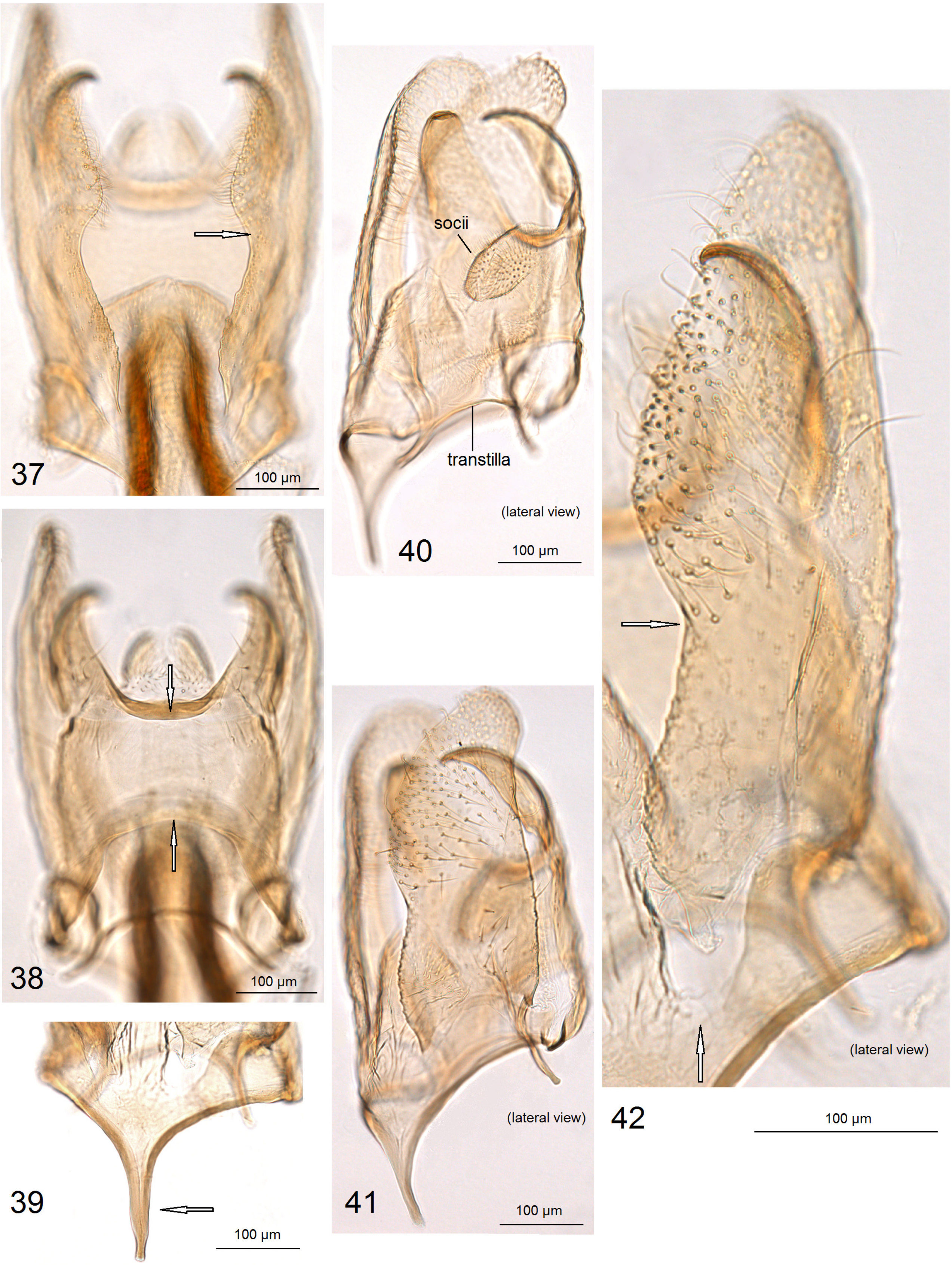
FIGURES 19–22. Male genitalia of *Coptotriche turpinia* Xu & Dai, **sp. nov.**, Jiangxi Province, China (GNU). 19, capsule with phallus removed, holotype, slide no. BX15012; 20, same, paratype, slide no. Liu0087001; 21, same, ventral view of phallus, paratype, slide no. Liu0087001; 22, lateral view of phallus, holotype, slide no. BX15012



