

Notes on some little known species of *Satyrrium* SCUDDER, 1876 from China

(Lepidoptera, Lycaenidae)

by

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Abstract: *Satyrrium dejeani* (RILEY, 1939), *S. minshanicum* MURAYAMA, 1992, *S. bozanoi* (SUGIYAMA, 2004) and *S. tshikolovetsi* BOZANO, 2015 (Theclinae: Eumaeini) are discussed, with the ♀ genitalia of *Satyrrium dejeani* (RILEY) and *S. tshikolovetsi* BOZANO described for the first time. *Satyrrium dejeani* (RILEY) and *S. tshikolovetsi* BOZANO are proved to be closely related in phylogeny, sharing most of the ♂ and ♀ genital characters. The ♂ of *S. bozanoi* (SUGIYAMA) is described and illustrated for the first time. A close examination shows that the ♂ of *S. minshanicum* MURAYAMA bears a very narrow androconial patch on forewing upperside which has been overlooked before.

Introduction: The genus *Satyrrium* SCUDDER, 1876 (type species: *Lycaena fuliginosa* EDWARDS, 1861) was recently reviewed by WEIDENHOFFER et al. (2004), with 18 species recognized from N America and 51 from Eurasia. However, this generic classification was not followed by most of the recent authors (BOZANO & ZHU, 2012; HSU, 2013; KIUCHI et al., 2014; UNO, 2014). The main arguments may exist in: 1) whether the Eurasian species should be placed into the genus *Satyrrium* SCUDDER alongside the N. American *Satyrrium fuliginosa* (EDWARDS, 1861) (type species of *Satyrrium* SCUDDER); 2) whether the species of this group should be divided into different genera by the presence or absence of a sclerotized keel on the ventral surface of the aedeagus. Some authors (SUGIYAMA, 2004; KIUCHI et al., 2014; UNO, 2014) preferred to use the genus *Fixsenia* TUTT, [1907] (type species: *Thecla herzi* FIXSEN, 1887 = *Thecla phyllo dendri* ELWES, 1882) to contain the E. Asian species of *Satyrrium* SCUDDER (sensu WEIDENHOFFER et al., 2004), no matter if these species have the sclerotized keel of aedeagus or not. The others (BOZANO & ZHU, 2012; HSU, 2013) tentatively respected the importance of the sclerotized keel on aedeagus and placed all the species with such keel into *Satyrrium* SCUDDER and all the species without such keel into *Fixsenia* TUTT, following CLENCH (1979). In this work the author follows WEIDENHOFFER et al.'s (2004) classification, and the reason is quoted as follows (WEIDENHOFFER et al., 2004): „presence or absence of male androconia, hindwing tails and similar wing coloration and pattern do not support any monophyly“; „genitalia morphology, often used to separate species, provides characters which in most of the cases are not qualitative but quantitative, and consequently these are difficult to apply even in species level taxonomy“; „the sclerotized keel in the male aedeagus“ „does not support a generic division, since its presence or absence seems to be erratic in both *Satyrrium* and *Neolycaena* species and does not seem to reflect any kind of monophyletic grouping“. Since the morphological characters seem not to support a convincing generic classification for this group, probably only a study on the molecular phylogeny can solve this taxonomic problem.

The following taxonomic changes in the subgenus *Satyrrium* SCUDDER (sensu WEIDENHOFFER et al., 2004) should be noted. *Satyrrium wabi* (SUGIYAMA, 2004) was proved to be a synonym of *S. ornata* (LEECH, 1890) (BOZANO & ZHU, 2012). *Satyrrium ulmi* (HIDA & IGARASHI, 2001) that had been considered as a synonym of *S. inouei* (SHIRÔZU, 1959) (WEIDENHOFFER et al., 2004) was proved to be separable from *S. inouei* (SHIRÔZU) in ♂ genitalic morphology (KIUCHI et al., 2014). The true taxonomic position of *S. ulmi* (HIDA & IGARASHI) remains uncertain, as *S. inouei xinglongshanum* MURAYAMA, 1995 has not been carefully studied. WEIDENHOFFER et al. (2004) stated that external characters of both, the imago and the early stages of *S. ulmi* (HIDA & IGARASHI), perfectly agree with those of *S. inouei* (SHIRÔZU), however it can be sure that the information of early stages of *Satyrrium inouei* (SHIRÔZU) quoted by WEIDENHOFFER et al. (2004) actually came from a specimen from Shaanxi (KOIWAYA, 1996: 139). The early stages of the true *S. inouei* (SHIRÔZU) from Taiwan have not been reported yet.

A large number of specimens of 20 *Satyrrium* species from China were examined by the author, and the following four species are particularly discussed in this paper due to their extreme rarity in collections and their incomplete knowledge in literature: *Satyrrium dejeani* (RILEY), *S. minshanicum* MURAYAMA, *S. bozanoi* (SUGIYAMA) and *S. tshikolovetsi* BOZANO. These four species share the rather rounded forewing-shape, the unmarked upperside of both wings and the interrupted postdiscal markings on hindwing underside (shifted at vein 4) in both sexes. A comparison in genitalic morphology supports a close relationship between *S. dejeani* (RILEY) and *S. tshikolovetsi* BOZANO as discussed below.

