Zootaxa 3357: 1–24 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Taxonomic review of *Syzeuxis* Hampson, 1895, with a discussion of biogeographical aspects (Lepidoptera, Geometridae, Larentiinae)

JING LI[1,2], DAYONG XUE[1], HONGXIANG HAN[1,4], ANTHONY C. GALSWORTHY[3]

[1] *Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing, 100101 China. E-mail: lijing@ioz.ac.cn; xuedy@ioz.ac.cn; hanhx@ioz.ac.cn*

[2] *Graduate University of Chinese Academy of Sciences, Beijing 100049 China*

[3] *The Natural History Museum, Cromwell Road, London SW7 5BD, UK. E-mail: ACGalsworthy@btopenworld.com*

[4] *Corresponding author*

Abstract

The genus *Syzeuxis* Hampson, 1895 is reviewed. In addition to the 11 species known worldwide, two new species are described: *S. furcalineas* sp. nov. from Assam, India and *S. pavonata* sp. nov. from Yunnan, China. One new synonymy is given: *S. miniocalaria* Xue, 1999 is sunk in *S. heteromeces* Prout, 1926. All the known species are redescribed and lectotypes are designated for *S. magnidica* Prout, *S. subfasciaria* (Wehrli) and *S. nigrinotata* (Warren). Generic characters based on all species are summarized. Illustrations of moths and genitalia are presented. The tribal placement of the genus is discussed, with the conclusion that it should be placed in the tribe Trichopterygini. A pilot phylogenetic study based on morphological characters of *Syzeuxis* indicates that four species-groups can be identified. The biogeographical aspects of the genus are also discussed.

Key words: *Syzeuxis*; taxonomy; new species; tribe; Trichopterygini; biogeography

Introduction

The genus *Syzeuxis* Hampson is a natural but rarely studied genus, which includes 11 known species. After its establishment in 1895 on the basis of the type species *Osicerda trinotaria* Moore, 1868, it has been treated in very few works. Warren (1896) established a new genus *Aphantoloba* based on a new Indian species, *Aphantoloba nigrinotata*, which was treated as a synonym of *Syzeuxis* by Hampson (1898). Prout (1926a, b) brought four new species from Northeast India into *Syzeuxis*. Inoue (1982) and Yazaki (1994) recorded two previously named species from Nepal. Parsons *et al*. (1999) only listed seven species, including *S. subfasciaria* (Wehrli, 1924), which was transferred from the genus *Lobogonia* Warren, 1893.

Xue and Zhu (1999) included detailed descriptions of four new species, *S. extritonaria*, *S. neotritonaria*, *S. calamisteria*, and *S. miniocalaria*, from Yunnan and Tibet in China, but without explicitly indicating them to be new. In fact, these four species were expected to have been published in 1998 in a separate paper, "A study on genus *Syzeuxis* Hampson, with descriptions of four new species from China (Lepidoptera: Geometridae)". This paper was accepted on 20 October 1997 by the journal *Acta Zootaxonomica Sinica* and cited as 'in press' by Xue and Zhu (1999), but unfortunately owing to an error it was not published until 2000. According to the Code (4th Edition, 1999, Article 16), names published before 2000 should be considered as available even if they were not explicitly indicated as new names ('*Every new name published after 1999, including new replacement names (Nomina nova), must be explicitly indicated as intentionally new.*' Code Article 16.1). Under this rule, the names published in 1999 should be available names.

In recent years, new material has been collected or discovered in collections and new taxa need to be described; some synonymic problems have arisen, and lectotype designation is desirable for three species, hence a review of the genus based on a wider study of material available in collections is now timely. Meanwhile, a phylogenetic analysis based on the morphological characters derived from the study materials was proposed in order to better understand the relationship between the species and the generic system of this small but special larentiine genus.

Accepted by L.F. Gall: 13 Apr. 2012; published: 26 Jun. 2012

The purposes of this paper are: to summarize the generic characters based on all known species; to describe two new species; to ensure stability for certain taxa by designating lectotypes; to sink *S. miniocalaria* Xue as a new junior synonym of *S. heteromeces* Prout; to deal with the problem of 1999/2000 dates of publication for four species; to discuss the tribal placement of the genus; to propose a new, more stable and more compatible generic system based on a morphological phylogeny analysis; and to summarize the biogeographical aspects of this Himalayan genus based on the known material. Some unclear type records are also discussed and clarified.

Material and methods

Most specimens examined are from the following collections: the Natural History Museum, London, UK (BMNH); the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS); and the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK). Genitalia were prepared following Robinson (1976). Wing venation terminology follows the Comstock–Needham System (Comstock 1918) as adopted for Geometridae by Scoble (1992) and Hausmann (2001); terminology for genitalia follows Pierce (1914), Klots (1970) and Nichols (1989). Photographs were taken using various conventional or digital cameras and microscopes. The digital images were enhanced and the plates compiled using Adobe Photoshop. The distribution map of the genus was created by GIS tools.

Taxonomy

Syzeuxis Hampson, 1895

Syzeuxis Hampson, 1895, *Fauna Br. India* (Moths), 3: 330 (key), 339. Type species: *Osicerda trinotaria* Moore, 1868, by original designation.

Aphantoloba Warren, 1896, *Novit. zool.*, 3: 117. Type species: *Aphantoloba nigrinotata* Warren, 1896, by original designation.

Description Antenna of male bipectinate and ciliate apically, rami long and ciliate; filiform with cilia in female. Frons moderately protruding, smooth-scaled. Labial palpus rough-scaled, segment III very short. Hind tibia not dilated, with two pairs of spurs. *Wing pattern.* Forewing moderately to very broad; costa with base slightly curved, central section straight and curved near apex; apex almost a right angle, sometimes distinctly protruding; outer margin curved gently, nearly straight, or concave under apex and slightly protruding at middle then straight to anal angle; anal angle rounded, inner margin straight; antemedial and postmedial lines usually forming dark patches on costa. Hindwing narrow and long; apex and anal angle rounded; costa elongate, longer than or equal to length of inner margin; postmedial line present, but often modified to X-shaped or broadened with extension; sometimes hindwing in male with a small basal lobe. Underside: usually with distinct postmedial line on both wings. *Venation* (Figure 1). forewing with one or two areoles, M_1 stalked with lower margin of areole; sometimes without areole, R_1 to R_5 long stalked, arising before upper angle of cell, M_1 not stalked; M_2 arising from above middle of discocellulars. Hindwing with $Sc+R_1$ and Rs separate and connected with a bar near center of cell. In male Rs stalked with M_1 or arising from cell; discocellulars often not biangulate, M_2 arising from second angle, close to M_3; CuA_1 shortly or long stalked with M_3 with only two exceptions; CuA_2 reaching anal angle, vein A missing; in female Rs and M_1 shortly stalked, CuA_2 reaching outer margin, 2A present. *Male genitalia*. Uncus flat, broad, length about 1.5 to 2 times width, usually concave at middle of posterior margin. Socii undeveloped, sometimes tiny, weak and membranous. Gnathos sclerotized, connected medially, with a large, thick, tapered median process. Valva relatively small and variously shaped, usually simple, without any process. Juxta often forming a sclerotized plate. Saccus not protruding. Aedeagus various, vesica smooth or with a bundle of spines. Abdominal sternite II of male with a central sac (not all species examined). *Female genitalia*. Apophyses anteriores very short, apophyses posteriores slender and long. Ductus bursae slender and long, with distinct antrum at upper part. Corpus bursae membranous, signum absent.

Diagnosis. Some species of *Syzeuxis* are distinctive in having a modified postmedial line on the hindwing, which is X-shaped. Moths included within *Syzeuxis* are externally similar to members of the genera *Lobogonia*

Warren, 1893, *Chrioloba* Prout, 1958 and *Heterophleps* Herrich-Schäffer, 1854 in having both antemedial and postmedial lines each forming a distinct patch on the costa of the forewing. *Syzeuxis* differs from *Chrioloba* in that the hindwing has a postmedial line, while *Chrioloba* lacks hindwing lines. The genus *Heterophleps* is characterized by having a hindwing inner margin which turns over in a flap, while this character is absent in *Syzeuxis*. Compared to *Lobogonia*, *Syzeuxis* has no distinct angle on vein M_3 on either fore- or hindwing margin, or is only shallowly concave under the apex if a small projection is present, while a distinct angular projection is distinctly present on both wings in *Lobogonia*. In the male genitalia, *Syzeuxis* is very distinctive in having a developed, ring-shaped gnathos and median process, which is not a common feature in the tribe Trichopterygini. In addition to the distinctive gnathos, *Syzeuxis* also differs from *Chrioloba* in the shapes of uncus and valva, and from *Heterophleps* in having no developed basal valval lobe. In the female genitalia, *Syzeuxis* is also one of the few genera that lack a scobinate corpus bursae.

Distribution. China (South), India (Northeast and Bengal), Nepal, Indonesia (North Sumatra).

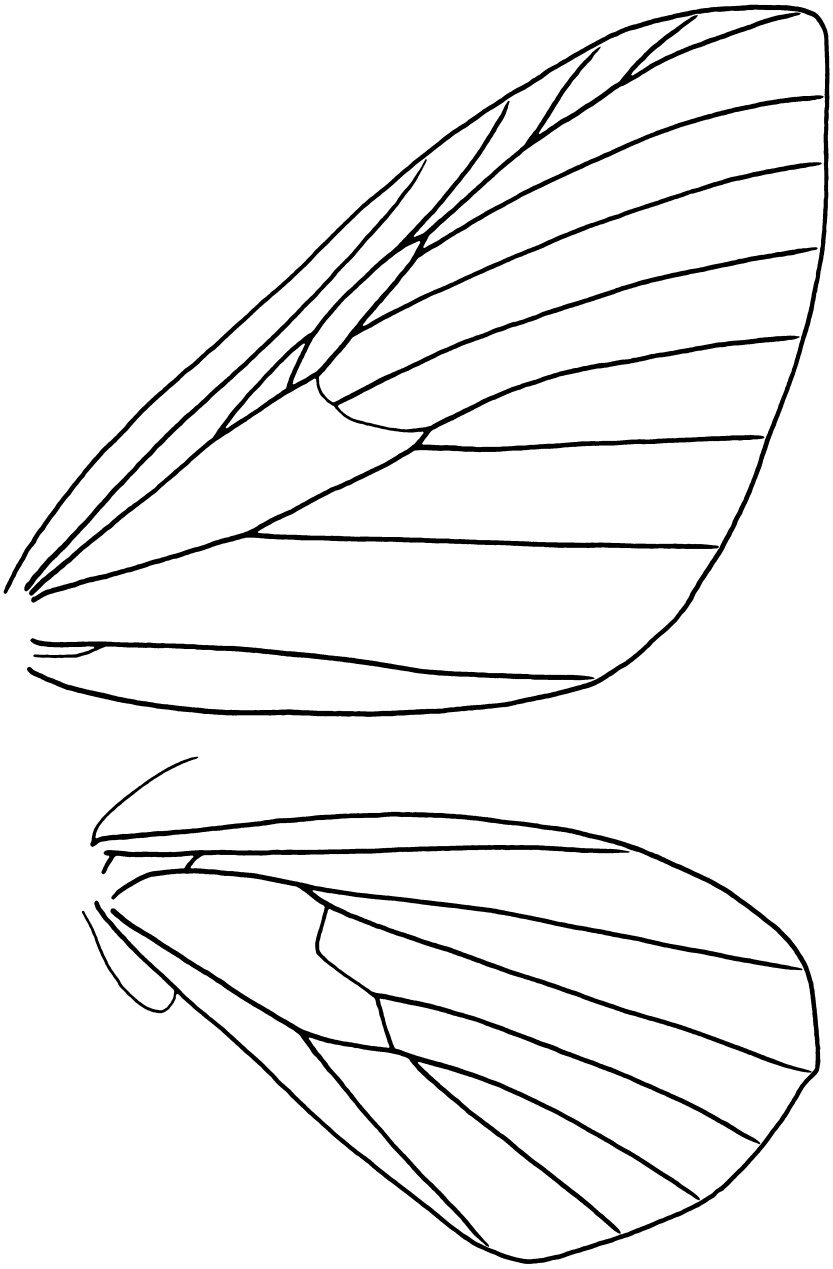
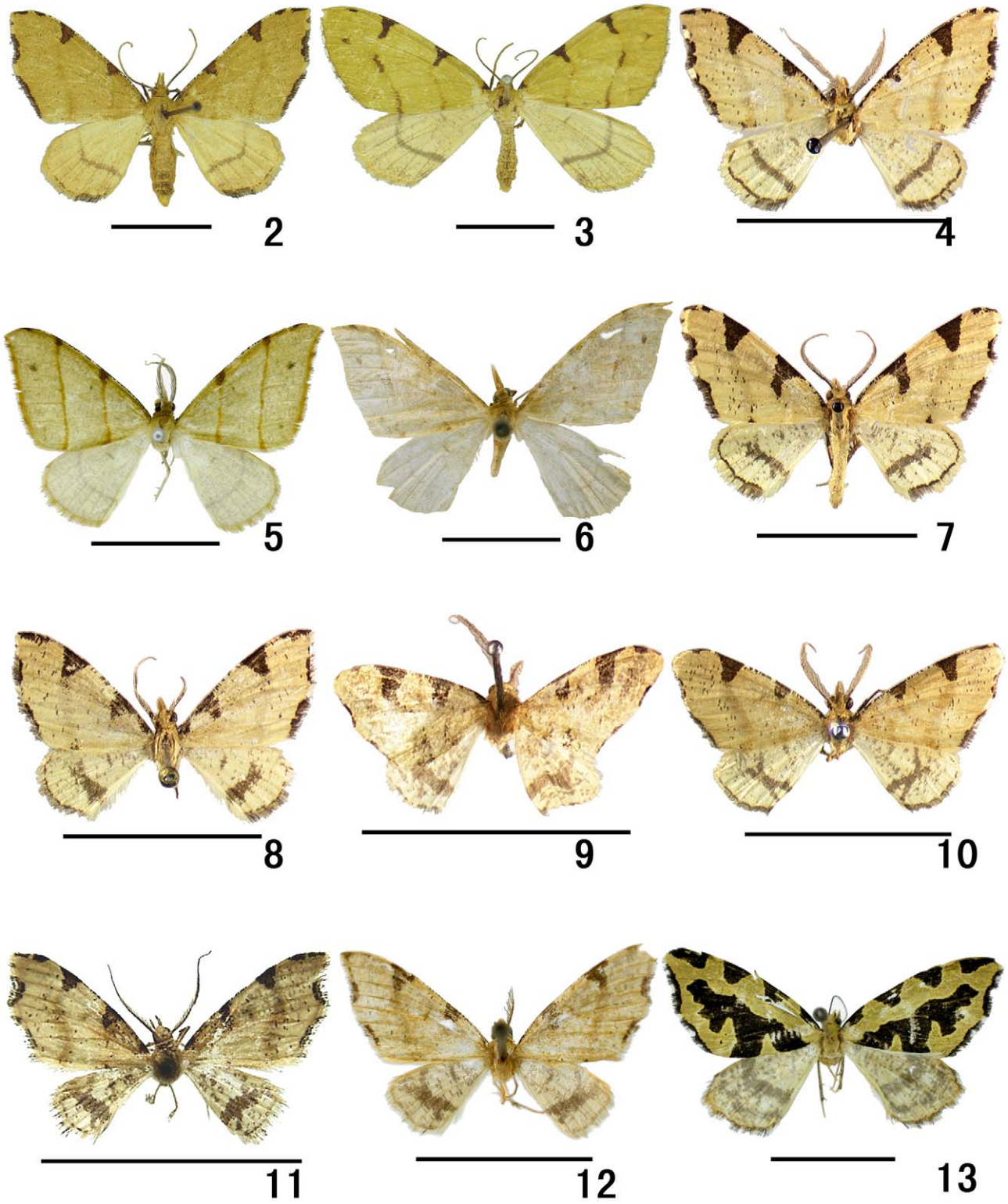