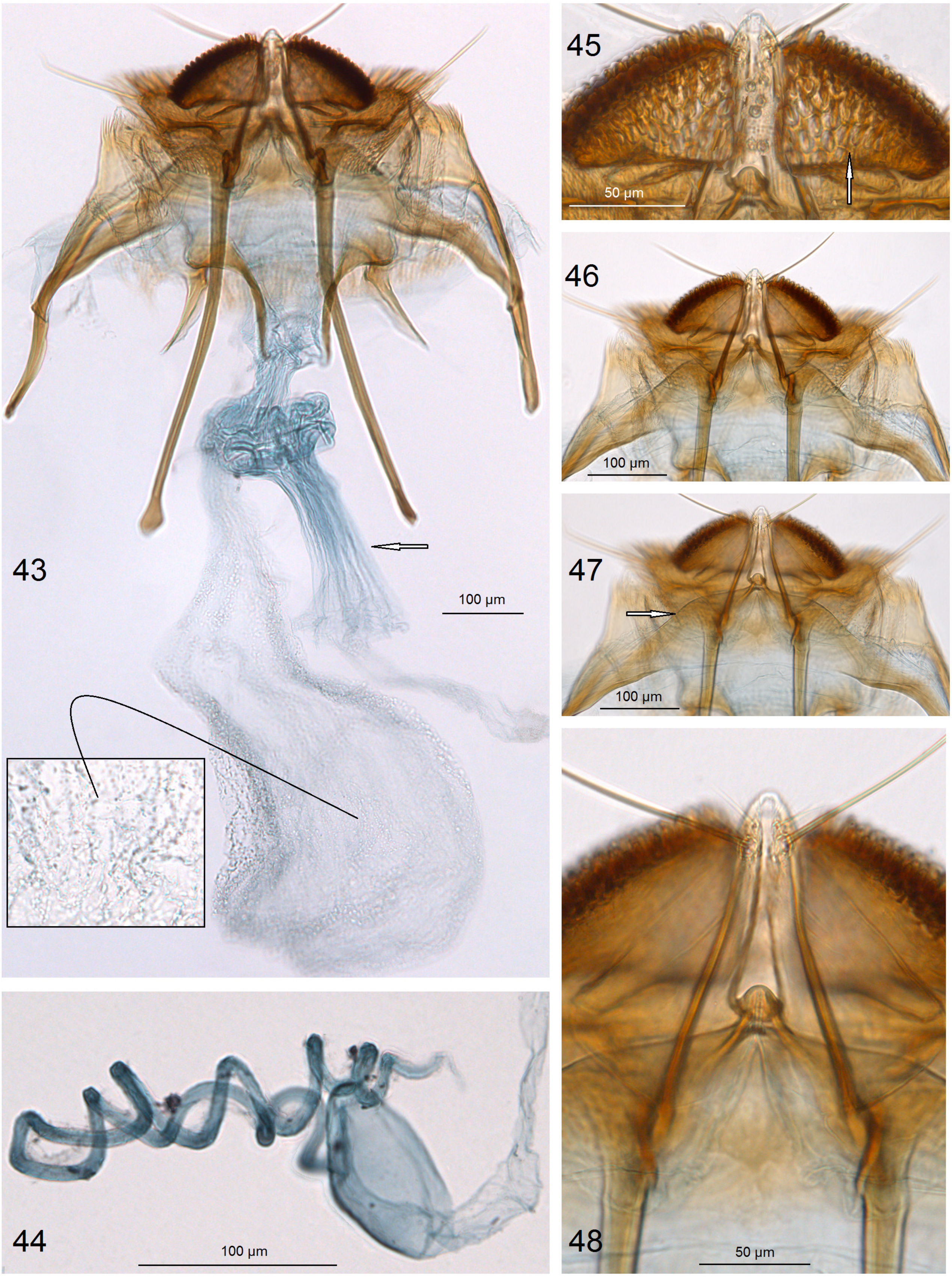
FIGURES 23–28. Male genitalia of *Coptotriche turpinia* Xu & Dai, **sp. nov.**, Lao Cai Province, Vietnam, paratype, slide no. AD1056 (ZIN). 23, ventral view, focused on uncus and transtilla; 24, same, focused on valva; 25, same, multifocus; 26, same, focused on tegumen; 27, same, focused on vinculum; 28, same, focused on spines of phallus