Taxonomic accounts

Satyrrium tshikolovetsi BOZANO, 2015 (Figs. 1-8, 21-25, 30-31, 35, 39)

Nachr. Ent. Ver. Apollo N. F. 35 (3): Type locality: SW of Dujiangyan, Sichuan.

Material: China: Gansu: 8 ♂♂, Long-nan City, Kang-xian County, on road from Qinghe-yakou to Qinghe-linchang, ca 1400 m, 18.-21.VI.2015, HAO HUANG leg.; 1 ♂, 3 ♀♀, Kang-xian County, on road from Qinghe-yakou to Qinghe-linchang, ca 1300-1500 m, 30.VI.-2.VII.2015, ZI-HAO LIU leg..

Individual variations of ♂: Length of forewing: 13,2-14,5mm. Androconial patch (figs. 22-25) variable in width, generally clearly defined and markedly paler than ground color but sometimes ill-defined and invisible to the naked eyes. Forewing termen varied in arching degree. Submarginal lunules on hindwing underside sometimes associated with orange patches in spaces 1 and 3, sometimes followed distally by an obscure black spot in space 1.

♂ **genitalia** (figs. 30, 35) generally as in other species of *Satyrium* SCUDDER; tegumen in dorsal view with midline shorter than in *S. dejeani* (RILEY); valvae simple and narrow, distally divergent; falces very long; juxta absent; aedoeagus with ventral keel at tip and two terminal cornuti; lower cornutus (fig. 35) dentate at tip; upper cornutus smooth at tip and slightly wider than lower cornutus.

♀ **genitalia** (fig. 39): Apophysis anterioris absent. Apophysis posterioris nearly as long as 8th tergum. 8th sternum not at all sclerotized and ostium opened just posterior to the 7th sternum and surrounded by a membranous area, no lamella antevaginalis and lamella postvaginalis. Ostium bursae strongly sclerotized and pigmented as a conical antrum, of which the midline along dorsal surface partly non-pigmented. Entrance of ostium bursae very large. Ductus bursae narrow and short, non-pigmented as in *S. dejeani* (RILEY), different from that of *S. bozanoi* (SUGIYAMA). Entrance of corpus bursae abruptly enlarged and even in width for a short distance like a bottleneck, weakly pigmented on dorsal surface, with ductus seminalis attached at the beginning. Signum rather long, with an inner projection at posterior end.

Remarks: *S. tshikolovetsi* BOZANO shares the rather rounded forewing-shape, the unmarked both wings upperside and the interrupted postdiscal markings on hindwing underside (shifted at vein 4) in both sexes with a small group of very little known *Satyrium* species, including *S. dejeani* (RILEY), *S. minshanicum* MURAYAMA and *S. bozanoi* (SUGIYAMA). Thus a comparison between all these species in genitalic morphology is made. The following ♂ and ♀ genital characters have been observed to be potential good characters in distinguishing species of *Satyrium* SCUDDER: 1) size of ♂ genitalia; 2) length of midline of tegumen in dorsal view; 3) shape of valvae in ventral view; 4) length of aedoeagus; 5) presence or absence of ventral keel of aedoeagus; 6) shape of ventral keel of aedoeagus if present; 7) width and shape of upper and lower cornuti; 8) shape and length of antrum in lateral or ventral view; 9) ductus bursae pigmented or colorless; 10) size and shape of signum on corpus bursae. After a comparison in ♂ and ♀ genitalic morphology, *S. tshikolovetsi* BOZANO is proved to be very close to *S. dejeani* (RILEY); both species are markedly different from *S. minshanicum* MURAYAMA and *S. bozanoi* (SUGIYAMA) by having size of ♂ genitalia smaller, valvae shorter, aedoeagus shorter with ventral keel markedly down-curved in lateral view, upper and lower cornuti subequal in width, and lower cornutus serrate at tip. A comprehensive comparison including the information from references does not find any other affinities of *S. tshikolovetsi* BOZANO except *S. dejeani* (RILEY).

Genital differences between *S. tshikolovetsi* BOZANO and *S. dejeani* (RILEY) are only found in length of midline of tegumen in ♂ genitalia and length of antrum in ♀ genitalia; these two allopatric species share too many morphological characters to be split away in any possible analysis on morphology phylogeny. There is no doubt that *S. tshikolovetsi* BOZANO and *S. dejeani* (RILEY) are sister species in phylogeny.

Satyrium dejeani (RILEY, 1939) (figs. 9-12, 26, 32, 36, 40, 43)

Strymon dejeani RILEY, 1939, Novit. Zool. **41**: 360; type locality: Siao-Lou (near Lianglu, Tianquan, Sichuan).