FIGURE 1. *Syzeuxis tessellifimbria* Prout, ♂ venation.



FIGURES 2–13. Adults. 2. *Syzeuxis trinotaria* (Moore), female; 3. *S. tessellifimbria* Prout, holotype, female; 4. *S. seminanis* Prout, holotype, male; 5. *S. extritonaria* Xue, holotype, male; 6. *S. neotritonaria* Xue, holotype, male; 7. *S. magnidica* Prout, lectotype, male; 8. *S. subfasciaria* (Wehrli), paralectotype, male; 9. *S. heteromeces* Prout, holotype, male; 10. *S. furcalineas* sp. nov., holotype, male; 11. *S. nigrinotata* (Warren), lectotype, male; 12. *S. pavonata* sp. nov., holotype, male; 13. *S. calamisteria* Xue, holotype, female. Scale bar = 1 cm.

***Syzeuxis trinotaria* (Moore, 1868)**
Figs 2, 14, 26

Osicerda trinotaria Moore, 1868, *Proc. zool. Soc. Lond.*, 1867 (3): 650. Syntype ♂, India: Bengal. (BMNH).
Syzeuxis trinotaria: Hampson, 1895, *Fauna Br. India* (Moths), 3: 339, fig. 168; Inoue, 1982, *Bull. Fac. domestic Sci., Otsuma Woman's Univ.*, 18: 140, fig. 14c; Yazaki, 1994, *in* Haruta (Ed.), *Tinea*, 14 (Suppl. 1): 12, pl.67: 24; Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 84, figs 2a, 5d, e.

Materials Examined. INDIA: 1♂, syntype, N. E. Bengal: Sherwill, Russell, Moore Coll. 94-106 (BMNH); 1♂, Sikkim, Collectio H.J. Elwes; 1♀, Khasis, June, 1894, nat. coll., Rothschild Bequest B.M. 1939-1 (BMNH). NEPAL: 1♂1♀, Kosi: Pheksinda, 780 m, 14–18 June 1990, coll. T. Haruta, slide no. Geom-00049 and Geom-00048 (IZCAS, ex. Dr. K. Yazaki, Japan); 1♂, Center. N. Ganesh Himal, Mailung Khola, 1050 m, 24 October 1995, leg. M. Fibiger (IZCAS, ex. Dr. M. Fibiger, Denmark).

Description Antennae in male bipectinate, ciliate at tip and in female. Labial palpus yellowish green, rough-scaled, extending about 1/3 beyond frons in both male and female. Frons, vertex, dorsal side of thorax yellowish green. Abdomen with dorsal side pale yellow-brown. *Wing pattern*. Forewing length: ♂ 13 mm, ♀ 14 mm. Forewing moderate in width; apex slightly acute, outer margin slightly angled at middle. Forewing pale greenish yellow, diffused with sparse black-brown speckles; a series of tiny dark streaks dispersed along costa; wing base with a small black patch on costa; grey antemedial and postmedial lines each forming a black triangular patch on costa; terminal line black, distinct, discontinuous under apex and between M_3 and CuA_1. Hindwing with grey arc-like postmedial line, paler towards costa; a small grey discal spot present in male, which is indistinct in female; terminal line thinner and paler than that on forewing. Male without hindwing basal lobe. Fringes of forewing black intermixed with yellowish brown (black where terminal line present, and yellowish brown where terminal line absent); yellowish brown on hindwing but grayish near anal angle. Underside: yellowish brown, diffused with dark grey speckles; both wings with dark grey discal spot; postmedial line black-brown, on forewing fading away towards inner margin, complete on hindwing. Forewing with a single areole. *Male genitalia*. Uncus large, broad, concave slightly at apical edge. Socii undeveloped. Gnathos developed, sclerotized, with large median process broad basally and tapered but blunt distally. Valva broad and short, blunt terminally, more expanded basally; costa concave, and ventral margin of valva convex, without any process. Juxta developed, forming a sclerotized oblong plate, slightly concave at posterior margin. Aedeagus broad, tube-like, without subposterior spines. *Female genitalia*. Not dissected (only female available for dissection had main part of genitalia missing).

Diagnosis. This species and another four species (*S. tessellifimbria*, *S. extritonaria*, *S. neotritonaria* and *S. calamisteria*) are different from the other congeneric species in that the forewing colour is green. The fresh specimen of *S. trinotaria* is quite similar to *S. tessellifimbria*. But *S. trinotaria* is much smaller; the forewing has only a single areole and hindwing discocellulars is not biangulate. It can also be distinguished form *S. tessellifimbria* by the differently shaped valva in the male genitalia. This species differs from *S. extritonaria* and *S. neotritonaria* in the black triangular patch on the forewing costa and the stalked M_3 and CuA_1 on the hindwing.

Distribution. India (Bengal, Sikkim), Nepal (East, Centre).

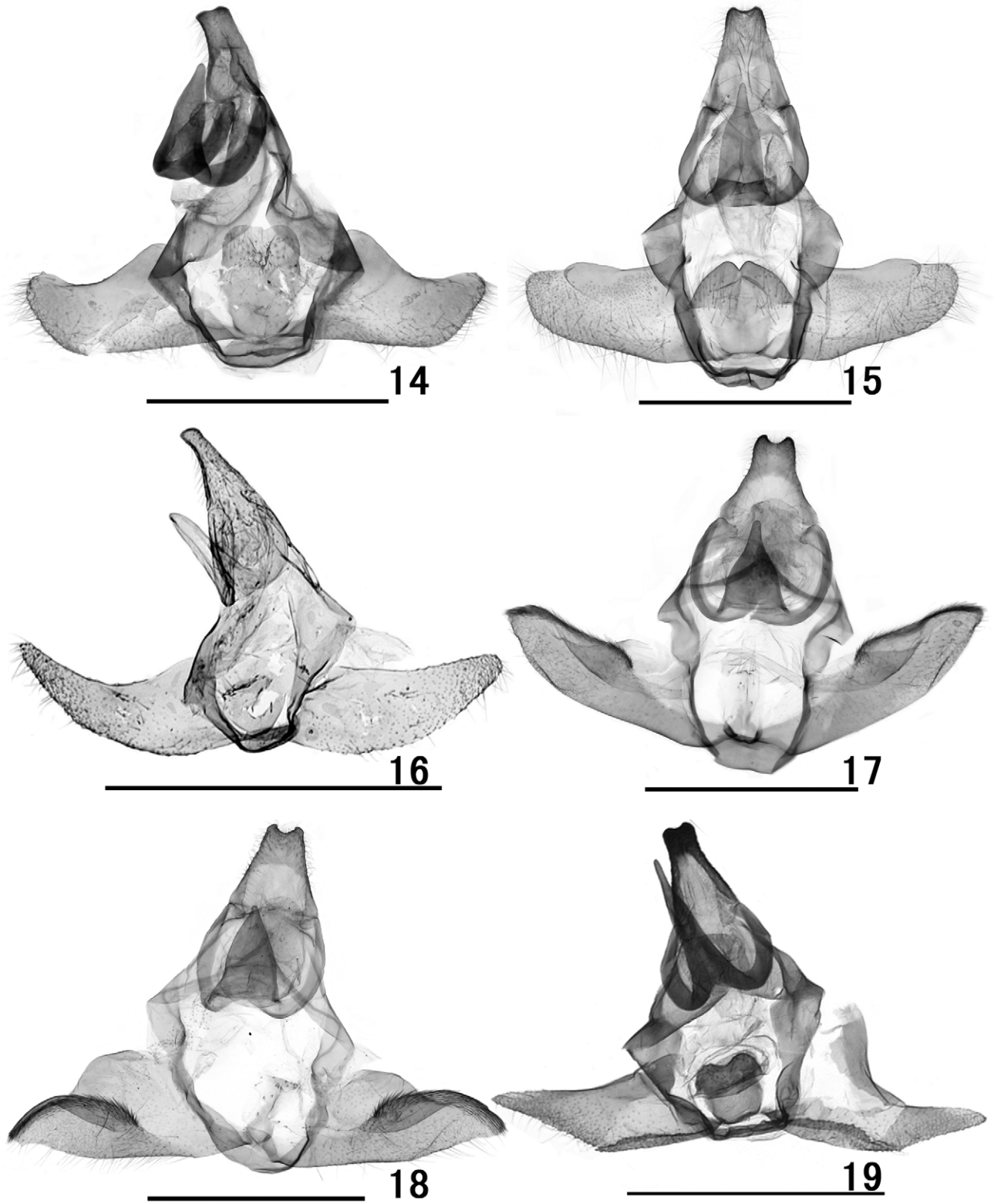
Remarks. The original description 'Bengal (*Sherwill*). In Coll. F. Moore.' does not indicate the number of specimens, and the undoubted type specimen in the BMNH collection must therefore be regarded as a syntype. However, it is probable that it was a unique type, and the designation of a lectotype is therefore unnecessary.