FIGURES 29–36. Male genitalia of *Coptotriche asiana* Diškus & Stonis, **sp. nov.**, Lao Cai Province, Vietnam. 29, general view, holotype, slide no. AD1044 (ZIN); 30–34, spines of phallus, paratype, slide no. AD1057 (GNU); 35, phallus, paratype, slide no. AD944 (NRC); 36, same, capsule, with phallus removed

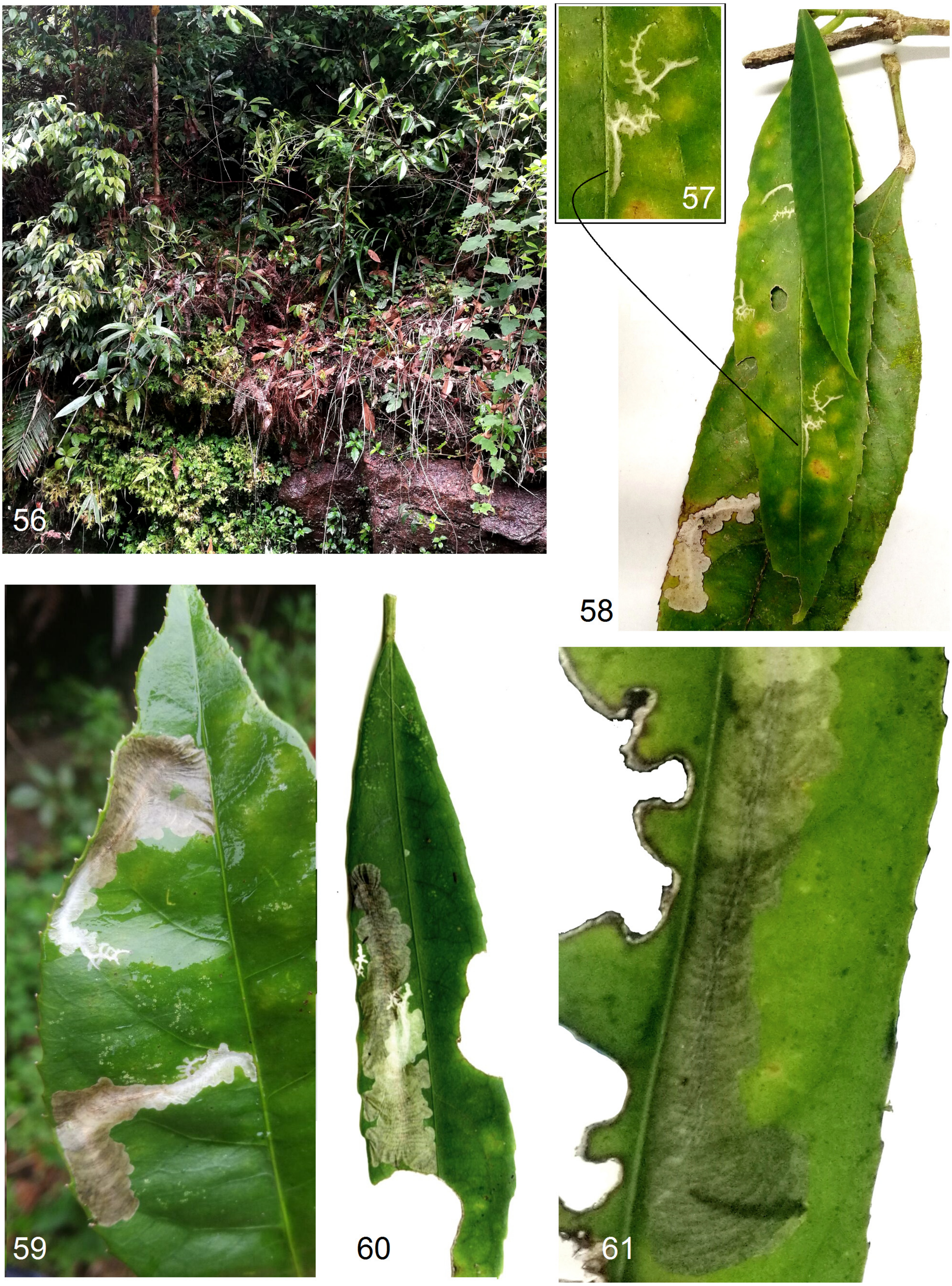


FIGURES 37–42. Male genitalia of *Coptotriche asiana* Diškus & Stonis, **sp. nov.** 37, 38, ventral view of capsule, paratype, slide no. AD1054 (NRC); 