Material: China: Sichuan: 1 ♂, 1 ♀, Ya-an City, Tianquan County, Lianglu, 1500-2100 m, 18.-23.VII.2011, HAO HUANG leg.

Identification: There is great confusion in identification between *S. dejeani* (RILEY) and *S. minshanicum* MURAYAMA. SUGIYAMA (2004: 6) suspected that these two species are probably conspecific, and he illustrated the ♀ genitalia of *S. minshanicum* MURAYAMA as those of *S. dejeani* (RILEY). BOZANO (2015: fig. 7) figured a ♂ of *S. minshanicum* MURAYAMA from Wenchuan as that of *S. dejeani* (RILEY). The type specimens of *S. dejeani* (RILEY), including 4 ♂♂ and 1 ♀, came from “Siao-lou”, a famous locality around the current Lianglu village of Tianquan County, Sichuan. WEIDENHOFFER et al. (2004) figured the ♂ holotype and its genitalia and the unique ♀ paratype, but without the figure of ♀ genitalia. It seems that only an examination of topotypic specimens can give the correct knowledge about this confusing species. The author successfully collected a pair of specimens from the type locality in the summer of 2011. A close examination of these topotypic specimens in both external features and genital structures compared with the information of type material published by WEIDENHOFFER et al. (2004) draws the following conclusions: 1) androconial patch is a useful character to distinguish the two species, it is wider and visible to the naked eyes in *S. dejeani* (RILEY) but is very thin and almost invisible to the naked eyes in *S. minshanicum* MURAYAMA; 2) for both sexes, the postdiscal line in space 7 on hindwing underside is always in a line with the marking of space 6 in *S. dejeani* (RILEY) but is more or less shifted-in from the marking of space 6 in *S. minshanicum* MURAYAMA; 3) upper cornutus of aedoeagus is slightly wider than lower cornutus in *S. dejeani* (RILEY) but is markedly narrower than lower cornutus in *S. minshanicum* MURAYAMA; 4) antrum of ♀ genitalia in *S. dejeani* (RILEY) is markedly narrower than in *S. minshanicum* MURAYAMA.

Remarks: It becomes clear that all the correctly identified specimens of *S. dejeani* (RILEY) are collected from the type locality whilst *S. minshanicum* MURAYAMA is widely distributed from Wenchuan area in the south to Huixian area, Gansu in the north. *Satyrium dejeani* (RILEY) is allopatric with either *S. minshanicum* MURAYAMA or *S. tshikolovetsi* BOZANO, whilst *S. minshanicum* MURAYAMA and *S. tshikolovetsi* BOZANO are sympatric. Though *S. dejeani* (RILEY)

is more externally similar to *S. minshanicum* MURAYAMA than to *S. tshikolovetsi* BOZANO in the yellowish underside ground color of both wings, an account of similarities in morphological characters between these three species shows that *S. dejeani* (RILEY) and *S. tshikolovetsi* BOZANO are markedly closer to each other than to *S. minshanicum* MURAYAMA by sharing the following characters: 1) ♂ brand larger and visible to the naked eyes; 2) postdiscal line in space 7 of hindwing underside in a line with the marking in space 6; 3) valvae of ♂ genitalia with distal half rather stout; 4) lower cornutus of aedoeagus not wider than upper cornutus; 5) antrum of ♀ genitalia rather narrow.

***Satyrium minshanicum* MURAYAMA, 1992 (figs. 17-20, 28, 29, 34, 38, 42, 43)**

Konch to Shizen (Nature & Insects) **27** (5): 40, fig. 8; type locality: Mt. Minshan (probably Jiuzhaigou); MURAYAMA, 1994: 308, description in English.

Strymonidia volt SUGIYAMA, 1993: 7, figs. 11-12 for ♂ holotype, fig. 19 for hand drawing of ♂ genitalia, type locality: N Mt. Sigunyang (Lixian, Sichuan). (Synonymised by WEIDENHOFFER et al., 2004: 30).

Satyrium dejeani: SUGIYAMA, 2004: 5, fig. 36 for ♀ genitalia; WEIDENHOFFER et al., 2004: 31, partim on figure of ♀ genitalia; BOZANO, 2015: 142, fig. 7 for ♂ from 25km south of Wenchuan, Sichuan. (Misidentification.)

Material: China: Gansu: 6 ♂♂, 5 ♀♀, Long-nan City, Huixian, 1300-1500 m, 10.-19.VI.2015, HAO HUANG leg..

Remarks: Specimens from Huixian, southern Gansu (part of Minshan Mts. range) examined by the author are identical in all details of wing-characters with the specimens from Jiuzhaigou (probably the type locality) illustrated by WEIDENHOFFER et al. (2004).

As discussed above, this species shows significant differences in cornuti of ♂ genitalia and antrum of ♀ genitalia from *S. dejeani* (RILEY).