***Syzeuxis tessellifimbria* Prout, 1926**
Figs 3, 15, 27, 38

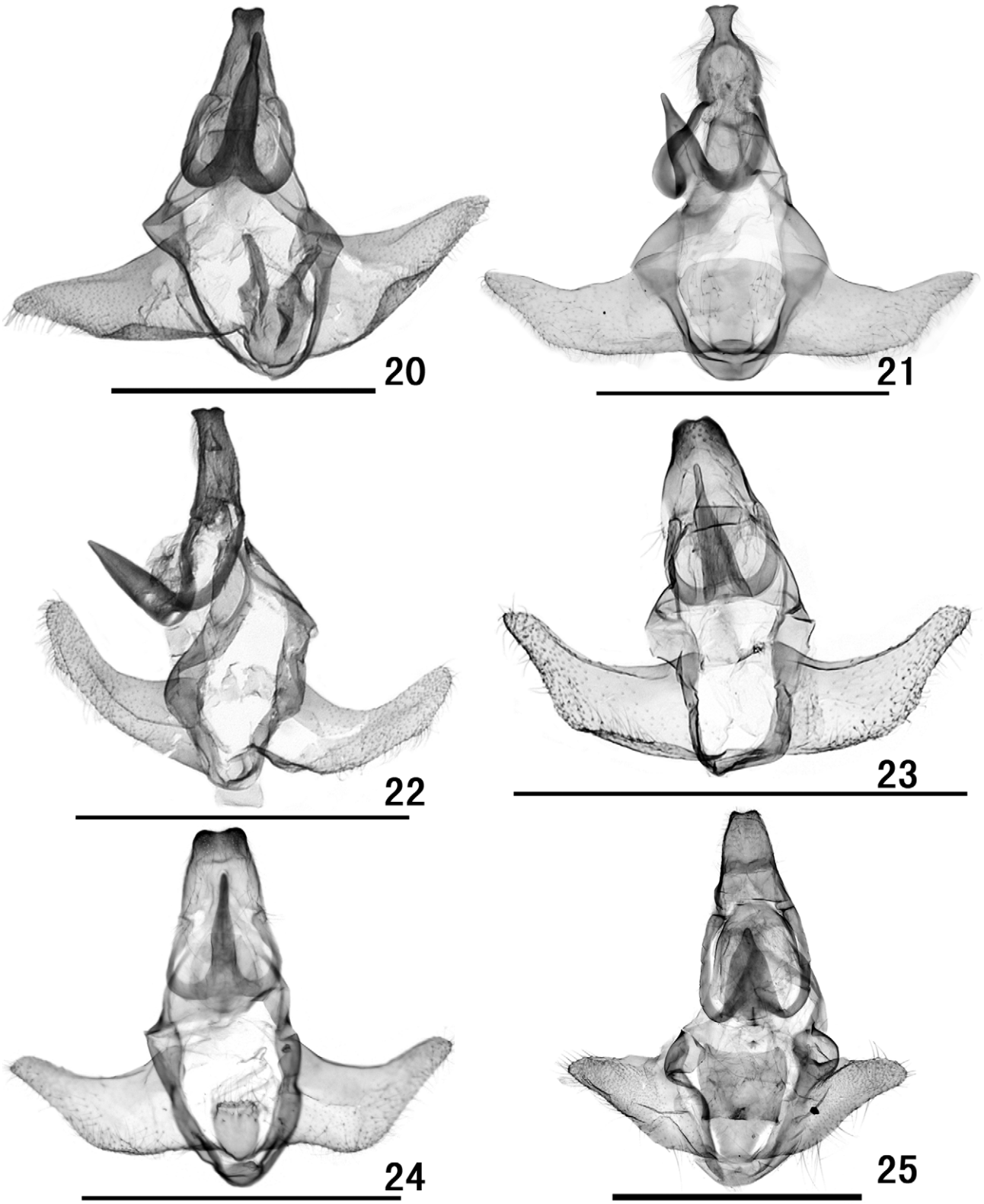
Syzeuxis ? tessellifimbria Prout, 1926a, *Novit. zool.*, 33: 12. Holotype ♀, India: Sikkim: Tonglo, 10,000 ft (3000 m). (BMNH)
Syzeuxis tessellifimbria: Inoue, 1982, *Bull. Fac. domestic Sci., Otsuma Woman's Univ.*, 18: 141, fig. 14h; Xue, 1999, in Xue & Zhu, *Fauna Sinica: Insecta*, 15: 191, figs 191–195, pl.IV: 1; Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 82, figs 1, 2b, c.

Materials Examined. INDIA: 1♀, Holotype, Sikkim: Tonglo, 10,000 feet, July 1886, H.J. Elwes, Collectio H.J. Elwes, Rothschild Bequest B.M.1939-1 (BMNH); CHINA: 1♂, Yunnan: Lushui, Pianma, 2300 m, 30 May 1981,

coll. Liao Subai, slide no. L-1049 (IZCAS); 3♀, Tibet: Mêdog, 2750 m, 21–23 August 1982, coll. Han Yinheng, slide no. for one female: L-1050 (IZCAS); 1♂, Tibet, no date, coll. Wang Baohai, slide no. L-1048 (IZCAS); 1♂, Tibet: Chumbi, D. Macdonald, B.M. 1923-137 (BMNH).



FIGURES 14–19. Male genitalia. 14. *Syzeuxis trinotaria* (Moore); 15. *S. tessellifimbria* Prout; 16. *S. seminanis* Prout; 17. *S. extritonaria* Xue; 18. *S. neotritonaria* Xue; 19. *S. magnidica* Prout. Scale bar = 1 mm.



FIGURES 20–25. Male genitalia. 20. *Syzeuxis subfasciaria* (Wehrli); 21. *S. heteromeces* Prout; 22. *S. furcalineas* sp. nov.; 23. *S. nigrinotata* (Warren); 24. *S. pavonata* sp. nov.; 25. *S. calamisteria* Xue. Scale bar = 1 mm.

Description. Antennae bipectinate almost to tip in male, ciliate in female. Labial palpus brown, rough-scaled, extending about 1/3 to 1/2 beyond frons in both male and female. Frons and vertex green. Thorax with dorsal side green. Abdomen with dorsal side brown. *Wing pattern.* Forewing length: ♂ 18–19 mm; ♀ 21 mm. Wings grass green. Outer margin of forewing smooth and slightly wavy in hindwing. Forewing with a small dark brown patch on costa near base; antemedial and postmedial lines curving outwards at middle, brown, distinct and forming dark

brown triangular patches on costa, indistinct and sometimes broken over rest of wing; submarginal line indistinct, only small patches visible on costa, between vein M_1 and M_2, between CuA_2 and anal vein; discal spot invisible. Hindwing yellowish brown, diffused with dark brown scales, much denser near outer margin; postmedial line broad, dark grey and curved outward, parallel to outer margin; discal spot a small dark brown patch. Fringes of forewing grass green mixed with dark brown basally, white terminally, and dark brown at vein ends; dark brown and whitish on hindwing. Underside: evenly yellowish brown diffused with dark scales; forewing base dark brown; both wings with distinct dark brown postmedial lines parallel to outer margins, and black discal spots. Forewing with areole double. Hindwing with discocellulars biangulate. Hindwing in male with a small basal lobe. *Male genitalia*. Uncus large and broad, concave slightly at apical margin. Gnathos developed, sclerotized, with large median process, broad basally and tapered but blunt distally. Valva small, blunt terminally; costa bearing a small subapical blunt process. Juxta developed, a sclerotized plate, with a concavity at centre of posterior margin and expanded laterally at middle, much narrower basally. Aedeagus broad, tube-like, slightly narrower and sclerotized posteriorly, with a cluster of sparse subposterior spines. *Female genitalia.* Apophyses posteriores very long, apophyses anteriores quite short and tapered. Ostium large, sterigma absent. Ductus bursae very long and narrow, gradually broader towards anterior end; with distinct, short and broad antrum. Corpus bursae small, membranous, expanded posteriorly. Signum absent.

Diagnosis. *S. tessellifimbria* is much larger than the congeneric species. The forewing is green, with areole double. The hindwing of the male has a small basal lobe, which is similar to *S. extritonaria*, *S. neotritonaria* and *S. calamisteria*. But *S. tessellifimbria* differs from those three species in different wing and valva shapes.

Distribution. China (Yunnan, Tibet), Nepal (East), India (Sikkim).

Remarks. The type material of this species was treated as 'Syntype (s) ♀' (Parsons *et al*. 1999). But the single type specimen was clearly cited in the original description, and should be regarded as a holotype.

Syzeuxis seminanis Prout, 1926

Figs 4, 16, 28

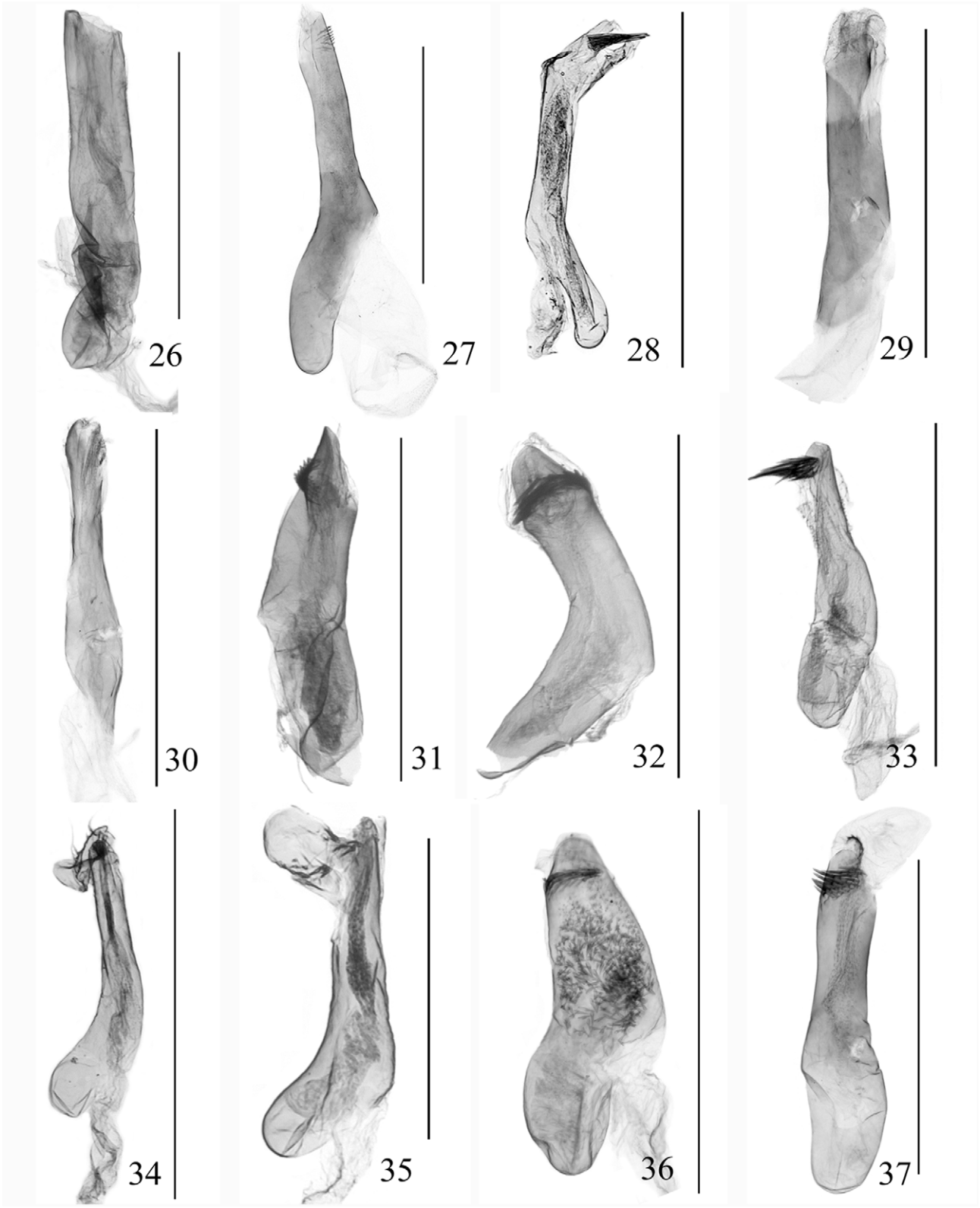
Syzeuxis seminanis Prout, 1926a, *Novit. zool*., 33: 13. Holotype ♂, India: Assam, Khasi Hills. (BMNH)

Materials Examined. INDIA: 1♂, Holotype, Assam, Khasi Hills, March 1894, nat. coll., Rothschild Bequest B.M. 1939-1 (BMNH); 1♂, Paratype, Khasia Hills, April 1894, nat. coll. (BMNH); 1♂, Khasis, nat. coll., Geometridae Genitalia slide no. 20791 (BMNH).

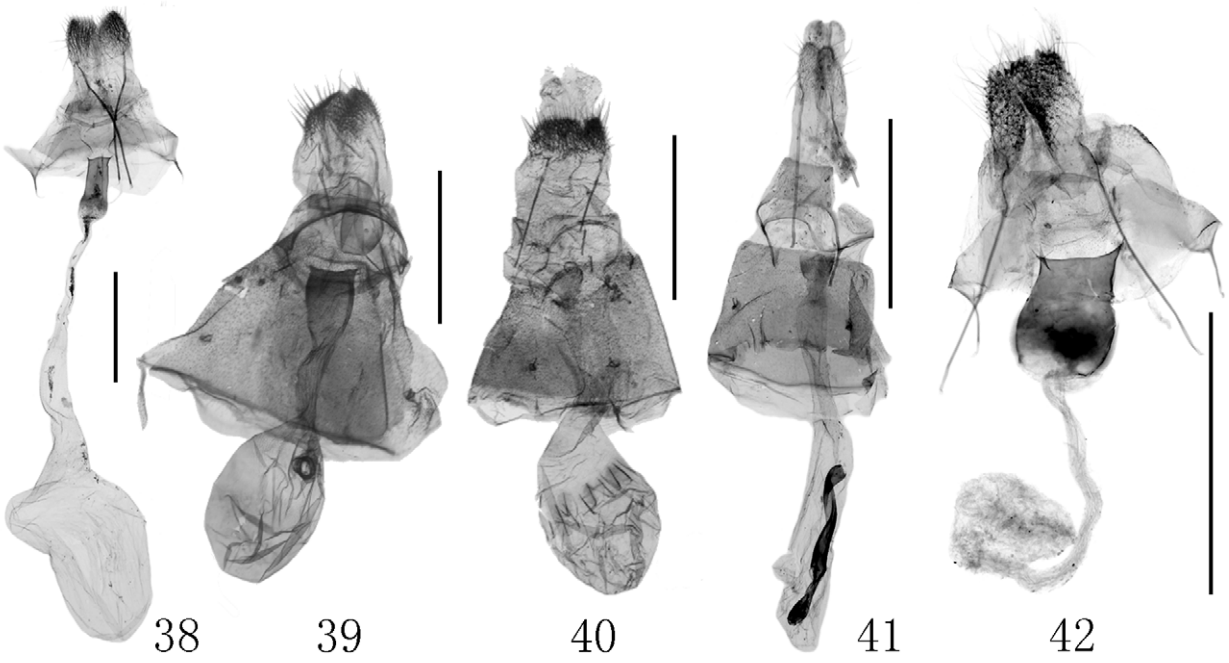
Description. Antennae in male bipectinate and ciliate at tip. Labial palpus brown, rough-scaled. Frons, vertex, dorsal side of thorax yellowish brown. Dorsal side of abdomen yellowish brown mixed with black scales. *Wing pattern.* Forewing length: ♂ 9 mm. Wings yellowish brown, diffused with black brown speckles, a little paler on hindwing. Forewing with outer margin under apex slightly concave, then straight to anal angle. Forewing with antemedial and postmedial lines dark yellowish brown, forming triangular black patches on costa; terminal line black, more distinct than in other species, but discontinuous under apex and under M_3. Hindwing with greyish discal spot; postmedial line distinct, black brown, broad, almost parallel to outer margin; terminal line black brown, more complete than that of forewing. Hindwing in male without basal lobe. Fringes black where terminal line present and yellowish brown where terminal line absent on forewing; yellowish brown on hindwing and black on anal angle. Underside: pale yellow diffused with dense grey to black speckles, more distinct on hindwing; both wings with black brown discal spots; postmedial line on forewing broader towards inner margin but not reaching it, straight and black on hindwing. Forewing with a small areole. *Male genitalia*. Uncus large but strongly narrowed towards tip. Gnathos developed, sclerotized, with a large but tapered, narrow median process. Valva narrower than previous two species, apex blunt, costa without process. Juxta a rounded sclerite, setose on posterior margin. Aedeagus with a posterior spinose tuft; vesica wrinkled and slightly sclerotized. *Female genitalia*. Unknown.

