

**Study on *Lethe procne* (LEECH, 1891) and *Lethe paraprocne* LANG & LIU, 2014
with the description of two new subspecies from SW China**

(Lepidoptera, Nymphalidae, Satyrinae)

by

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Abstract: In this paper, *Lethe procne* (LEECH, 1891) and its closely related species *L. paraprocne* LANG & LIU, 2014 are studied, especially based upon the morphology of androconia. The *L. procne*-complex is erected to include *L. procne* (LEECH) and its relatives. Two new subspecies, *L. procne shunana* **subspec. nov.** from SW Sichuan and N. Yunnan and *L. procne abaensis* **subspec. nov.** from N. Sichuan and S. Gansu are described and illustrated.

Lethe (Zophoessa) procne (LEECH, 1891) is a common satyrid butterfly known from mountainous areas of SW China (LANG & LIU, 2014), and recently, *L. paraprocne* LANG & LIU, 2014, a cryptic species very like *L. procne* (LEECH) was described from Sichuan, together with its subspecies *L. paraprocne kawagarboensis* LANG & LIU, 2014 from NW Yunnan. Here, the present author suggests erecting the *L. procne*-complex to include *L. procne* (LEECH) and its close relatives. Androconia are used currently as a morphological indicator of taxonomic status, and they appear to be relatively consistent in overall size and shape within species (WAKEHAM-DAWSON & KUDRNA, 2000). When *L. paraprocne* LANG & LIU and *L. p. kawagarboensis* LANG & LIU were described, the structure of androconia was not mentioned. The present author collected additional material of the *L. procne*-complex and studied their androconia structure. Though morphology of ♂ genitalia does not provide any diagnosis character for identification in this species complex (LANG & LIU, 2014), the stable features of wing patterns and androconia can effectively be used to clarify the taxonomy of the *L. procne*-complex. As a result, in this paper, two new subspecies of *L. procne* (LEECH) from SW China are described.

Materials: The specimens examined in this research are deposited in Chongqing Museum of Natural History, Chongqing, China (CMNH), Naturhistoriska Riksmuseet, Stockholm, Sweden (NHRS), SONG-YUN LANG's private collection, Chengdu, Sichuan, China (LSY) and ZI-HAO LIU's private collection, Fengtai, Huainan, Anhui, China (LZH).

Androconia were prepared and measured using the methods described in WAKEHAM-DAWSON & KUDRNA (2000) & WAKEHAM-DAWSON et al. (2007). Terminology of androconia follows WAKEHAM-DAWSON & KUDRNA (2000) and KOIWAYA & SHIZUYA (2011).

Androconia (fig. 15) of the *L. procne*-complex consist of three parts, from top down: the apical spines (KOIWAYA & SHIZUYA, 2011), the lamina and the basal stalk (WAKEHAM-DAWSON & KUDRNA, 2000). The androconia from the specimens of the complex were measured, and lengths (AL = Androconium Length), breadths (AB = Androconium Breadth) and shape ratios (RLB = Ratio of AL/AB) are shown in Table 1.

Taxonomy of *Lethe procne*-complex

***Lethe procne procne* (LEECH, 1891) (figs. 1, 2, 14 a, 16 a)**

Zophoessa procne LEECH, 1891, Entomologist 24 (Suppl.): 2; TL: Wa-shan.

Material: 60 ♂♂, China: Sichuan, Omei, from Xixinsuo to Leidongping, 1460-2430 m, 5.-10.VIII.2013, leg. YI LANG & S-Y. LANG, LSY; 11 ♂♂, China: Sichuan, Ebian, Heizhugou, 1800-2000 m, 17.-18.VIII.2013, leg. YI LANG & S-Y. LANG, LSY; 2 ♂♂, China: Sichuan, Tianquan, Labahe, 5.VIII.2009, leg. S-Y. LANG, LSY; 1 ♂, China: Sichuan, Tianquan, Mt. Erlang, 2.IX.2010, leg. JIAN-QING ZHU, LSY.

Distribution: China (CS).

***Lethe procne abaensis* **subspec. nov.** (figs. 3, 4, 13, 16 b, 18)**

Zophoessa procne: NORDSTRÖM, 1934, Arkiv för Zoologi 27 A 7: 20.