39, vinculum, paratype, slide no. AD1057 (GNU); 40, 41, lateral view of capsule with phallus removed, paratype, slide no. AD1043 (ZIN); 42, lateral view of valva, paratype, slide no. AD1057 (GNU)



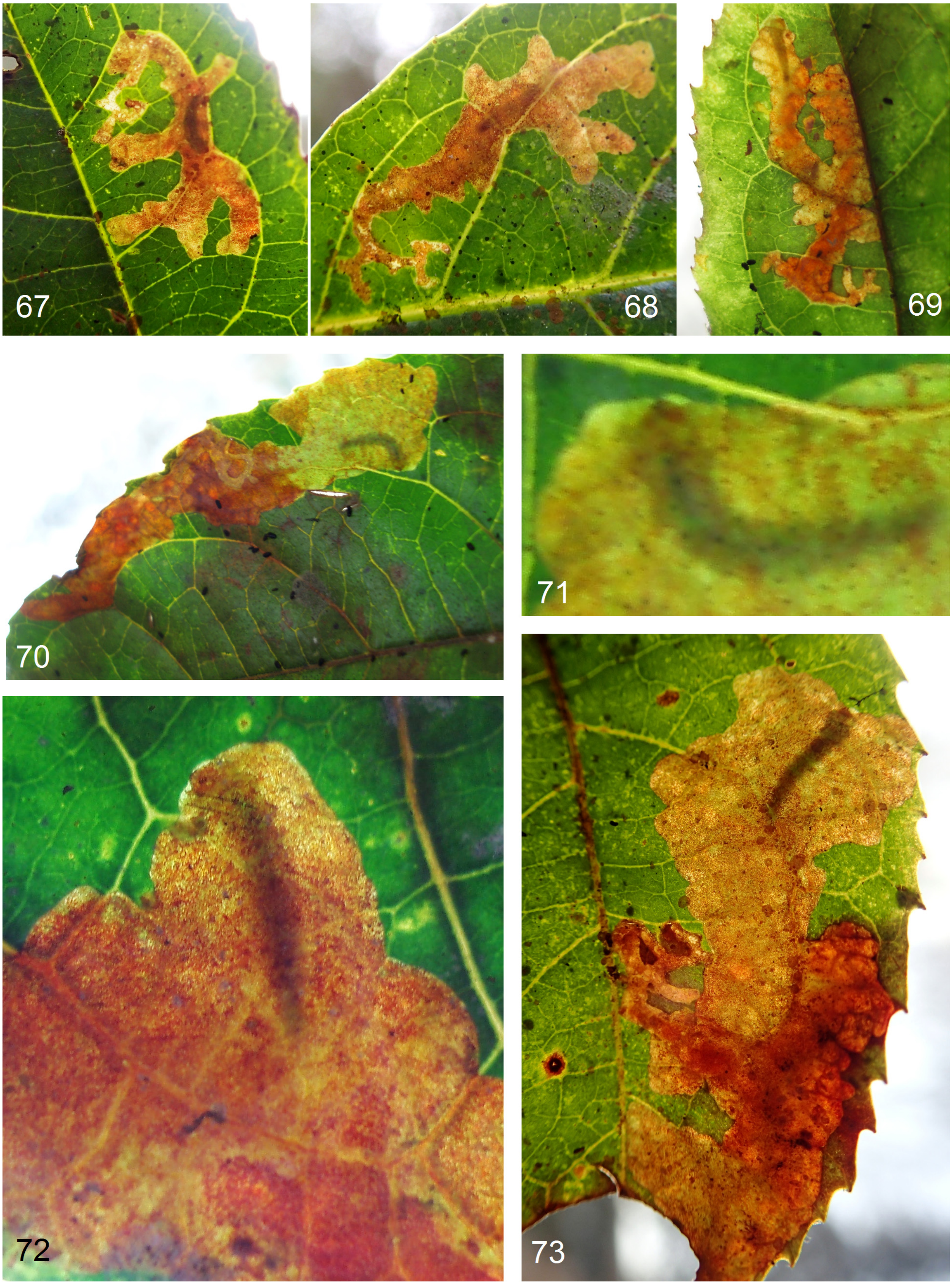
FIGURES 43–48. Female genitalia of *Coptotriche asiana* Diškus & Stonis, **sp. nov.** 43, general view, paratype, slide no. AD1053 (GNU); 44, coils of ductus spermathecae, paratype, slide no. AD1041 (ZIN); 45–48, variously focused on ovipositor lobes, paratype, slide no. AD1053 (GNU)