Diagnosis. *S. seminanis, S. magnidica, S. subfasciaria, S. heteromeces, S. furcalineas, S. nigrinotata* and *S. pavonata* share many common features, such as the small size, the absence of a basal lobe on the male hindwing; the lack of biangulate hindwing discocellulars. *S. seminanis* differs from the other species in that the postmedial line on the hindwing is a single line, not double, nor X-shaped. In the male genitalia, the uncus is long and narrow.

Distribution. India (Khasi Hills).



FIGURES 26–37. Aedeagus. 26. *Syzeuxis trinotaria* (Moore); 27. *S. tessellifimbria* Prout; 28. *S. seminanis* Prout; 29. *S. extritonaria* Xue; 30. *S. neotritonaria* Xue; 31. *S. magnidica* Prout; 32. *S. subfasciaria* (Wehrli); 33. *S. heteromeces* Prout; 34. *S. furcalineas* sp. nov.; 35. *S. nigrinotata* (Warren); 36. *S. pavonata* sp. nov.; 37. *S. calamisteria* Xue. Scale bar = 1 mm (except scale bar = 0.5 mm for fig. 35.)



FIGURES 38–42. Female genitalia. 38. *Syzeuxis tessellifimbria* Prout; 39. *S. magnidica* Prout; 40. *S. heteromeces* Prout; 41. *S. nigrinotata* (Warren); 42. *S. calamisteria* Xue. Scale bar = 1 mm.

Syzeuxis extritonaria Xue, 1999

Figs 5, 17, 29

Syzeuxis extritonaria Xue, 1999, *in* Xue & Zhu, *Fauna Sinica: Insecta*, 15: 193, fig. 199, pl.4: 4. Holotype ♂, China: Yunnan, Tengchong, Dahaoping. (IZCAS)
Syzeuxis extritonaria Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 85, figs 4a, 5f.

Materials Examined. CHINA: 3♂, Holotype and two Paratypes, Yunnan: Tengchong, Dahaoping, 2020 m, 24–26 May 1992, coll. Xue Dayong, slide no. of Holotype: L-2304, one of Paratypes: L-2277 (IZCAS).

Description. Antennae in male bipectinate and ciliate apically, female unknown. Labial palpus grey-yellow, very long, extending for more than 1/2 its length beyond frons in male. Frons, vertex, dorsal side of thorax and abdomen grey-yellow to grey yellowish green. *Wing pattern*. Forewing length: ♂ 12–13 mm. Forewing grey-yellow to grey yellowish green, hindwing slightly paler. Forewing very broad, with apex pointed, and a little falcate; outer margin straight, with no protrusion, almost equal to inner margin in length; anal angle rounded. Hindwing with apex and anal angle rounded. Forewing with antemedial and postmedial lines straight, yellowish brown, forming small dark brown specks on costa; submarginal line only present as small black dots on costa and between M_1 and M_2. Hindwing with indistinct dark grey discal spot, very thin curved postmedial line almost parallel to outer margin. Fringes of forewing bright yellowish brown and a little paler on hindwing. Underside: both wings yellow, scattered with dark scales, especially from base to postmedial line on forewing; both wings with black discal spots and yellowish brown postmedial lines, which are almost parallel to outer margins. Forewing with a very small areole. M_3 and CuA_1 of hindwing not stalked. Hindwing in male with a small basal lobe. *Male genitalia*. Uncus and gnathos of *S. extritonaria* similar to that of *S. tessellifimbria*, but median process of gnathos much shorter and a little broader. Valva membranous and expanded basally; other parts slightly sclerotized, tapered apically, and with a partial flap extending over basal part; costa with a row of dense spines. Juxta undeveloped. Aedeagus a simple tube, without spines or process posteriorly. *Female genitalia*. Unknown.

Diagnosis. *S. extritonaria* and *S. neotritonaria* are closely related and differ from other species by the lack of a stalked M_3 and CuA_1 on the hindwing, the distinctly falcated forewing apex and the folded valva in the male geni-

talia. *S. extritonaria* can be distinguished from *S. neotritonaria* by the smaller size, the straighter forewing outer margin, and the differently shaped valve.

Distribution. China (Yunnan).

Syzeuxis neotritonaria Xue, 1999

Figs 6, 18, 30

Syzeuxis neotritonaria Xue, 1999, *in* Xue & Zhu, *Fauna Sinica: Insecta*, 15: 194, fig. 200, pl.4: 5. Holotype ♂, China: Tibet, Co Nag, Mama. (IZCAS)
Syzeuxis calamisteria Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 86, figs 4b, 5g.

Materials Examined. CHINA: 1♂, Holotype, Tibet: Co Nag, Mama, 2900 m, 6 August 1974, coll. Huang Fusheng, slide no. L-0997, (IZCAS); 1♂, Tibet: Mêdog, 2400 m, 18 August 1982, coll. Han Yinheng (IZCAS).

Description. Antennae in male bipectinate. Labial palpus extremely long, segment I and II rough-scaled, segment III smooth, extending about 2/3 beyond frons. Frons, vertex, dorsal side of thorax brown. Abdomen with dorsal side pale brown, sparsely diffused with black scales. *Wing pattern.* Forewing length: ♂ 15 mm. Wing shape and streaks quite similar to that of *S. extritonaria*. Differences lie in: wing colour and streaks of *neotritonaria* much paler on both upper and undersides; forewing with outer margin slightly protruding outwards at middle; antemedial and postmedial lines discontinuous, not as distinct and continuous as in *S. extritonaria*; postmedial line on hindwing very indistinct, hardly traceable. Venation and male hindwing basal lobe identical to those of *S. extritonaria*. *Male genitalia*. Quite similar to *S. extritonaria*, but gnathos with median process much larger; valva with base much broader; aedeagus much more slender. *Female genitalia*. Unknown.

Diagnosis. See diagnosis under the previous species.

Distribution. China (Tibet).

Syzeuxis magnidica Prout, 1926

Figs 7, 19, 31, 39

Syzeuxis magnidica Prout, 1926a, *Novit. zool.*, 33: 12. Lectotype ♂, India: Khasis [Khasi Hills], **here designated**. (BMNH)

Materials Examined. INDIA: 1♂, Lectotype (here designated), Khasis, nat. coll., Collectio H.J. Elwes, Rothschild Bequest B.M.1939-1 (BMNH); 1♀, Paralectotype, Khasis, nat. coll. (BMNH); 1♂, Paralectotype, Khasis, August 1894, nat. coll., Rothschild Bequest B.M. 1939-1, Geometridae Genitalia slide no. 20324 (BMNH); 1♀, Paralectotype, Khasis, April 1895, nat. coll. (BMNH); 1♀, Khasis 96-246, nat. coll. Geometridae Genitalia slide no. 24013 (BMNH); 1♀, Paralectotype, Khasis, nat. coll. (ZFMK).

Description. Antennae bipectinate for about basal 2/3 in male, ciliate apically and in female. Frons, vertex, dorsal sides of thorax and abdomen yellowish brown, diffused with sparse dark scales on abdomen. *Wing pattern.* Forewing length: ♂ 13.5 mm; ♀ 14 mm. Forewing with apex rounded, outer margin almost straight. Wings yellowish brown, sparsely diffused with black speckles, much paler on hindwing and speckles more dense. Forewing with antemedial and postmedial lines indistinct, but forming large black patches on costa and extending downwards, patch on antemedial line reaching CuA_2; postmedial line also forming a small black spot on inner margin; terminal line discontinuous, developed between M_1 and M_3, and under CuA_1. Hindwing with black-brown postmedial line, not reaching costa, extending outwards on CuA_2 in male. Hindwing in male without basal lobe. Fringes of forewing black where terminal line present, and yellowish brown where terminal line absent; yellowish brown on hindwing and blackish on anal angle. Underside: much darker than upperside; patch formed by antemedial line on upperside discernible; distinct postmedial line black brown, reaching inner margin; hindwing similar to upperside. Forewing without areole. *Male genitalia*. Uncus large and broad, tapered towards apex, slightly concave at apical margin and strongly sclerotized. Gnathos with large median process very long, tapered. Valva small, terminal half tapered, with pointed apex; costa without process. Juxta developed, a sclerotized plate, upper half a little broader and more strongly sclerotized than basal half, with a concavity at centre of posterior margin. Aedeagus broad, with a spinose subposterior tuft. *Female genitalia*. Ductus bursae narrow, somewhat broadened and weakly sclerotized near ostium. Corpus bursae oval, much broader than ductus bursae.

Diagnosis. *S. magnidica*, *S. subfasciaria*, *S. nigrinotata* and *S. pavonata* lack an areole on the forewing, in distinction from *S. seminanis*, *S. heteromeces* and *S. furcalineas*. The labial palpus of this species is longer than that of *S. nigrinotata* and *S. pavonata*, more than 1/2 extending beyond frons. The black costal patch on the antemedial line of the forewing reaches CuA_2, which is distinctly longer than in other species. The juxta of the male genitalia lacks a pair of sclerotized processes which are present in *S. subfasciaria*.

Distribution. India (Khasi Hills).

Remarks. The syntype series consists of 2 males and 3 females, 4 types are deposited in BMNH and one female in ZFMK. One male labelled 'type' by Prout is designated as lectotype in order to ensure stability. Two female paralectotypes in BMNH were originally described in the syntype series of *Aphantoloba nigrinotata* Warren, 1896. Prout (1926a) included these females in the type series of *magnidica*.

Syzeuxis subfasciaria (Wehrli, 1924)

Figs 8, 20, 32

Lobogonia subfasciaria Wehrli, 1924, *Mitt. münch. ent. Ges.*, 14 (6–12): 133, pl. 1, fig. 4. Lectotype ♂, Südchina: [Guangdong]: Lingping [Lianping], **here designated**. (ZFMK)
Syzeuxis subfasciaria: Parsons *et al.*, 1999, *Geometrid Moths of the World, a Catalogue*, 2: 920.

Materials Examined. CHINA: 1♂, Lectotype (here designated), Guangdong: Lingping [Lianping], 22 May, coll. H. Höne (ZFMK); 4♂, Paralectotypes, Guangdong: Lingping [Lianping], 22 May, coll. H. Höne (ZFMK); 1♂, Paralectotype, Canton [Guangdong], no date, coll. H. Höne (ZFMK); 1♂, Paralectotype, labelled as 'Paratype' Guangdong: Lingping [Lianping], Südchina, 22 April, coll. H. Höne, Geometridae Genitalia slide no. 20321 (BMNH).

Description. Antennae with basal 2/3 bipectinate in male. Labial palpus yellowish brown, rough-scaled. Frons, vertex, dorsal side of thorax yellowish brown. Abdomen pale brown with diffuse black speckles. *Wing pattern.* Forewing length: ♂ 9 mm. Wings yellowish brown, sparsely diffused with black speckles. Outer margin of forewing smooth, curved outward slightly. Forewing with a small black patch on costa near base; antemedial and postmedial lines indistinct, each forming a strongly marked black triangular patch on costa; another slender black patch present near apex on costa; terminal line black, discontinuous, distinct between M_1 and M_3, CuA_1 to anal angle; discal spot invisible. Hindwing: postmedial line very broad, black brown, more or less X-shaped, but indistinct (or with small extension); terminal line black, much thinner than that of forewing, discontinuous on vein ends; discal spot forming a small dark brown elongate patch. Hindwing in male without basal lobe. Fringes of forewing black where terminal line present, whitish brown where terminal line absent; dark brown on hindwing, whitish brown around apex. Underside: diffuse dark brown speckles denser; forewing with postmedial line more distinct than upperside; terminal line more continuous; hindwing similar to upperside. Venation similar to that of *S. magnidica*. *Male genitalia*. Uncus large and broad, narrowing steadily towards apex, concave slightly at apical margin. Gnathos with large median process much narrowing strongly distally and blunt. Valva small, tapered; costa without process. Juxta a pair of sclerotized processes protruding posteriorly. Aedeagus very short and broad, lapped with a circle of spines subposteriorly. *Female genitalia*. Unknown.

Diagnosis. This species is very similar to *S. magnidica*. But it can be distinguished from that species in the smaller size, the shorter costal patch on the antemedial line of the forewing, as well as the presence of a pair of sclerotized processes on the juxta of the male genitalia.

Distribution. China (Guangdong).