Holotype ♂, China: Sichuan, Maoxian, Songping-gou, 2400-2900 m, 18.VIII.2015, leg. S-Y. LANG, LSY. Paratypes: 5 ♂♂, same data as holotype, LSY; 1 ♂, NHRS-TOBI 000001022/177/Kina S. Kansu/SVEN HEDINS Exp. Ctr. Asien Dr HUMMEL/ 5/8 Vabago/*Zophoessa procne* LEECH/, NHRS.

Description: ♂ forewing length: 24-27 mm. Upperside: ground color and markings the same as in nominotypical subspecies; forewing subapical spots whitish yellow. Underside: ground color and markings similar to nominotypical subspecies; forewing postdiscal spots whitish yellow; hindwing yellowish discal band broad. Androconia (fig. 16b): long and narrow with RLB = 5.35. The ♂ genitalia (fig. 18): similar to those of nominotypical subspecies. The ♀ is unknown.

Diagnosis: The new subspecies can be distinguished from nominotypical subspecies by the combination of the fol-

lowing characters: a) on upper surface of forewing, subapical spots are whitish yellow, whereas they are yellow in the nominate subspecies; b) on under surface of hindwing, yellowish discal spots in spaces 6 and 7 are much broader than in the nominate subspecies; c) androconia with RLB = 5,35 are longer and narrower than in the nominate subspecies with RLB = 4,78 (table 1).

Etymology: The taxon *abaensis* is named after Aba, an Autonomous Prefecture at N. Sichuan for Tibetan and Qiang people.

Notes: This subspecies had been reported as *Zophoessa procne* LEECH by NORDSTRÖM (1934), based upon 1 ♂ collected by Dr. HUMMEL from S. Gansu (Vabago = Wabagou, Zhagana, Tewa County). The photographs of the specimen (fig. 13) studied by NORDSTRÖM, which is kept in NHRS, were provided by MALM, and it is designated here as a paratype of *Lethe procne abaensis* subsp. nov.

Distribution: China (NS, S. Gansu).

Lethe procne shunana subsp. nov. (figs. 5-8, 16 c-d, 19)

Holotype ♂, China: Sichuan, Yanbian, Gesala, 3000 m, 7.VIII.2014, leg. S-Y. LANG, LSY. Paratypes: 10 ♂♂, China: Sichuan, Yanbian, Gesala, 2700-3000 m, 6.-9.VIII.2014, leg. YI LANG & S-Y. LANG, LSY; 10 ♂♂, 2 ♀♀, China: Sichuan, Puge, Mt. Luojishan, 3000-3600 m, 13.-14.VIII.2014, leg. YI LANG & S-Y. LANG, LSY; 12 ♂♂, 1 ♀, China: Sichuan, Muli, 30.VII.-9.IX.1992, leg. WEN-PING LIU, CMNH; 1 ♂, China: Yunnan, Dongchuan, 2360 m, 14.VII.2012, LZH.

Description: ♂ forewing length: 23-29 mm. Upperside: ground color blackish brown; markings the same as in nominotypical subspecies. Underside: ground color blackish brown; markings the same as in nominotypical subspecies; forewing postdiscal spots and hindwing discal spots in spaces 6 and 7 pale yellow. Androconia (fig. 16 c-d): short and rather wide, with RLB = 3,69. The ♂ genitalia (fig. 19): similar to those of nominotypical subspecies.

The ♀ forewing length: 26-29 mm. Similar to ♂. Upperside: ground color paler than in ♂; forewing subapical spots whitish yellow; forewing blackish fascia alongside the inner margin of the yellowish postdiscal spots clear. Underside: ground color paler than that of ♂.

Diagnosis: The new subspecies can be distinguished from the nominotypical subspecies by the combination of the following characters: a) the ground color of both surfaces is blackish brown, whereas it is yellowish brown in the nominotypical subspecies; b) under surface, forewing discal bar and postdiscal spots and hindwing discal spots in spaces 6 and 7 are pale yellow, whereas they are yellow in the nominotypical subspecies; c) androconia with RLB = 3,69 is shorter than in the nominate subspecies with RLB = 4,78 (table 1).