FIGURES 49–55. Bionomics of *Coptotriche camptotheca* Xu & Dai, **sp. nov.** 49, habitat, Guizhou Province, China; 50, host plant *Camptotheca acuminata* Decne. (Nyssaceae); 51–55, leaf mines

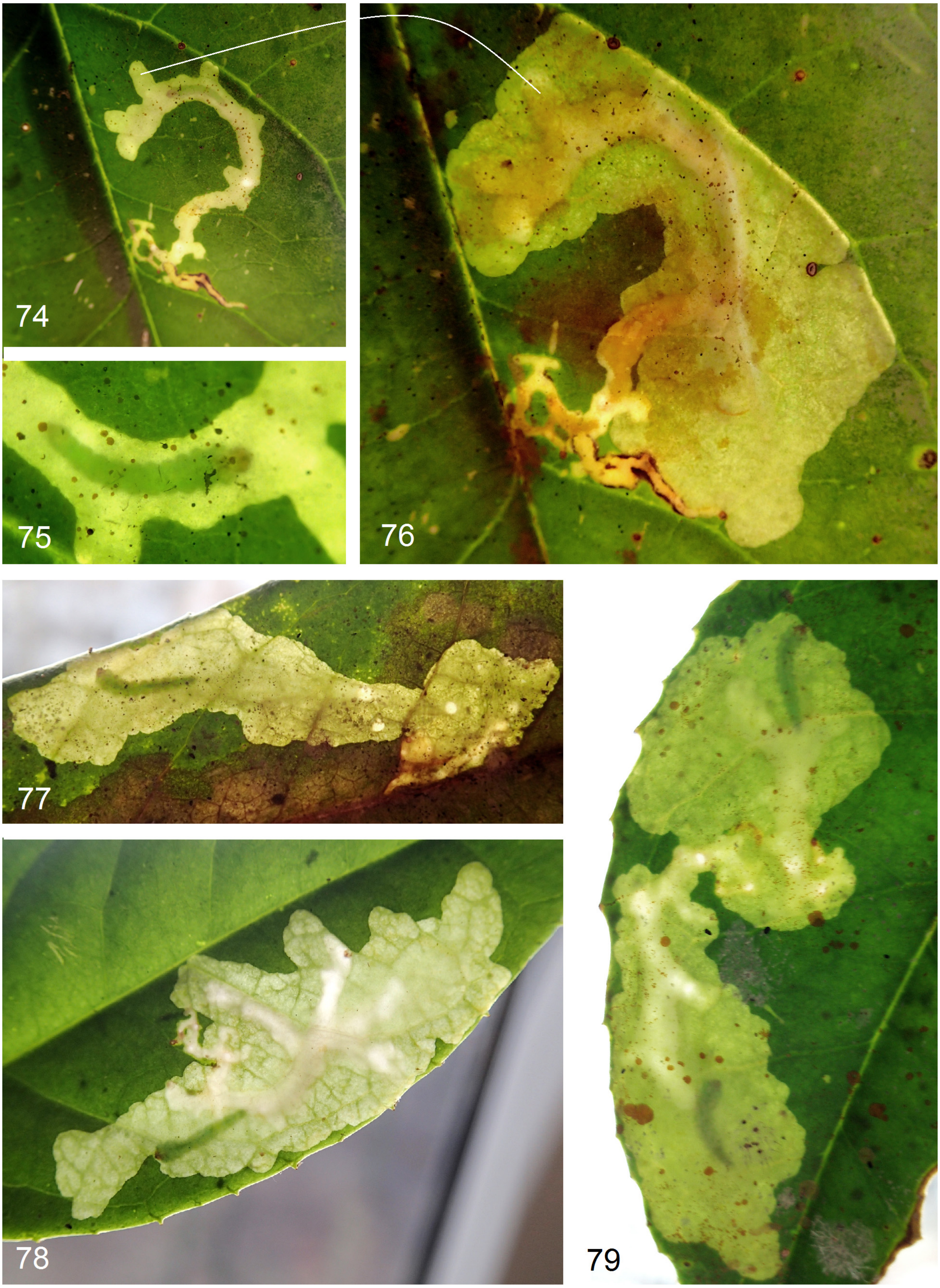


FIGURES 56–61. Bionomics of *Coptotriche turpinia* Xu & Dai, **sp. nov.** 56, habitat, Jiangxi Province, China; 57–61, leaf mines on *Turpinia arguta* (Lindl.) Seem. (Staphyleaceae)

FIGURES 62–66. Habitat and host plants of *Coptotriche asiana* Diškus & Stonis, **sp. nov.** 62, habitat 15 km NW of Sa Pa, Lao Cai Province, Vietnam, 22°20'N, 103°46'E, elevation ca. 1900 m; 63, *Symplocos sumuntia* Buch.-Ham. ex D. Don, sample no. 5191; 64, *S. poilanei* Guill., sample no. 5193; 65, 66, *Symplocos glauca* (Thunb.) Koidz., sample no. 5197



FIGURES 67–73. Leaf mines of *Coptotriche asiana* Diškus & Stonis, **sp. nov.** on *Symplocos sumuntia* Buch.-Ham. ex D. Don (Symplocaceae), sample no. 5191, Lao Cai Province, Vietnam



FIGURES 74–79. Leaf mines of *Coptotriche asiana* Diškus & Stonis, **sp. nov.** on *Symplocos poilanei* Guill. (Symplocaceae), sample no. 5193, Lao Cai Province, Vietnam

with some brown scales distally; tegula ochreous yellow. Forewing ochreous yellow to bright ochre, with some sparsely distributed brown-black or black scales which apically form a distinctive C-shaped streak and small spot