***Satyrium bozanoi* (SUGIYAMA, 2004) (figs. 13-16, 27, 33, 37, 41, 43)**

Fixsenia bozanoi SUGIYAMA, 2004, Pallarge **8**: 4; type locality: Wuling Mts., Hunan.

Material: China: Zhejiang: 1 ♂, Lin-an City, Qingliang-feng, 1300m, 13.VI.2014, JIAN-QING ZHU leg.; 1 ♀, Qingliang-feng, 800-900 m, 13.VI.2014, WEN-XUAN Bi leg.; 1 ♀, Lin-an City, W Tianmushan, 1400 m, 24.VI.2008, HAO HUANG leg.

Identification: This species was described on 1 ♀ from central China. Unexpectedly the author collected a worn-out ♀ from Tianmushan, eastern China in the summer of 2008. Several ♂♂ and ♀♀ were subsequently collected by the friends of the author from Tianmushan area. The ♀♀ from eastern China examined by the author are in common with the holotype in all wing-characters and ♀ genitalia illustrated by SUGIYAMA (2004).

♂ characters: The ♂ has a clearly defined androconial patch on forewing upperside; otherwise as in ♀. The following ♂ genital characters (figs. 33, 37) are noticed: aedoeagus rather long, without a ventral keel at distal end, and with upper cornutus more than three times wider than lower cornutus in dorsal view; valvae sharply pointed at tip in ventral view. **♀ genitalia** (fig. 41): Ductus bursae strongly pigmented and not separable from antrum; the conjoined ductus bursae and antrum rather long; entrance of corpus bursae strongly pigmented; signa on corpus bursae rather small.

Remarks: *Satyrium bozanoi* (SUGIYAMA) is not closely related to *S. dejeani* (RILEY), *S. tshikolovetsi* BOZANO and *S. minshanicum* MURAYAMA as some of the wing-characters suggest. It has the following peculiar genital characters: aedoeagus very long, without ventral keel; upper cornutus markedly wider than lower cornutus; tip of valvae sharply pointed; ductus bursae of ♀ genitalia entirely pigmented; antrum very long; signum on corpus bursae very small.

The true systematic position of this species needs a further research on more species in both, ♂ and ♀ genitalia, which is beyond the scope of this paper.