Etymology: The subspecific name *shunana* is named after “Shu-nan” which means South Sichuan.

Distribution: China (SWS, N. Yunnan).

Lethe paraprocne paraprocne LANG & LIU, 2014 (Figs. 9, 10, 14 b, 16 e)

Lethe paraprocne LANG & LIU, 2014, *Atalanta* 45 (1-4): 167; TL: Heizhugou, Ebian, Sichuan.

Material: The holotype ♂ of *Lethe paraprocne* LANG & LIU, China: Sichuan, Ebian, Heizhugou, 1800-2000 m, 17.VIII.2013, leg. S-Y. LANG, LSY.

Diagnosis: *Lethe paraprocne* LANG & LIU can be distinguished from *L. procne* (LEECH) by the following characters: a) upper surface of forewing, the yellowish subapical spots in spaces 4 and 5 are vestigial, whereas they are well developed in *L. procne* (LEECH); b) upper surface of forewing, the brand (fig. 14 b) is weakly developed, does not enter the discal cell, and is distantly interrupted in the space 1 b, whereas it is dense, enters the discal cell from the bases of spaces 2 and 3, and is continuous or only weakly interrupted in the space 1 b in *L. procne* (LEECH) (fig. 14 a); c) upper side of forewing, the blackish fascia alongside the inner margin of the yellowish postdiscal spots is clearly visible, whereas it is vestigial or absent in *L. procne* (LEECH); d) the ground color of under side is blackish brown, whereas it is yellowish brown in *L. procne* (LEECH); e) under side of forewing, the yellowish postdiscal spots in spaces from 1b to 4 are small and well separated from each other, whereas they are large and nearly confluent in *L. procne* (LEECH); f) androconia with RLB = 2,65 are shorter and much broader than that in *L. procne* (LEECH) with RLB = 4,78 (table 1).

Distribution: China (CS).

Lethe paraprocne kawagarboensis LANG & LIU, 2014 (Figs. 11, 12, 14 c, 16 f)

Atalanta 45 (1-4): 167; TL: Deqin, Yunnan.

Material: Holotype ♂ of *Lethe paraprocne kawagarboensis* LANG & LIU, China: Yunnan, Deqin, Mingyong village, 2500 m, 10.VIII.2013, leg. ZI-HAO LIU, LSY; 3 ♂♂, paratypes, same data as holotype, LSY; 1 ♂, ditto (CMNH); 4 ♂♂, ditto, LZH.

Diagnosis: *Lethe paraprocne kawagarboensis* LANG & LIU can be distinguished from the nominate subspecies by the

following characters: a) upper surface of forewing, the yellowish subapical spots in spaces 4 and 5 are well developed as in *L. procne* (LEECH), whereas they are vestigial in *L. paraprocne* LANG & LIU; b) upper surface of forewing, the yellowish postdiscal series are well developed, whereas they are smaller in *L. paraprocne* LANG & LIU; c) upper surface of forewing, the brand (fig. 14 c) is denser than in *L. paraprocne* LANG & LIU; d) upper surface of hindwing, the black round postdiscal spots are usually larger than in *L. paraprocne* LANG & LIU; e) under surface of forewing, the yellowish postdiscal spots in spaces from 1b to 4 are somewhat larger than those of *L. paraprocne* LANG & LIU; f) androconia with RLB = 3,76 are obviously narrower than in *L. paraprocne* LANG & LIU with RLB = 2,65 (Table 1).

Lethe paraprocne kawagarboensis LANG & LIU and *L. procne shunana* **subspec. nov.** share the similar shape of androconia, but they can be distinguished from the latter by the following characters: a) upper surface of forewing, the brand is narrow and does not enter into the discal cell, whereas it is wide, and enters the discal cell from the bases of spaces 2 and 3 in *L. procne shunana* **subspec. nov.**; b) upper surface of forewing, the blackish fascia alongside the inner margin of the yellowish postdiscal spots is clearly visible, whereas it is vestigial or absent in *L. procne shunana* **subspec. nov.**; c) upper surface of hindwing, the black round postdiscal spots are usually larger than in *L. procne shunana* **subspec. nov.**

Distribution: China (NW Yunnan).