on tornus; fringe ocherous yellow, without fringe line; forewing underside densely speckled with ochre-brown scales, except for a large area below the fold. Hindwing dark grey on upper side and underside but may look paler depending on angle of view (Fig. 8); fringe ochre glossy, pale grey. Legs pale ochre-yellow, darkened with black-grey scales on upper side. Abdomen yellowish grey on upper side and underside; genital segments large, yellowish cream; anal tuft dorsal, long, ochre-yellow to yellowish cream.

Female. Forewing length 4.5–5.0 mm, wingspan 9.8–11.3 mm (n = 6). Hindwing slightly wider than in male. Otherwise, similar to male.

Male genitalia (Figs. 29–42). Capsule about 730 µm long. Uncus with two long lateral lobes. Socii membranous, sometimes indistinctive. Tegumen relatively long (150–170 µm), with long lateral arms. Valva about 435 µm long, wide (Fig. 41), in ventral view, with a distinctive median excavation (Figs. 29, 36, 37, 42). Transtilla with medium-long sublateral processes and a slender, slightly curved transverse bar (Fig. 36). Vinculum with a distinctive, about 150 µm long process (Figs. 36, 39). Anellus distinctive, membranous, with numerous tiny spines (Fig. 29). Phallus 560–680 µm long (Figs. 29, 35), very slender, with a strongly extended tulip-shaped apex and two long lateral bands of spines (Figs. 30–34).