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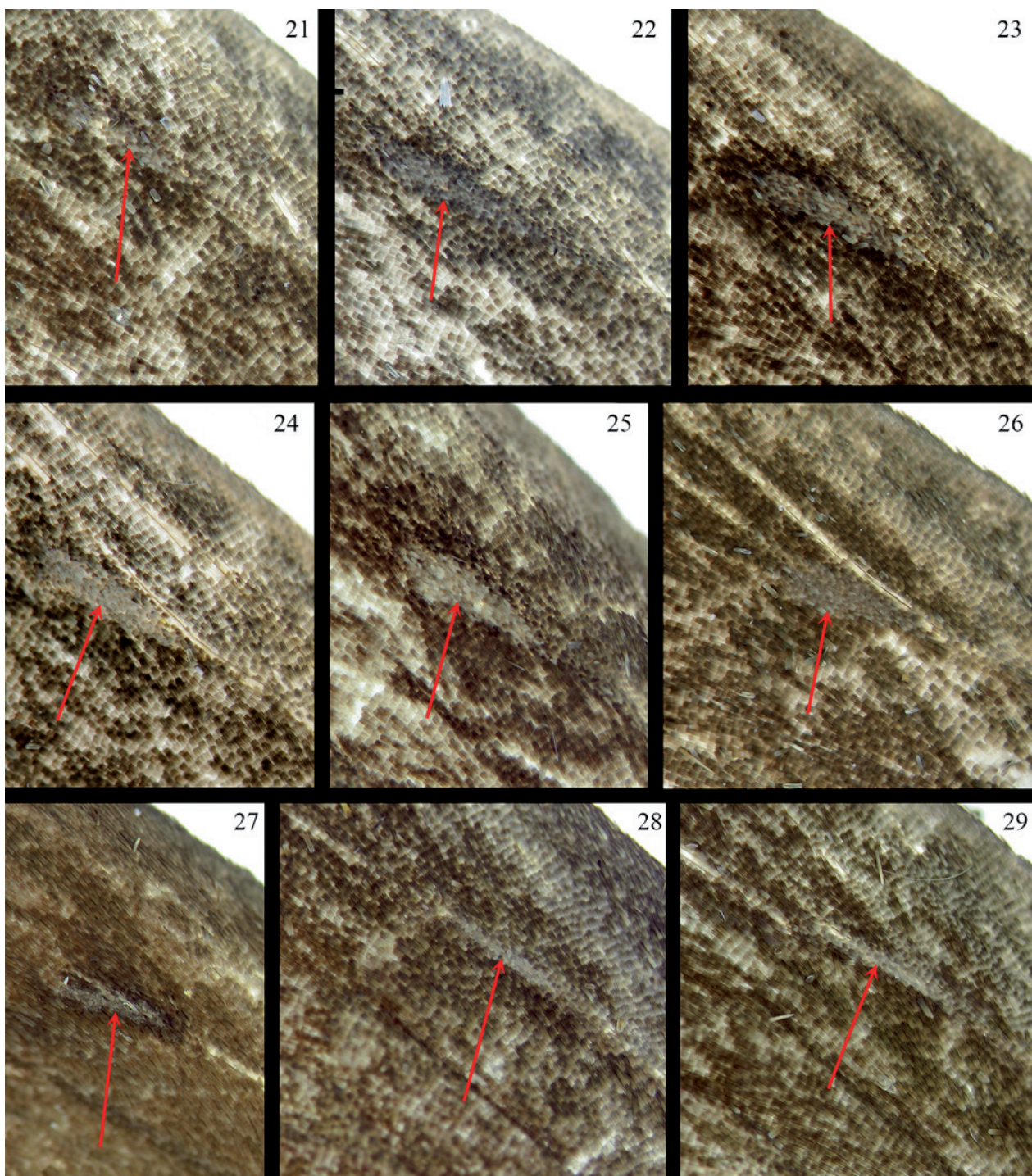
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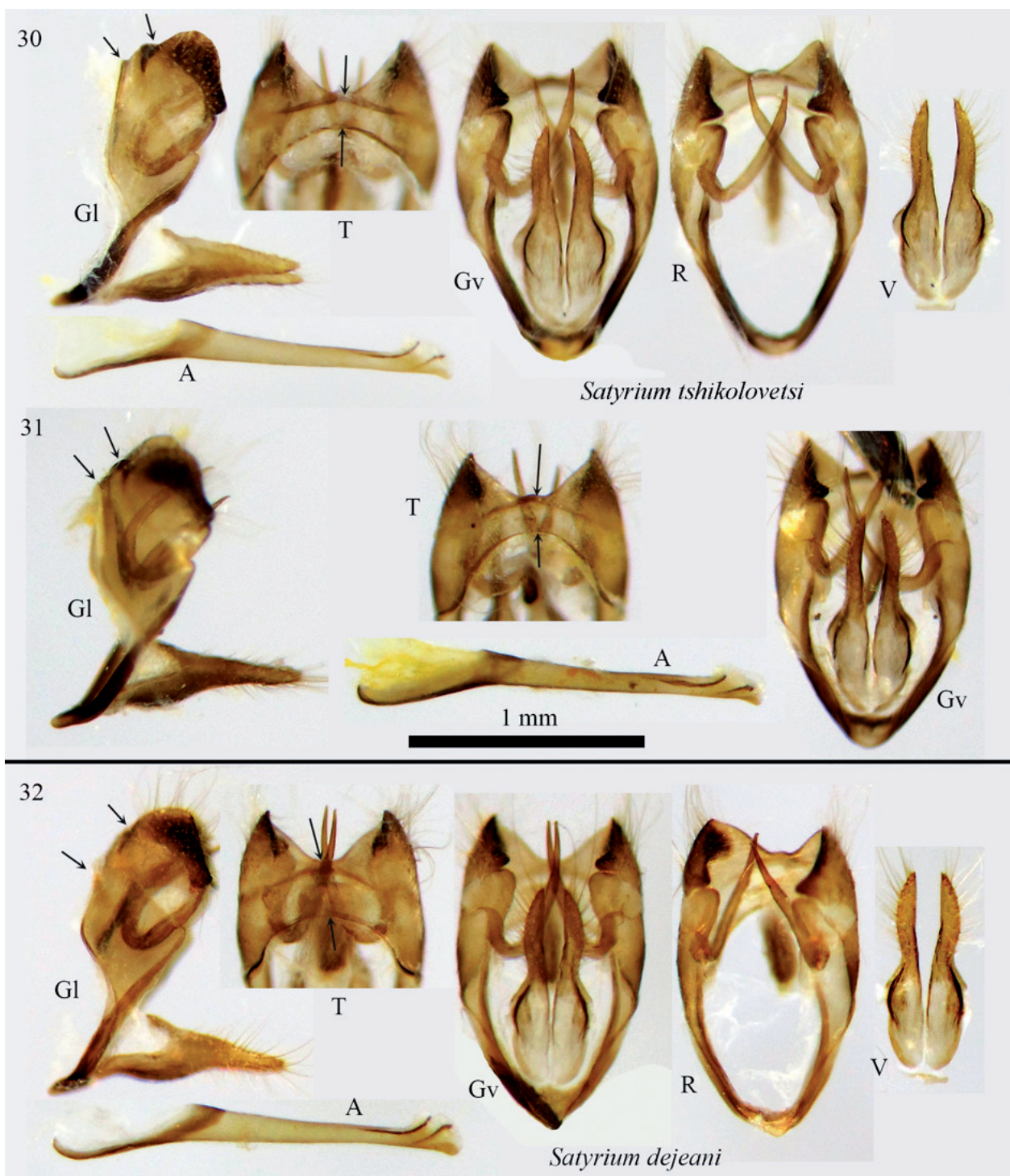
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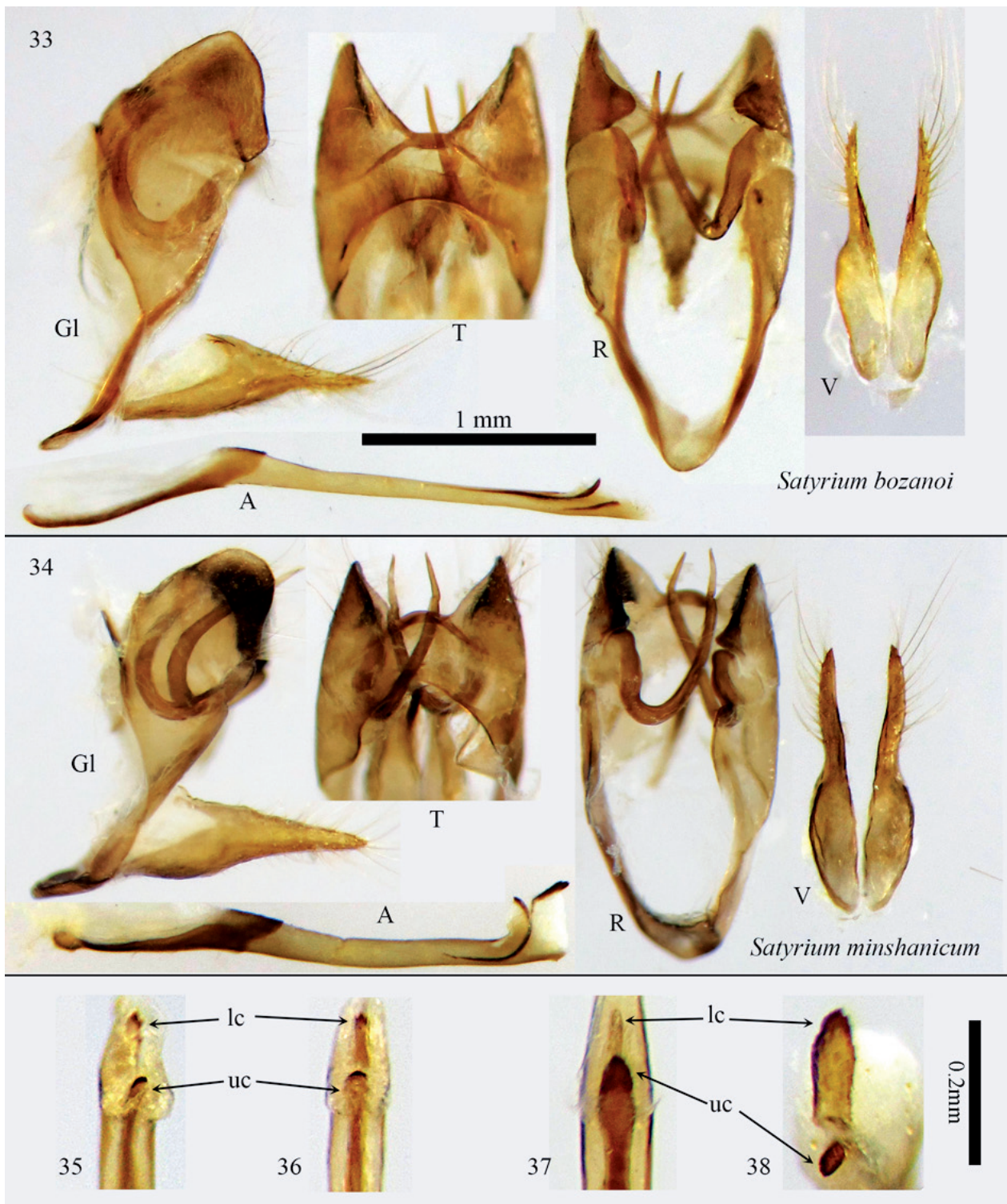
Figs. 1-20: Habitus of *Satyrium* species at same scale (scale bar 1 cm). (1-8) *Satyrium tshikolovetsi* BOZANO; (9-12) *Satyrium dejeani* (RILEY); (13-16) *Satyrium bozanovi* (SUGIYAMA); (17-20) *Satyrium minshanicum* MURAYAMA.