Discussion: 1. Western Sichuan Province, the eastern frontier of the Tibetan Plateau, consists of a series of south-north orientated great mountain ranges, the Hengduan Mts. In this region, the landforms are very complex with many high snow peaks, for instance Mt. Gongga (Minya Konka) with altitude 7,556 m and Mt. Siguniang (Four Girls) with altitude 6250 m, and various river valleys. The bamboo flora of this region, at different altitudinal gradient from about 300 m to 4000 m, is abundant. The larvae of *Lethe* HÜBNER species feed on bamboos, and more than 50 species have been reported from this region. This species richness indicates that the region is an important speciation centre for the genus *Lethe* HBN. and especially for the Sino-Himalayan species groups, for instance, the subgenus *Zophoessa* DOUBLEDAY of which nearly 20 species are known from this region.

Biogeographically, western Sichuan can be divided into four subregions (fig. 20): NW Sichuan (NWS), N. Sichuan (NS), C. Sichuan (CS) and SW Sichuan (SWS). Mt. Gongga, which is located at the juncture of NWS, SWS and CS, and Mt. Siguniang, which is located at the juncture of NWS, CS and NS, are two key biogeographical nodes of this region. NWS subregion has a high plateau climate which is similar to that of Tibet, and there is hardly any suitable ecotope for *Lethe* HBN. species. SWS subregion shares the same fauna with N. Yunnan Province, and NS subregion shares a similar fauna with SE Gansu and S. Shaanxi Provinces.

The differences between the species of *Lethe* HBN. in NS, CS and SWS are conspicuous. For instance, in the subgenus *Zophoessa* DBLD., *Lethe lee* WANG & ZHAO, 2000 and *L. uemurai* (SUGIYAMA, 1994) from NS are absent from CS and SWS; *L. neofasciata* LEE, 1985 and *L. shirozui* (SUGIYAMA, 1997) from SWS are both absent from CS and NS; *L. armandina* (OBERTHÜR, 1881) and *L. helle* (LEECH, 1891) from CS and SWS do not occur in NS; *L. nigrifascia* LEECH, 1890 from CS and NS is absent from SWS. The distributional pattern of the *L. procne*-complex is also an indication of this subregional division. *Lethe paraprocne paraprocne* LANG & LIU is known from CS. *Lethe paraprocne kawagarboensis* LANG & LIU occurs in N. Yunnan which is next to and shares the similar fauna with SWS. Though *L. procne* (LEECH) is found in NS, CS and SWS, a different subspecies occurs in each of the three subregions. However, the precise boundaries of above mentioned subregions need further study.

2. *Lethe procne* (LEECH) can easily be distinguished from *L. paraprocne* LANG & LIU on external features and structure of androconia. The strikingly different androconial structure of the two sympatric taxa from CS proves that there are two distinct species in this complex. However, in the southern populations, viz. *L. procne shunana* **subspec. nov.** from SWS and N. Yunnan and *L. paraprocne kawagarboensis* LANG & LIU from NW Yunnan, the shape and size of androconia are the same, which shows the moderate taxonomic distance between nominotypical *L. procne* LEECH and nominotypical *L. paraprocne* LANG & LIU (fig. 17). So far, there has been no sympatric distribution record of *L. procne shunana* **subspec. nov.** and *L. paraprocne kawagarboensis* LANG & LIU, but it is possible that both fly together in nature somewhere. Though differences in the androconia and in the ♂ genitalia have not been found, the two taxa, *L. procne shunana* **subspec. nov.** and *L. paraprocne kawagarboensis* LANG & LIU, have stable differences of external features, which are respectively close to their own corresponding nominotypical subspecies.