Female genitalia (Fig. 43–48). Total length about 1245 µm. Ovipositor lobes very large (Fig. 45), densely clothed with short, modified, peg-like setae. Second pair of lobes weakly developed, rather indistinctive (Figs. 46, 47). Anterior apophyses significantly shorter than posterior apophyses; the latter sometimes slightly widened distally. Prela comprised of three pairs of rod-like projections. Vestibulum without antrum, slightly thickened laterally. Ductus bursae slender, without spines. Corpus bursae oval, membranous, without spines or signa. Ductus spermathecae wide and folded in proximal part (Fig. 43), with 8–10 large coils distally (Fig. 44).

Bionomics (Figs. 62–79). Host plants are various *Symplocos* spp., including *S. sumuntia* Buch.-Ham. ex D. Don (Fig. 63), *S. poilanei* Guill. (Fig. 64), and *S. glauca* (Thunb.) Koidz. (Figs. 65, 66) (Symplocaceae). The larvae mine leaves in February. The leaf mines vary from distinctly reddish (Figs. 67–73) to white (Figs. 74–79). The shape of the leaf mines changes in the course of their development (Figs. 74, 76). Adults fly in March. Pupation in silken nidus, inside of the leaf mine.

Distribution. *Coptotriche asiana* is known from three sites close to Sa Pa, Lao Cai Province, northern Vietnam, at elevation of about 1900–2000 m (Fig. 62).

Etymology. The new species is named after the continent where it occurs.

Discussion

The guild of phytophagous insects is among the most speciose and taxonomically diverse groups of organisms on the planet. It has been estimated that nearly half of all insect species consume plants or their products and are thus referred to as phytophagous (Schoonhoven *et al*. 2005). Additionally, most of the estimated two to five million phytophagous insect species are highly host-specific, usually feeding on a small selection of the plant species that they encounter over their lifetime (Strong *et al.* 1984; Mitter *et al*. 1988; Jaenike 1990).

The leaf-mining larvae of Tischeriidae are very selective of their host plants, i.e. stenophagous: monophagous or oligophagous (Stonis *et al*. 2018). Prior to our studies, Tischeriidae were known to be trophically associated with plants of 10 orders of flowering plants (rosids and asterids I core eudicot angiosperms): Malpighiales (Euphorbiaceae and Hypericaceae); Fabales (Fabaceae); Rosales (Rhamnaceae, Rosaceae, Ulmaceae, and Urticaceae); Fagales (Betulaceae and Fagaceae); Myrtales (Combretaceae); Sapindales (Anacardiaceae and Sapindaceae); Malvales (Malvaceae, including the former Sterculiaceae and Tiliaceae); Ericales (Ericaceae, Theaceae, and Symplocaceae); Gentianales (Apocynaceae); and Asterales (Asteraceae) (Xu *et al*. 2018; Stonis *et al.* 2017, 2020a, 2021). It was expected (Stonis *et al*. 2018) that this list of host plants will continue to grow. As a confirmation of this prediction, during the recent studies in China and the adjacent northern territory of Vietnam, we discovered that there were at least two more, hitherto unregistered, host-plant families of Tischeriidae, Nyssaceae, and Staphyleaceae. Both of them also represent novel host-plant orders: Cornales and Crossosomatales.