Figs. 21-29: End of discocellular cell on forewing upperside to show androconial patch of ♂. (21-25) *Satyrium tshikolovetsi* BOZANO; (26) *Satyrium dejeani* (RILEY); (27) *Satyrium bozanoi* (SUGIYAMA); (28-29) *Satyrium minshanicum* MURAYAMA.

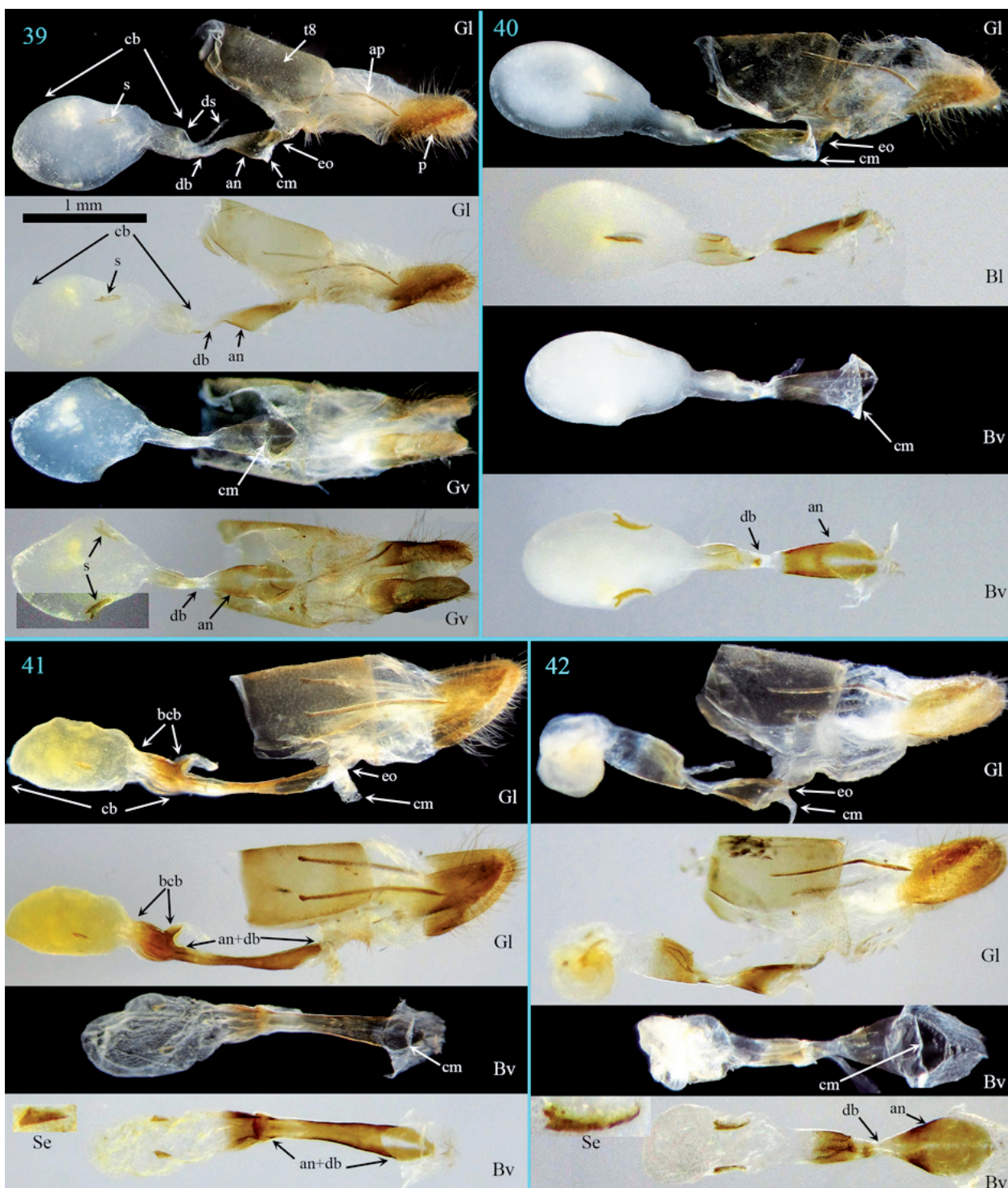


Figs. 30-32: ♂ genitalia at same scale. (30-31) *Satyrium tshikolovetsi* BOZANO; (32) *Satyrium dejeani* (RILEY). Gl = genitalia in lateral view; T = Tegumen in dorsal view; A = Aedoeagus in lateral view; Gv = genitalia in ventral view; R = ring in ventral view; V = valvae in ventral view; arrows directing to the borders of tegumen.



Figs. 33-34: ♂ genitalia at same scale. (33) *Satyrium bozanoi* (SUGIYAMA); (34) *Satyrium minshanicum* MURAYAMA. Gl = genitalia in lateral view; T = Tegumen in dorsal view; A = Aedoeagus in lateral view; R = ring in ventral view; V = valvae in ventral view.

Figs. 35-38: End of aedoeagus in dorsal view to show cornuti at same scale. (35) *Satyrium tshikolovetsi* BOZANO; (36) *Satyrium dejeani* (RILEY); (37) *Satyrium bozanoi* (SUGIYAMA); (38) *Satyrium minshanicum* MURAYAMA. lc = lower cornutus; uc = upper cornutus.