The geographical trend of morphological changes of androconia suggests the possibility of a hypothesis that the evolution route of the *Lethe procne*-complex was from south to north (fig. 17). The southern taxa, *L. procne shunana* **subspec. nov.** and *L. paraprocne kawagarboensis* LANG & LIU from SWS and N. Yunnan, which share the archetype of androconium which is moderate in shape and large, are ancestors of respective species. They are very similar, and can only be distinguished on small but stable differences in external features. Their descendants in the nearby northern region, CS, *L. procne procne* (LEECH) and *L. paraprocne kawagarboensis* LANG & LIU with their characteristic androconia, evolved from the moderate archetype to a more slender version and a more robust kind respectively. Be that as it may, in CS androconia of the two species are strikingly different. Still further north, in NS subregion, the androconia of *L. procne abaensis* **subspec. nov.** are even longer than in *L. procne procne* (LEECH). So far, *L. paraprocne* LANG & LIU is either absent or has yet to be discovered in NS.

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Table 1: Measurement of Androconia of *Lethe procne*-complex. AL = Androconium Length (means \pm standard deviation, SD); AB = Androconium Breadth (means \pm SD); Shape ratios RLB = Ratio of AL/AB (means \pm SD); N1 = Number of androconia measured for each taxon; N2 = Number of specimens measured for each taxon

Taxa	AL (um)	AB (um)	RLB	N1	N2
<i>L. procne procne</i>	132,30 \pm 8,88	2 7,70 \pm 1,72	4,78 \pm 0,34	20	5
<i>L. p. abaensis</i>	142,70 \pm 6,64	26,90 \pm 2,45	5,35 \pm 0,36	20	5
<i>L. p. shunana</i>	115,25 \pm 6,69	31,25 \pm 1,36	3,69 \pm 0,27	20	5
<i>L. paraprocné paraprocné</i>	101,90 \pm 2,51	38,60 \pm 1,69	2,65 \pm 0,16	10	1
<i>L. p. kawagarboensis</i>	115,73 \pm 3,48	30,85 \pm 1,69	3,76 \pm 0,24	20	5

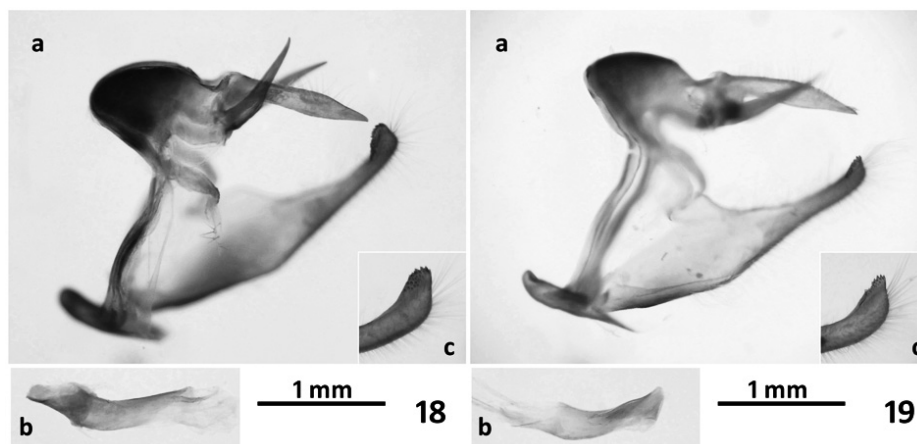


Fig. 18: σ genitalia of *Lethe procne abaensis* subsp. nov. in lateral view with left valva and aedeagus removed (a), aedeagus in lateral view (b) and tip of the σ valva in dorsal view (c), holotype, China, Sichuan, Maoxian, LSY.

Fig. 19: σ genitalia of *Lethe procne shunana* subsp. nov. in lateral view with left valva and aedeagus removed (a), aedeagus in lateral view (b) and tip of the σ valva in dorsal view (c), holotype, China, Sichuan, Gesala, LSY.