Remarks. The original syntype series consists of seven males, among which six are deposited in ZFMK, with one labelled 'Type' and four labelled 'Paratype'; the sixth is labelled 'Canton', but without type label. According to the description, the whole series should come from 'Lianping, Guangdong, China'. Since the description itself does not distinguish between specimens labelled 'type' and 'paratype', they must all be regarded as syntypes. The specimen labelled 'Type' by Wehrli has been partly destroyed; it has no head, no abdomen and only a small part of the thorax is left. So it is not appropriate to be selected as the lectotype. There is only one other specimen with clear label data which is in good condition. We designate this specimen as lectotype with the agreement of Dr. D. Stüning, ZFMK. Only one syntype specimen is deposited in BMNH (Geometridae Genitalia slide no. 20321); it has the label data 'Lingping, Südchina, iv.22, coll. H. Höne' and was labelled as 'Paratype' by Wehrli, we treat this specimen as a paralectotype.

***Syzeuxis heteromeces* Prout, 1926**
Figs 9, 21, 33, 40

Syzeuxis heteromeces Prout, 1926b, *Mem. Dep. Agric. India (Ent.)*, 9 (8): 253. Holotype ♂, India: Turzum Tea Estate, Nagrispur, near Darjiling. (BMNH)
Syzeuxis miniocalaria Xue, 1999, in Xue & Zhu, *Fauna Sinica: Insecta*, 15: 193, fig. 198, pl.4: 3. Holotype ♂, China: Yunnan, Tengchong, Heinitang. (IZCAS) Syn. nov.
Syzeuxis miniocalaria Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 85, figs 3c, 5c.

Materials Examined. INDIA: 1♂, Holotype, Turzum Tea Estate, Nagrispur, no date, coll. O. Linlyrea, Geometridae Genitalia slide no. 20325 (BMNH); 1♀, Khasis, nat. coll., ex Oberthür coll., Brit. Mus. 1927-3 (BMNH); 1♀, Sylhet, H.M.Parish, 1910-62, Geometridae Genitalia slide no. 24012 (BMNH). CHINA: 1♂, Holotype of *S. miniocalaria* Xue, Yunnan: Tengchong, Heinitang, 1930 m, 28–30 May 1992, coll. Xue Dayong, slide no. L-2273 (IZCAS).

Description. Antennae in male bipectinate with tip ciliate, female unknown. Labial palpus strongly rough-scaled, about extending 1/3 beyond frons. Vertex yellowish brown. Thorax and abdomen with dorsal side yellowish white to yellowish brown. *Wing pattern.* Forewing length: ♂ 8 mm; ♀ 10 mm. Forewing pale yellowish brown, streaks black brown, hindwing slightly paler. Forewing with apex rounded and outer margin slightly protruding at middle. Forewing with a small black patch at wing base; antemedial and postmedial lines indistinct but broad, grey, forming large oblong black patches on costa; another small black patch present near apex; terminal line black, discontinuous. Hindwing with postmedial line thin at upper half and then suddenly broadened to inner margin; terminal line black brown between veins; discal spot tiny, grey brown. Male hindwing without basal lobe. Fringes of forewing black brown between vein M_1–M_3 and between CuA_1 and vein 2A, yellowish white on other parts; yellowish white on hindwing, and black-brown under CuA_1. Underside: forewing paler than upperside; with diffuse dense grey brown speckles from lower margin of cell to CuA_2; postmedial line dark grey-brown, straight and broad, not reaching inner margin; with dark grey brown discal spot. Forewing with a single areole. *Male genitalia*. Uncus large and broad, slightly concave, posterior half with lateral margins strongly curved inwards towards a narrow apical section, expanded at tip. Gnathos with median process as in *S. tessellifimbria*. Valva membranous, small, with apex narrow; costa without process. Juxta developed, a large sclerotized rounded plate. Aedeagus narrow, with a blunt sclerotized posterior process, bearing a spinose tuft. *Female genitalia*. Ductus bursae short and membranous, without antrum or any sclerotized area. Corpus bursae oval, circled with a series of weakly sclerotized folds above middle.

Diagnosis. *S. heteromeces* is similar to *S. nigrinotata* in its small size and X-shaped hindwing postmedial line. But it differs in the presence of an areole on the forewing, which is absent in *S. nigrinotata*. In the male genitalia, the shape of the uncus of *S. heteromeces*, broadened and oval on basal two-thirds, and then suddenly narrowed at top one-fourth, is distinctly different from other species.

Distribution. China (Yunnan), India (Northeast).

***Syzeuxis furcalineas* Galsworthy & Han sp. nov.**
Figs 10, 22, 34

Type Material. Holotype, ♂, Khasia Hills, Assam, Nissary, Joicey Bequest. Brit. Mus. 1934-120, Geometridae Genitalia slide no. 20322 (BMNH).

Description. Antennae bipectinate in male, ciliate at tip and in female. Labial palpus, frons, vertex, and dorsal side of thorax brown. Labial palpus extending about 1/3 beyond frons. *Wing pattern.* Forewing length: ♂ 8 mm. Wings yellow brown, with diffuse dark speckles, hindwing much paler. Outer margin of forewing slightly protruding at middle, then straight towards anal angle. Forewing with costa black-brown; antemedial and postmedial lines indistinct, only a little darker than wing colour, but forming dark brown triangular patches on costa, costal patch of postmedial line reaching M_2; terminal line present between M_1 and M_3, CuA_1 and anal angle; discal spot invisible. Hindwing with postmedial line dark brown, X-shaped, the two branches having the same width; terminal line complete, but broken on vein ends; discal spot a small dark brown patch. Hindwing in male without basal lobe. Fringes of forewing dark brown where terminal line present, pale brown on other parts; on hindwing, dark brown below M_2

and pale brown above M_2. Underside: forewing paler than upperside; the upper half with denser dark speckles, but dark speckles almost absent in lower half; postmedial line dark brown, broad, not reaching inner margin; terminal line complete except near apex; hindwing similar to upperside, a little darker. Forewing with a single areole. *Male genitalia*. Uncus narrower than other species, with small and shallow concavity at apical end. Gnathos developed, tapered. Valva membranous, curved upwards, with terminal part a little narrower than basal part. Juxta not developed. Aedeagus membranous, with anterior part much broader than posterior part, without spines. *Female genitalia*. Unknown.

Diagnosis. The hindwing postmedial line of *S. furcalineas* is similar to those of *S. nigrinotata* and *S. pavonata*, which also have an X-shaped line, but is different from those two species in having two branches of the same width, connected only for a very short distance, while the other two species have one branch which is much broader than the other and the connection between the two is long. The present species also differs in the presence of an areole on the forewing, which is absent in the other two species. In the male genitalia, *S. furcalineas* differs from both in the lack of spines in the aedeagus, and the narrowness of the uncus.

Distribution. India (Khasi Hills).

Etymology. The specific name is derived from the X-shaped postmedial line on the hindwing.

Remarks. The type specimen was found among the BMNH series of *S. seminanis*.

Syzeuxis nigrinotata (Warren, 1896)

Figs 11, 23, 35, 41

Aphantoloba nigrinotata Warren, 1896, *Novit. zool.*, 3: 117. Lectotype ♂, India: Khasias [Khasi Hills], **here designated**. (BMNH)

Syzeuxis nigrinotata: Hampson, 1898, *J. Bomb. Nat. Hist. Soc.*, 12: 75 (as syn. of *S. trinotaria*); Prout, 1926a, *Novit. zool.*, 33: 12.

Materials Examined. INDIA: 1♂, Lectotype (here designated), Khasi Hills (as 'Khasias' in original description and labelled as 'Khasis'), March 1895, nat. coll., Geometridae Genitalia slide no. 20323 (BMNH). INDONESIA: 1♂, North-Sumatra, Mt. Sibayak, 1650 m, 6 km, NW. Brastagi, 03˚14'N/098˚29'E, 2 March 2002, leg. K. Larsen & M. Fibiger (IZCAS, slide no. Geom-00737, ex. Dr. M. Fibiger, Denmark); 1♀, North-Sumatra, Near Sipirok, 1435 m, Danau Marsabut, 01˚37'50"N/099˚20'30"E, 27 February 2002, leg. M. Fibiger (IZCAS, slide no. Geom-00738, ex. Dr. M. Fibiger, Denmark).

Description. Antennae in male bipectinate, filiform at tip and in female. Labial palpus grayish brown, rough-scaled, extending about one half of its length beyond frons in both male and female. Frons, vertex and thorax greyish brown. *Wing pattern*. Forewing length: ♂♀ 8 mm. Wings yellowish brown, with diffuse black speckles, denser on hindwing. Hindwing relatively smaller than in other species. Forewing with outer margin under apex distinctly concave; a small dark patch present on base of costa; antemedial and postmedial lines greyish yellow, parallel to each other, forming two triangular black patches on costa; another small dark patch on costa near apex; terminal line black, discontinuous, more distinct from M_1 to M_3. Hindwing with X-shaped postmedial line, one branch very broad, the other one very narrow. Hindwing in male without basal lobe. Fringes of forewing black where terminal line distinct, yellowish brown on other parts; yellowish brown mixed with sparse black spots on hindwing. Underside: yellowish white, with diffuse black speckles; forewing with lower half much paler; postmedial line black brown, broad, fading away towards inner margin; hindwing similar to upperside. Forewing without areole, R_1 to R_5 long stalked, arising before upper angle of cell, R_1 very shortly touching or connected to Sc after arising from stalk. *Male genitalia*. Uncus large and broad, slightly concave at apical margin. Socii undeveloped. Gnathos developed, with a large relatively narrow median process with a blunt tip. Valva small, subapical strongly narrowed; costa without process. Juxta undeveloped. Aedeagus broad, with sparse spines subposteriorly around aedeagus. *Female genitalia*. Region around ostium membranous; ductus bursae long and narrow, without antrum. Corpus bursae long and narrow, slightly broader than ductus bursae, membranous. Signum absent.

Diagnosis. See diagnosis under *S. pavonata*.

Distribution. India (Khasi Hills), Indonesia (North Sumatra).

Remarks. The type status of this species is quite complex. Warren wrote in his original description 'Several from the Khasias', which means that the type series should be considered as syntypes. Prout (1926a) restricted *S.*

nigrinotata to the male syntype and considered only the single male syntype of *S. nigrinotata* to be this species. He linked the female syntypes to a new species *S. magnidica* (see remarks under that species). Parsons *et al*. (1999) listed the male syntype as a holotype, we do not think that it can be so regarded, given Warren's original description. We follow Prout's treatment, and for the avoidance of doubt hereby formally designate the specimen listed above as lectotype.

Syzeuxis pavonata Xue & Han sp. nov.

Figs 12, 24, 36

Type Material. Holotype: ♂, CHINA: Yunnan: Pingbian, Daweishan, 1500 m, 20 June 1956, coll. Huang Ke-ren, slide no. Geom-00087 (IZCAS).

Description. Antennae bipectinate in male, female unknown. Labial palpus rough-scaled, yellowish brown, tinged with white on upper surface, less extending than 1/2 its length beyond frons. Frons yellowish green. Vertex and dorsal side of thorax yellowish brown. *Wing pattern*. Forewing length: ♂ 10 mm. Vertex yellowish brown. Forewing with the apex acute, outer margin of forewing slightly protruding at middle. Forewing dirty pale yellow, diffused with dark brown. Antemedial and postmedial lines forming triangular patches on costa, the latter extending below as a dark yellowish brown fascia-like mark; a small dot on costa near apex; terminal line black, discontinuous. Hindwing dirty white, scattered with dark scales; postmedial line dark greyish brown, X-shaped, with one branch broader than the other. Hindwing in male without small basal lobe. Fringes pale brown on both wings, dark brown on forewing where terminal line present. Underside of both wings pale yellowish, scattered with dark brown streaks, which are almost absent on lower half of forewing; postmedial line dark brown, same as upperside on hindwing and more distinct than that of forewing upperside. Forewing without areole. *Male genitalia*. Uncus relatively short and broad, length and width similar. Gnathos with median process long, narrow, and tapered. Valva with basal half broad and distal half rapidly narrowing; costa concave and ventral margin of valva convex. Juxta a rounded plate, setose on posterior margin. Saccus small. Aedeagus extremely broad, with a row of tiny spines forming a partial ring subposteriorly; cornutus a large spinose patch. *Female genitalia*. Unknown.

Diagnosis. *S. pavonata* is very close to the Indian species *S. nigrinotata* on wing pattern, in both species the asymmetric X-shaped postmedial lines on the hindwing are very characteristic. These two species are very difficult to distinguish on wing pattern, though *S. pavonata* is a little larger and paler. Both species lack the areole on the forewing, and have R_1 to R_5 long stalked, arising before the upper angle of the cell, and R_1 separating from first the stalk. But in *S. pavonata* R_1 is free, while in *S. nigrinotata* R_1 is shortly touching or connected to Sc after arising from the stalk. *S. pavonata* differs from *S. nigrinotata* in the male genitalia in that the uncus is much broader, and the aedeagus is of an entirely different shape.

Distribution. China (Yunnan).

Etymology. The specific name is derived from the Latin name for the peacock.

Syzeuxis calamisteria Xue, 1999

Figs 13, 25, 37, 42

Syzeuxis calamisteria Xue, 1999, in Xue & Zhu, *Fauna Sinica: Insecta*, 15: 192, figs 196,197, pl.4: 2. Holotype ♀, China: Tibet, Mêdog. (IZCAS)

Syzeuxis calamisteria Xue, 2000, *Acta Zootaxonomica Sinica*, 25 (1): 83, figs 3a, 3b, 5b.