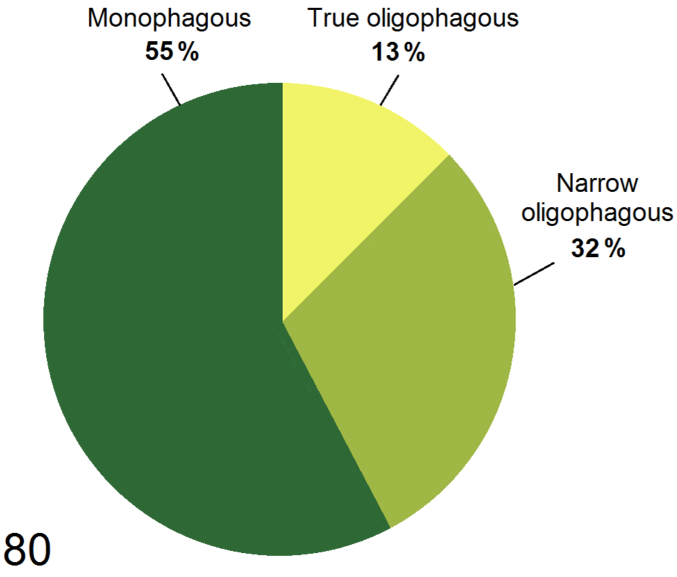
Coptotriche asiana **sp. nov.** was found mining several species of *Symplocos* (Symplocaceae, Ericales): sample no. 5191 was collected on *Symplocos sumuntia* Buch.-Ham. ex D. Don; sample no. 5193, on *S. poilanei* Guill.; and sample no. 5197, on *S. glauca* (Thunb.) Koidz. The leaf mines of each of them differed slightly in their shape and colour (Figs. 67–79). Despite this, the dissected genitalia of insects feeding on different host plants did not display any variation. We, therefore, conclude that *C. asiana* **sp. nov.** is a narrow oligophagous species feeding on different but related host plants.

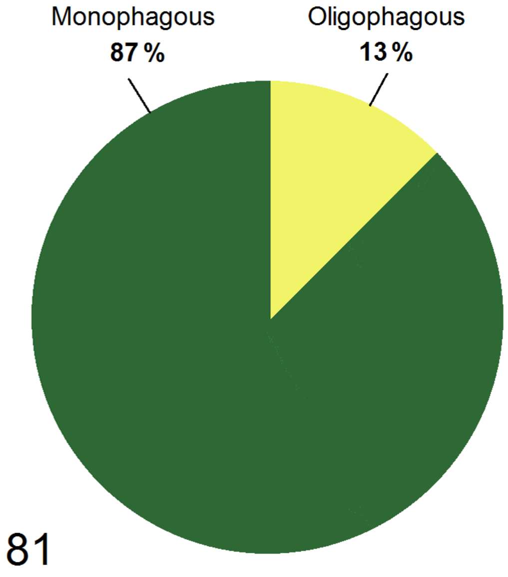
The physiological efficiency hypothesis states that dietary specialists are better adapted than generalists at physiologically utilizing their host plants as food (Schoonhoven *et al.* 2005). On the other hand, a broad host range may allow oligophagous species to colonize new hosts in areas where their original or preferred hosts are absent or much less abundant (Schoonhoven *et al.* 2005).

We follow a terminological system for stenophagous insects (see Stonis *et al.* 2016), whereas strictly monophagous insects are only those which feed on a single plant species. Insects feeding on two or more plant species from the same genus are called narrow oligophagous, whereas feeders on various plant genera of the same plant family are indicated as true oligophagous.

However, the term monophagous is often extended to include species feeding on plants within one genus, i.e. insects utilizing few closely related plant species within the same genus are also often referred to as monophagous. When feeding is limited to a restricted number of plant genera all belonging to the same plant family, species are often termed as oligophagous (Bernays & Chapman 1994; Schoonhoven *et al.* 2005).

Though host plant relationships are still not fully clear and they have been revealed only for 68% of the world's Tischeriidae species, we estimate that among these trophically studied species, monophagous Tischeriidae make about 55% and narrow oligophagous, about a third (Fig. 80). Following another terminological system, monophagous species strongly prevail in the global fauna (Fig. 81).





FIGURES 80–81. Global predominance of the monophagous species among currently studied Tischeriidae (following two different terminological systems)

We believe that such enormously large percentage of monophagous species is mostly caused by the lack of field studies. With increased collecting, the portion of the so-called narrow oligophagous like *C. asiana* **sp. nov.** should rise significantly.

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