Figs. 39-42: ♀ genitalia at same scale. (39) *Satyrium tshikolovetsi* BOZANO; (40) *Satyrium dejeani* (RILEY); (41) *Satyrium bozanoi* (SUGIYAMA); (42) *Satyrium minshanicum* MURAYAMA. Gl = genitalia in lateral view; Gv = genitalia in ventral view; BL = bursa copulatrix in lateral view; Bv = bursa copulatrix in ventral view; Se = signum enlarged; p = papillae anales; ap = apophysis posterioris; t8 = 8th tergum; eo = entrance of ostium; cm = cut line of membrane; an = antrum; db = ductus bursae; ds = ductus seminalis; cb = corpus bursae; bcb = beginning of corpus bursae; s = signum; an + db = conjoined antrum and ductus bursae.

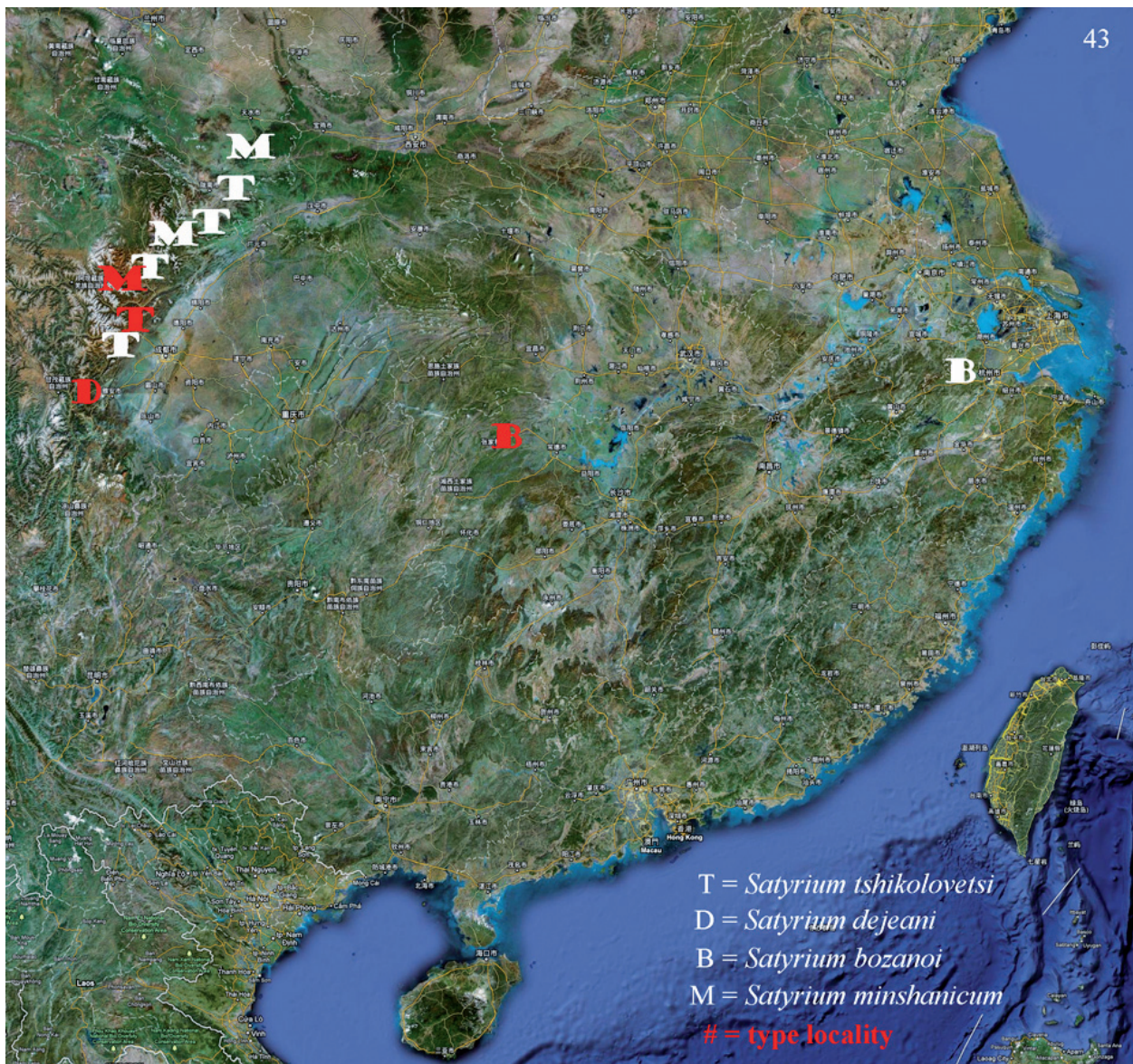


Fig. 43: Distribution of *Satyrium tshikolovetsi* BOZANO, *Satyrium dejeani* (RILEY), *Satyrium bozanoi* (SUGIYAMA) and *Satyrium minshanicum* MURAYAMA.

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