Materials Examined. CHINA: 1♀, Holotype, Tibet: Mêdog, 2750 m, 23 August 1982, coll. Han Yinheng (IZCAS); 1♀, Paratype, same data as Holotype, slide no. L-0987 (IZCAS); 1♂1♀, paratypes, Tibet: Mêdog, Beibeng, 850 m, 21 May 1983, coll. Han Yinheng, male slide no. L-0986 (IZCAS).

Description. Antennae in male bipectinate and ciliate apically, ciliate in female. Labial palpus brown, extending about 1/3 beyond frons. Frons and vertex greenish yellow. Thorax and abdomen with dorsal sides greyish yellow to greyish yellow brown. *Wing pattern.* Forewing length: ♂♀ 15 mm. Wings yellowish green. Outer margin of forewing slightly protruding at middle. Forewing with four dark patches along costa from base to near apex; another undulating dark band extending transversely from near base, not reaching outer margin, upper margin of

band with four small teeth and lower margin extending to wing's inner margin at base and medially, end of band with four small teeth. Hindwing yellowish brown, scattered with dense dark brown dots, denser near outer margin; postmedial line broad, grey, parallel to outer margin. Discal spot absent on both wings. Fringes of forewing dark and whitish on apex and partly whitish between M_3 and CuA_1; yellowish brown on hindwing. Hindwing in male with a small lobe at base. Underside: yellowish brown scattered with dark dots; black band on forewing and postmedial line on hindwing discernible on underside. Forewing with areole double. Hindwing with discocellulars biangulate. Hindwing in male without basal lobe. *Male genitalia*. Uncus large and broad, concave slightly apically. Gnathos with large median process very broad and only tapered distally. Valva quite small and short, tapered towards apex, but apex blunt; costa without process. Vinculum near valva base stongly expanded. Juxta developed, forming a large sclerotized plate, with posterior margin slightly depressed across its width. Aedeagus simple, broad, tube-like, with sparse spines posteriorly. *Female genitalia*. Apophyses posteriores very long, apophyses anteriores quite short. Ostium very broad, sterigma absent. Ductus bursae narrow and long except for very large, broad, sclerotized antrum, the latter about 1/3 length of ductus bursae, much broader than in *S. tessellifimbria*. Corpus bursae small and weak, membranous. Signum absent.

Diagnosis. *S. calamisteria* differs from all other congeneric species by the remarkable black markings on the forewing.

Distribution. China (Tibet).

Phylogenetic analysis

The monophyly of *Syzeuxis* is well supported by specific features of the male genitalia. In order to illuminate the detailed phylogentic relationship within the genus so as to propose a new, more stable and more compatible generic system, a phylogenetic analysis of *Syzeuxis* was undertaken based on morphological characters. *Chrioloba cinerea* (Butler, 1880), the type-species of the genus *Chrioloba* Prout, 1958, was chosen as an outgroup in order to root the tree and polarize the characters. Species of *Syzeuxis* are externally similar to members of *Chrioloba* in wing pattern and species distribution, as well as having a ring-shaped gnathos or a pair of gnathi in the male genitalia, and for this reason we treat these two genera as closely related sister-groups (See detailed discussion under the section "Tribal placement"). 28 characters were derived from the total 13 species (See detail in Appendix 1). Because the female genitalia of most species are not known, female genitalia characters were not included in this study. The characters were coded and summarized in a matrix (See detail in Appendix 2).

The character matrix was analysed using computer program NONA version 2.0 (Goloboff 1999). All characters were weighted equally. Final trees, a strict consensus tree and character optimizations were studied using WinClada v.1.00.08 (Nixon 2002). In addition, to estimate the validity of the tree obtained by NONA, we also applied a heuristic search to carry out the cladistic analysis in PAUP version 4 (Swofford 1999). A 50% majority rule was applied to construct the consensus trees. Bootstrap supports (Felsenstein 1985) for each clade within the phylogram and consensus tree were estimated using 1000 replications and by options of tree-bisection-reconnection.

The initial search of 28 characters resulted in 6 parsimonious trees (L=51, Ci=0.56, Ri=0.73). The strict consensus tree (Figure 43a) with 53 steps, consistency index of 0.54, and retention index of 0.71 showed a dichotomy composed of two main components, which was congruent with the topology of the 50% majority consensus tree obtained from PAUP (Figure 43b): the first component (A) comprises two species, *S. extritonaria* and *S. neotritonaria*, which are very similar in morphology. Three characters, forewing apex acute and falcate (ch 6: 1), valva costa with a row of dense spines (ch 20: 1), and terminal half of valva folded over costa (ch 28: 1), were identified as the synapomorphies of this component. The other component (B+C+D) contained the remaining species. Within this component, the minimum dichotomy (D) that included the type species (*S. trinotaria*) is marked by four synapomorphic characters: with coherent colour and similar marking style on both wings (ch 14: 1), hindwing in male without a small basal lobe (ch 15: 1), male hindwing Rs stalked with M_1 (ch 17: 1) and terminal half of valva bent upwards (ch 22: 1). As a sister group, the species *S. calamisteria* shares three synapomorphic characters (ch 11, ch 12, ch 27) with component D. These three synapomorphies separate the complex component of C+D out from the component B, although the whole component of B+C+D owns two synapomorphies (ch 7, ch 10).

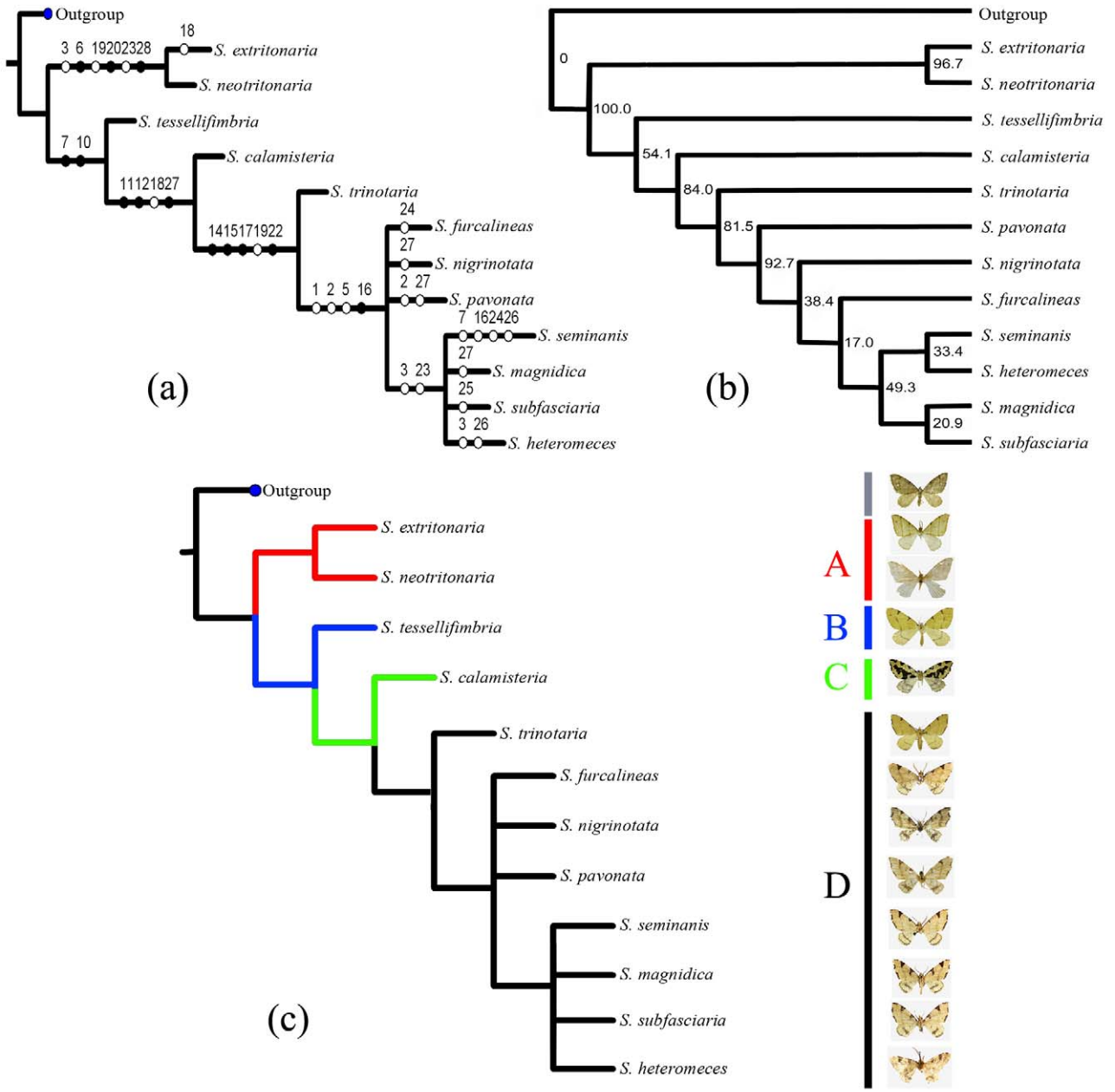


FIGURE 43. Phylogenetic tree of the genus *Syzeuxis* based on 28 characters of adult morphology. (A) Strict consensus of 6 equally parsimonious trees (L=53, CI=0.54, RI=0.71) obtained from NONA. Numbers above branches represent characters which correspond with data matrix in the appendix 2. Black cicles in the branches represent synapomorphies, whereas white circles represent homoplasies. (B) 50% Majority consensus tree obtained from PAUP. Bootstrap values for each branch are shown against the braches (C) Phylogenetic consensus tree of the genus *Syzeuxis*. Pictures of the species are on the right-hand.

Discussion and conclusion

Tribal placement

The tribe Trichopterygini, the members of which are distributed worldwide, is a large tribe within the Larentiinae, and was originally established by Warren in 1894 as a subfamily. Studies by Dugdale (1980), Xue (1992), Holloway (1997) and Sihvonen *et al*. (2011) include more than 30 genera within this tribe. Holloway (1997) characterized the principal apomorphies of the tribe as the reduction of the male hindwing which is often modified into a

lobe or lappet that sometimes bears what appears to be a row of carinae, and the presence of a central sac or pair of sacs supported from a pair of triangular structures on the male second abdominal sternite. The hind tibial hair-pencil (Forbes 1948; Hashimoto 2005) and gnathos in the male genitalia (Holloway 1997) are two tribal characters, which are present only within the Trichopterygini in the Larentiinae, but these two characters are often absent in several genera of the tribe. There are two main forms of the relationship between vein $Sc+R_1$ and Rs on the hindwing in the tribe Trichopterygini: 1) $Sc+R_1$ fused with Rs more than one half the length of the upper margin of the cell, for example in *Brabira* Moore, 1888, *Lobophora* Curtis, 1825, *Tyloptera* Christoph, 1881, *Acasis* Duponchel, [1845]1844, *Nothocasis* Prout, 1937, *Phthonoloba* Warren, 1893, and *Trichopterigia* Hampson, 1895. 2) $Sc+R_1$ separated from Rs and connected by a bar, as in *Carige* Walker, 1863, *Cryptoloba* Warren, 1893, *Trichopteryx* Hübner, [1825]1816, *Lobophorodes* Hampson, 1903, *Esakiopteryx* Inoue, 1958, *Epilobophora* Inoue, 1943, *Goniopteroloba* Hampson, 1895, *Tympanota* Warren, 1895, *Sauris* Guenée, 1858, and *Episteira* Warren, 1899. *Syzeuxis* belongs to this second form.

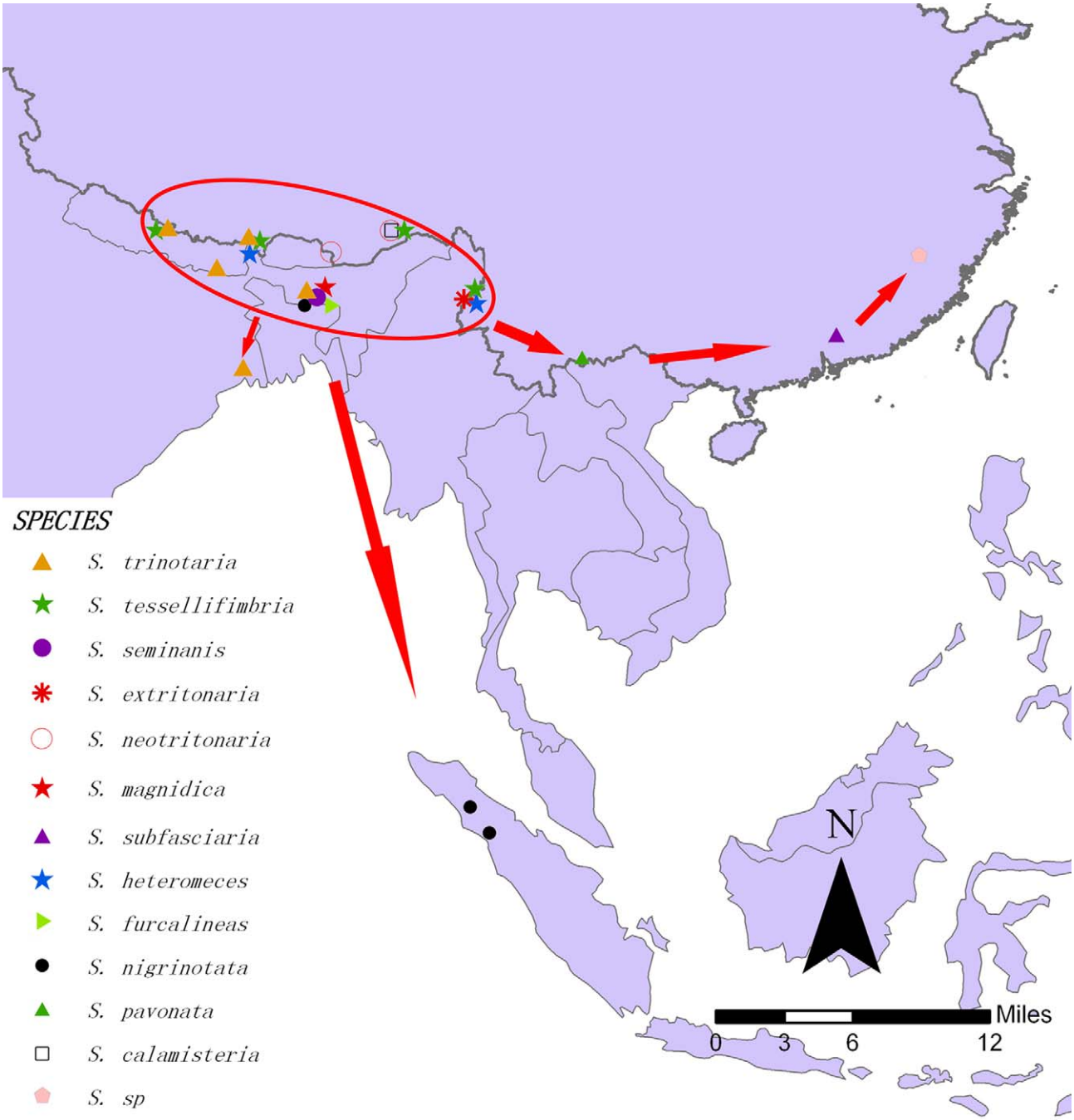


FIGURE 44. Species distribution patterns of the genus *Syzeuxis*.

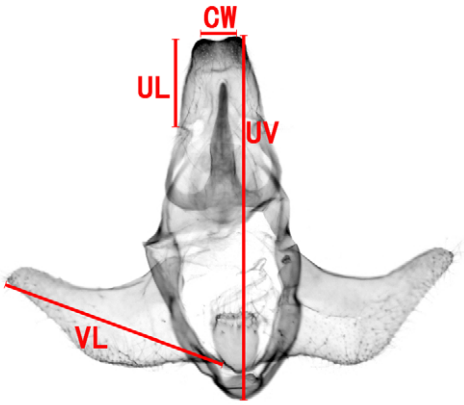


FIGURE 45. Schema of male genitalia characters used in the phylogenetic analysis. VL: length of valva; UV: full length from uncus to saccus; CW: terminal width of uncus; UL: length of uncus.

As noted by Holloway (1997), genera in the tribe Trichopterygini can be divided roughly into two groups by the forewing fasciae: genera such as *Sauris*, *Tympanota*, *Episteira* and *Phthonoloba* generally have multiple and complex fasciae whereas the fasciation of the other genera, such as *Carige*, *Chrioloba*, *Cryptoloba*, *Heterophleps*, *Lobogonia*, *Syzeuxis* and *Tyloptera*, is simple rather than multiple. However Holloway himself has noted (pers. com.) that the division into two groups within the tribe Trichopterygini is only a hypothesis which needs to be tested in a wider revision of the tribe.

Athough lacking the hind tibial hair-pencil, the genus *Syzeuxis* falls well within the tribe Trichopterygini on the basis of having the male hindwing base modified into a lobe, the male second abdominal sternite modified with a central sac in most species, and having a ring-shaped gnathos in the male genitalia. With simple forewing fasciae, rather deep and varyingly bifalcate forewing, and with the hindwing outer margin often angled, the genus *Syzeuxis* could be placed into the group of the Trichopterygini with simple fasciae as discussed above.

The genus *Syzeuxis* is one of few genera in the tribe Trichopterygini that have a gnathos in the male genitalia: we have found gnathoi in *Chrioloba* Prout, 1958, *Goniopteroloba* Hampson, 1895, *Ptygmatophora* Gumppenberg, 1887, and *Tyloptera* Christoph, 1881. Whereas, in the former three genera, the gnathos takes the form of two lateral arms, in *Tyloptera* and *Syzeuxis*, the lateral arms are fused at the medial point.

In the definition of the tribe Trichopterygini by Holloway (1997) and Choi (2007), it is also mentioned that the members often have a valva with costal and saccular ornamentation. However, *Syzeuxis* only has a very simple valva, usually without ornamentation, similar to those of *Tristeirometa* Holloway, 1997 and *Episteira* Warren, 1899 within the Trichopterygini. In the female genitalia, *Syzeuxis* is also one of quite few genera in the Trichopterygini that lack scobination in the corpus bursae.

To sum up, based on both external and genital features, it seems clear that *Syzeuxis* belongs within the Trichopterygini.

Species groups

Based on the consensus tree from the phylogenetic analysis (Figure 43c), the genus *Syzeuxis* divides into four species groups: *S. tessellifimbria* and *S. calamisteria* fall into group B and group C respectively; group A comprises two species, *S. extritonaria* and *S. neotritonaria*; the remaining species, *S. trinotaria*, *S. seminanis*, *S. magnidica*, *S. subfasciaria*, *S. heteromeces*, *S. furcalineas*, *S. nigrinotata*, *S. pavonata*, comprise group D. The physical dimensions of the adults gradually reduce from group B, C, A to group D. The forewings of the first three groups all have a greenish hue, and do not match the hindwing ground colour. But the markings of group A are much simpler than those of the first two groups. Apart from the type species *S. trinotaria*, which also has a greenish hue to the forewing, the other species of group D have a pale yellow or yellowish brown forewing, and all species of this group have a coherent colour, as well as similar marking style on both wings. There is a further important group character in group D, that the postmedial lines on the hind wing usually form an X-shape (except in the type species *S. trino-*

taria). The black spots on the forewing antemedial line of group A are small and the lower part of the spots does not reach the discal cell, and the species of this group have no black patch on the forewing base: all these characters are different from the other three groups. Looking at the venation, groups B and C have biangulate discocellulars in the male hindwing, which is uncommon in the tribe Trichopterygini. The male hindwing Rs is stalked with M_1 in group D. In the male genitalia, the valva costa of group A has a row of dense spines while that of group B has a distinct protrusion; terminal half of valva of group A is usually folded over costa while that of group D is bent upwards. In groups A, B and C the male hindwing has a small basal lobe, which is absent in group D. There is an unidentified single female specimen in ZFMK, collected from Guadun, Mt. Wuyi, Fujian, in the south of China (label data: Kuatun (2300m), 27.40n. Br., 117.40ö. L, J. Klapperich, 17.5.1938 (Fukien)) (*S.* sp. in fig. 44). The morphology of this specimen is very similar to the species of group D, based on physical dimensions of the adults, colour, streaks and venation of the wings.

Distribution patterns of the genus *Syzeuxis* Hampson (Figure 44)

Syzeuxis Hampson is mainly distributed on the southern side of the Himalayan chain. Nine species of the genus have been found in that area (*S. trinotaria, S. tessellifimbria, S. seminanis, S. neotritonaria, S. magnidica, S. heteromeces, S. furcalineas, S. nigrinotata, S. calamisteria*). The distribution patterns of *Syzeuxis* in this area are strictly restricted to the subtropical and tropical rainforest areas of the Himalayas. Most species are distributed in the zones of evergreen broad-leaf forests at an altitude of 1000–2300 meters, while only three species were recorded at higher altitudes (above 2300 meters) in coniferous-broad leaved mixed forests (Zhang 1999). Influenced directly by the Indian Ocean monsoon, the climate of the region is warm and wet (Huang 1981). The distribution of *Syzeuxis* in the Hengduan Mountains is restricted to the western margin of the area, in a narrow low hill zone west of Mt. Gaoligong. All three known species (*S. heteromeces*, *S. tessellifimbria* and *S. extritonaria*) distributed here are extensions of Himalayan species or closely related to them. The three records from southeast Yunnan to Guadun, Fujian and the record from North Sumatra, all belonging to species of group D (*S. subfasciaria*, *S. pavonata*, *S.* sp.), are also from evergreen broad-leaf forests in low mountains, where, influenced by the southeast monsoon, the weather is also warm and wet.

The following general conclusions can be drawn from the distribution patterns described above about the zoogeographical features of the genus *Syzeuxis*.

(1)Linear pattern: The species of the genus *Syzeuxis* show a linear geographic distribution along the Tropic of Cancer in the eastern Hemisphere (Only spreading southwards to northern Sumatra in Indonesia).

(2)Warm and wet climate in low mountains: *Syzeuxis* species are adapted to a warm and wet climate. All species of *Syzeuxis* are distributed in low mountains in subtropical rainforest and monsoon forest within the Oriental Region.

(3)Biodiversity increases from east to west: the number of species increases distinctly and the biodiversity tends to be higher from east to west.

(4)Restricted distribution of species: over half the species in the genus *Syzeuxis* are restricted to a very narrow distribution range.

(5)Correlation with geophysical factors: apart from southeast China (Guangdong and Fujian), the remaining distribution area of the species of *Syzeuxis* is almost perfectly located on the areas produced by the collision of the Indian and Eurasian Plates.

The southern foothills of the Himalayas (marked with a Red circle in Figure 44) contains the highest species diversity of the genus *Syzeuxis*, missing only a few species of group D, which spread southward and eastward to the Sumatra and the south of China. In the phylogenetic analysis of the genus *Syzeuxis* in this paper, species of group A, B and C share a particular character, the modification of small basal lobe in the male hindwing. This character is common and generally regarded as a synapomorphy in the tribe Trichopterygini, which suggests that the evolutionary histories of groups A, B, and C might be longer than that of group D. It might therefore be reasonable to hypothesize that *Syzeuxis* originated somewhere in the southern foothills of the Himalayas, and diversified into different groups. Among these groups, the youngest group (Group D) has extended eastward and southward to the south of China and Sumatra respectively.

Such patterns of distribution through the Himalayas and western China can be found in several close genera within the tribe Trichopterygini, based on the type localities listed in the Scoble catalogue (Parsons *et al.* 1999). Some are generally overlapping with *Syzeuxis*, such as *Chrioloba*, and some extend further east to Japan, such as *Carige*, which also extends southwards to Sumatra. *Goniopteroloba*, with a northeastern Indian type species, is the most southerly, with most of its diversity in Sundaland, extending east to the Philippines and Sulawesi (Holloway 1997). This overlapping distributional pattern of the genera mentioned above suggests the great influence of important geological events for species distribution, such as the collision of the Indian and Eurasian Plates and the rapid uplift of the Qinghai-Tibetan Plateau (Huang 1981). Such distribution patterns are found not only within the tribe Trichopterigini, but also in other groups of Lepidoptera, such as the tribe Cidariini (Choi 2000).

These distribution patterns are no more than a small part of the whole and complex pattern of the tribe Trichopterygini, and our study of *Syzeuxis* can only be a a very preliminary biogeographical analysis. A further study based on more technologies, including molecular, ethological and ecological, and more taxonomic groups within the Trichopterygini, would be required to draw firm conclusions about the origins of the tribal geographical pattern.

Acknowledgements

We express our warm thanks to D. Carter and G. Martin, Department of Entomology, Natural History Museum, London, UK, for their loan of specimens and generous help. We especially thank G. Martin, for his communications on some confused type specimens and agreement on the lectotype designations. We also thank Dieter Stüning, Zoologishces Forschungsmuseum Alexander Koenig, Bonn, for providing us the pictures and other information on the type specimen of *S. subfasciaria* and the information of the genus in ZFMK collections. Thanks also to K. Yazaki, Japan and M. Fibiger, Denmark, for their kind gifts of specimens of *S. trinotaria* from Nepal and *S. nigrinotata* from Sumatra. Finally, we are grateful to Jeremy Holloway, Department of Entomology, Natural History Museum, London, UK, and Zhang Zhi-Qiang, Landcare Research, New Zealand Arthropod Collection, Auckland, New Zealand, for their reading of the manuscript and valuable comments on the phylogenetic and biogeographical analyses, as well as linguistic corrections. The project was supported by the National Natural Science Foundation of China (No. 31172127, 30870320), the Key Project of Scientific Innovation of CAS (KSCX2-YW-Z-0909), the National Science Fund for Fostering Talents in Basic Research (NSFC-J0930004) and a grant from the Key Laboratory of the Zoological Systematics and Evolution of the Chinese Academy of Sciences (No. O529YX5105).

References

Butler, A.G. (1880) Descriptions of new species of Asiatic Lepidoptera Heterocera. *Annals and Magazine of Natural History*, (5) 6, 61–69, 119–129, 214–230.

Choi, S.W. (2000) Cladistic biogeography of the moth tribe Cidariini (Lepidoptera, Geometridae) in the Holarctic and Indo-Chinese regions. *Biological Journal of the Linnean Society*, 71(3), 529–547.

Choi, S.W. (2007) Taxonomic study of the genus *Trichopteryx* Hübner (Lepidoptera: Geometridae) in Korea. *Entomological Research*, 37, 46–53.

Christoph, H. (1881) Neue Lepidopteren des Amurgebietes. *Bulletin de la Société Impériale des Naturalistes de Moscou*, 55 (3), 33–124.

Comstock, J.H. (1918) *The Wings of Insects*. Comstock Publishing Company, Ithaca, New York, 430 pp.

Curtis, J. (1823-1839) *British Entomology*. London, 16 vols, 770 pls.

Dugdale, J.S. (1980) Australian Trichopterygini (Lepidoptera: Geometridae) with descriptions of eight new taxa. *Australian Journal of Zoology*, 28, 301–340.

Duponchel, P.A.J. ([1845]1844) *Catalogue méthodique des Lépidoptères d'Europe*. Méquignon-Marvis, Paris, xxx + 523 pp.

Felsenstein, J. (1985) Confidence limits on phylogenies: an approach using the bootstrap. *Evolution*, 39, 783–791.

Forbes, W.T.M. (1948) Lepidoptera of New York and neighbouring States. Geometridae, Sphingidae, Notodontidae, Lymantridae. Part ?. *Memoirs Cornell Agric Expt Sta Ithaca*, 274, 1–263.

Goloboff, P. (1999) NONA. Program and Documentation, Version 2.0. Published by the author.

Guenée, A. (1858) Uranides et Phalénites 1. *In* Boisduval, J.B.A.D. & Guenée, A. (Eds.), *Histoire naturelle des Insectes* (Species général des Lépidoptères), 9, i–lvi, 1–514; 10, 1–584; Atlas, pls. 1–22.

Gumppenberg, C.V. (1887) Systema Geometrarum zonae temperatioris septentrionalis. Theil 1. *Nova Acta Ac. L.-C. Nat. cur.*, 49, 229–400, pls 8–10.
Hampson, G.F. (1895) *The Fauna of British India including Ceylon and Burma*, (Moths) 3, Geometridae. Taylor and Francis, London, pp. 138–519.
Hampson, G.F. (1898) The moths of India, supplementary paper to the volumes in The fauna of British India. Series I, Part IV. *Journal of the Bombay Natural History Society*, 11, 73–98.
Hampson, G.F. (1903) The moths of India. Supplementary paper to the Volumes in the Fauna of British India. Series II, Part viii. *Journal of the Bombay Natural History Society*, 14, 639–659.
Hashimoto, S. (2005) Homology and taxonomic importance of the tibial hair-pencil and its related structures in the family Geometridae (Lepidoptera). *Tinea*, 18, 146–158.
Hausmann, A. (2001) Introduction. Archiearinae, Orthostixinae, Desmobathrinae, Alsophilinae, Geometrinae. *In* Hausmann, A. (Ed.), *The Geometrid Moths of Europe*. Apollo Books, Stenstrup, 1, 282 pp.
Herrich-Schäffer, G.A.W. ([1854]1850–1858) *Sammlung neuer, oder wenig bekannter, Aussereuropäischer Schmetterlinge*. Regensburg, 128 pls.
Holloway, J.D. (1997) The moths of Borneo: family Geometridae, subfamilies Sterrhinae and Larentiinae. *Malayan Nature Journal*, 51, 1–242, 608 figs, 12 pls.
Huang, F-S. (1981) Sudden ascent of Xizang Plateau in relation to insect fauna (I). *In* Chen, S-X. (Ed.), *Insects of Xizang*. Science Press, Beijing, pp 1–34.
Hübner, J. (1816–1826) *Verzeichniss bekannter Schmettlinge.* Augsburg, 431 pp.
ICZN. (1999) *International Code of Zoological Nomenclature*, Fourth Edition. London, xxix+126 pp.
Inoue, H. (1943) New and little known Geometridae from Japan. *The Transactions of the Kansai Entomological Society* 12 (2), 1–25, figs 1–8, pl. 11.
Inoue, H. (1958) Descriptions and records of some Japanese Geometridae (II). *Tinea*, 4 (2), 241–256, 1 pl., 10 figs.
Inoue, H. (1982) Geometridae of Eastern Nepal based on the collection of the Lepidopterological Research Expedition to Nepal Himalaya by the Lepidopterological Society of Japan in 1963. Part II. *Bulletin of Faculty of Domestic Sciences of Otsuma Women's University*, 18, 129–190.
Klots, A.B. (1970) Lepidoptera. *In* Tuxen, S.L. (Ed.), *Taxonomist's Glossary of Genitalia in Insects*. Munksgaard, Copenhagen, pp. 115–130.
Moore, F. (1868) On the Lepidopterous Insects of Bengal (Tribe Geometres *et al*.). *Proceedings of the Zoological Society of London*, 1867, 612–686, pls 32–33.
Moore, F. (1888) Heterocera continued (Pyralidae, Crambidae, Geometridae, Tortricidae, Tineidae). *In* Hewitson, W.C. & Moore, F. (Eds.), *Descriptions of New Indian Lepidopterous Insects from the colletion of the late Mr.W.S. Atkinson*, (3). Asiatic Society of Bengal, Calcutta, pp. 199–299, pls 7–8.
Nichols, S.W. (1989) *The Torre-Bueno Glossary of Entomology.* New York Entomological Society in cooperation with the American Museum of Natural History, New York, xvii + 840 pp.
Nixon, K. (2002) WinClada, Version 1.00.08. Ithaca, New York, Published by the author.
Parsons, M.S., Scoble, M.J., Honey, M.R., Pitkin, L.M. & Pitkin, B.R. (1999) The catalogue. *In* Scoble, M.J. (Ed.), *Geometrid moths of the world: a Catalogue (Lepidoptera, Geometridae)*. CSIRO, Collingwood, 1016 pp.
Pierce, N. (1914, reprint 1976) *The Genitalia of the Group Geometridae of the British Islands*. E. W. Classey Ltd., Middlesex, xxix + 88 pp., 48 pls.
Prout, L.B. (1926a) New Geometridae. *Novitates Zoologicae*, 33, 1–32.
Prout, L.B. (1926b) New Indian Geometridae. *Memoirs of the Department of Agriculture in India Entomological series*, 9, 247–257.
Prout, L.B. (1934–1954) Geometridae. *In* Seitz, A. (Ed.), *The Macrolepidoptera of the World*, vol. 4 (Supplement). Alfred Kernen, Stuttgart, pp. 1–253. pls. 1–18.
Prout, L.B. (1958) New species of Indo-Australian Geometridae. *Bulletin of the British Museum (Natural History)* (Entomology), 6, 365–463.
Robinson, G.S. (1976) The preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. *Entomologist's Gazette*, 27, 127–132.
Sihvonen, P., Mutanen, M., Kaila, L., Brehm, G., Hausmann, A. & Staude, H.S. (2011) Comprehensive molecular sampling yields a robust phylogeny for geometrid moths (Lepidoptera: Geometridae). *PloS one*, 6(6), 1–11.
Scoble, M.J. (1992) *The Lepidoptera, Form, Function and Diversity.* Oxford University Press, Oxford , xi+404 pp.
Swofford, D.L. (2001) PAUP*. Phylogenetic analysis using parsimony (*and other methods), Version 4. Sinauer Associates, Sunderland, Massachusetts.
Walker, F. (1863) *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum*. British Museum, London, vol. 26, pp. 1479–1796.
Warren W (1893) On new genera and species of moths of the family Geometridae fromIndia, in the collection of H. J. Elwes. *Proceedings of the Zoological Society of London*, 1893, 341–434.
Warren, W. (1894) New genera and species of Geometridae. *Novitates Zoologicae*, 1, 366–466.
Warren, W. (1895) New species and genera of Geometridae in the Tring Museum. *Novitates Zoologicae*, 2, 82–159.
Warren, W. (1896) New Geometridae in the Tring Museum. *Novitates Zoologicae*, 3, 99–148.

Warren, W. (1899) New species and genera of the families Drepanulidae, Thyrididae, Uraniidae, Epiplemidae, and Geometridae from the Old-World Regions. *Novitates Zoologicae*, 6, 1–66.
Wehrli, E. (1924) Neue und wenig bekannte palaarktische und Sudchinesische Geometriden-Arten und Formen. (Sammlung Hone.) ii. Teil. *Mitteilungen Münchner Entomologische Gesellschaft*, 14 (6–12), 130–142.
Xue, D.-Y. (1992) A study on the tribe Trichopterygini Warren of China (Lepidoptera: Geometridae, Larentiinae). *Sinozoologia*, 9, 267–296.
Xue, D.-Y. & Zhu, H-F. (1999) *Fuana Sinica* (Insecta Vol.15, Lepidoptera, Geometridae, Larentiinae). Science Press, Beijing, xxxii+1090 pp, 1197 figures, 25 plates.
Xue, D.-Y. (2000) A study on genus *Syzeuxis* Hampson, with the descriptions of four new species from China (Lepidoptera, Geometridae). *Acta Zootaxonomica Sinica*, 25 (1), 81–89.
Yazaki, K. (1994) Geometridae. *In* Haruta, T. (Ed.), Moths of Nepal, Part 3. *Tinea*, 14 (Supplement), 5–40.
Zhang, R.-Z. (1999) *Zoogeography of China*. Science Press, Beijing, xiv+502 pp.

Appendix 1. Morphological characterization

Head
1. Vertex colour (0: yellowish brown to brown; 1: with green)
2. Frons colour (0: yellowish brown to brown; 1: with green)
3. Labial palpus (0: extending less than 1/2 beyond frons; 1: extending more than 1/2 beyond frons)

Wing pattern
4. Forewing length in male (0: less than 15 mm; 1: more than 15 mm)
5. Forewing colour (0: not green; 1: green)
6. Shape of forewing apex (0: rounded; 1: acute or falcate)
7. Base of forewing costa with a small black patch (0: No; 1: Yes)
8. Forewing antemedial and postmedial lines (0: Thin; 1: Broad)
9.Forewing postmedial lines on costa forming large triangular patches (0: No; 1: Yes)
10. The lower half of the patches on forewing costa forming by antemedial lines has reached or past the discal cell costa (0: No; 1: Yes)
11. Forewing outer margin (0: under apex slightly concave, then straight or slightly curve; 1: slightly protruding at middle)
12. Forewing with distinct marginal line (0: No; 1:Yes)
13. Forewing with submarginal black dots between M_1 and M_2 (0: No; 1: Yes)
14. With a coherent colour and similar marking style of on both wings (0: No; 1: Yes)
15. Male hindwing with a small basal lobe (0: Yes; 1: No;)
16. Hindwing postmedial line (0: Absent; 1: Single line; 2: Double lines, X-shaped)
17. Male hindwing Rs stalked with M_1 (0: No; 1: Yes)
18. Hindwing with distinct terminal line (0: No; 1: Yes)
19. Male hindwing discocellulars (0: Biangulate; 1: Not biangulate)

Male genitalia
20. Valva costa with a row of dense setae (0: No; 1: Yes)
21. Valva costa with distinct protrusion (0: Yes; 1: No)
22. Terminal half of valva bent upwards (0: No; 1: Yes)
23. Ratio of valva length (VL) to the distance from the apex of uncus to vinculum (UV) (0: <0.5; 1: ≥ 0.5) (Fig. 45)
24. Ratio of aedeagus length to aedeagus width (0: >6; 1: ≤ 6)
25. Juxta with a pair of central protruding (0: Yes; 1: No)
26. Ratio of uncus basal width to terminal width (0: $>1/2$; 1: $\leq 1/2$)
27. Ratio of uncus terminal width (CW) to uncus length (UL) (0: $> 1/3$; 1: $\leq 1/3$) (Fig. 45)
28. Terminal half of valva folded over costa (0: No; 1: Yes)

Appendix 2. Morphological characters matrix of the genus *Syzeuxis* based on 12 species and 1 outgroup.

Characters	*Chrioloba cinerea* (OGU)	*S. trinotaria*	*S. tessellifimbria*	*S. seminanis*	*S. extritonaria*	*S. neotritonaria*	*S. magnidica*	*S. subfasciaria*	*S. heteromeces*	*S. furcalineas*	*S. nigrinotata*	*S. pavonata*	*S. calamisteria*
1	0	1	1	0	1	1	0	0	0	0	0	0	1
2	0	1	1	0	1	1	0	0	0	0	0	1	1
3	0	0	0	1	1	1	1	1	0	0	0	0	0
4	0	0	1	0	0	1	0	0	0	0	0	0	1
5	0	1	1	0	1	1	0	0	0	0	0	0	1
6	0	0	0	0	1	1	0	0	0	0	0	0	0
7	0	1	1	0	0	0	1	1	1	1	1	1	1
8	0	0	0	1	0	0	1	1	1	1	1	1	1
9	0	0	0	1	0	0	1	1	1	1	1	1	1
10	0	1	1	1	0	0	1	1	1	1	1	1	1
11	0	1	0	1	0	0	1	1	1	1	1	1	1
12	0	1	0	1	0	0	1	1	1	1	1	1	1
13	0	0	1	0	1	1	0	0	0	0	0	0	0
14	0	1	0	1	0	0	1	1	1	1	1	1	0
15	0	1	0	1	0	0	1	1	1	1	1	1	0
16	0	1	1	1	1	1	2	2	2	2	2	2	1
17	0	1	0	1	0	0	1	1	1	1	1	1	0
18	0	1	0	1	1	0	1	1	1	1	1	1	1
19	0	1	0	1	1	1	1	1	1	1	1	1	0
20	0	0	0	0	1	1	0	0	0	0	0	0	0
21	0	1	0	1	1	1	1	1	1	1	1	1	1
22	0	1	0	1	0	0	1	1	1	1	1	1	0
23	0	0	0	1	1	1	1	1	1	0	0	0	0
24	0	1	1	0	1	1	1	1	1	0	1	1	1
25	0	1	1	1	1	1	1	0	1	1	1	1	1
26	0	0	0	1	0	0	0	0	1	0	0	0	0
27	0	1	0	1	0	0	0	1	1	1	0	0	1
28	0	0	0	0	1	1	0	0	0	0	0	0	0