Fig. 14

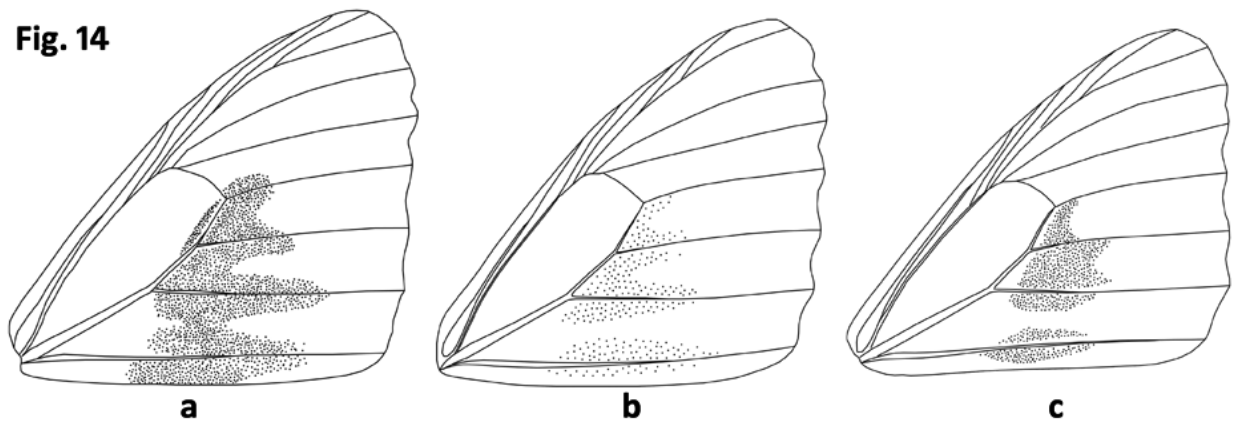


Fig. 14: Forewing and ♂ brand (from LANG & LIU, 2014). (a) *Lethe procne* (LEECH, 1891); (b) *Lethe paraprocne* LANG & LIU, 2014; c - *Lethe paraprocne kawagarboensis* LANG & LIU, 2014.

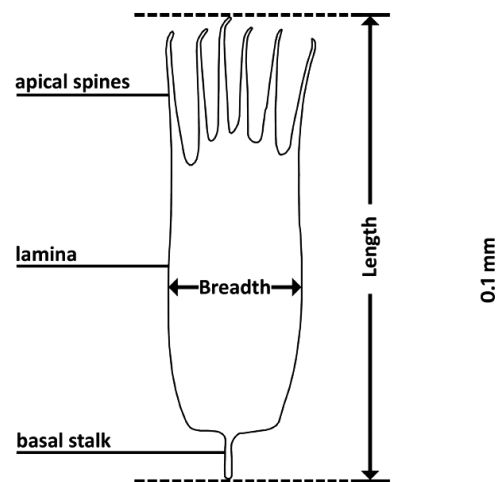


Fig. 15

Fig. 15: Androconium of *Lethe procne*-complex.

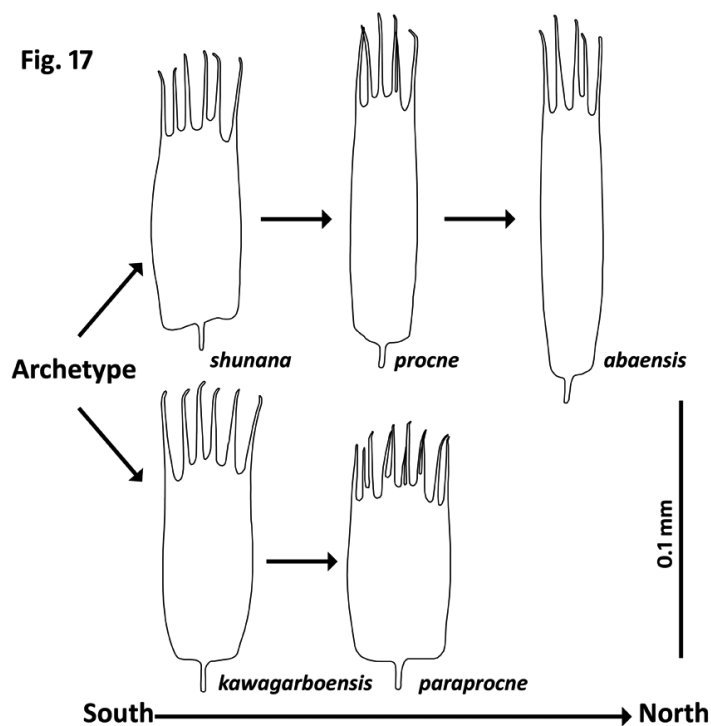


Fig. 17: Hypothetical evolution route of androconia of the *Lethe procne*-complex.

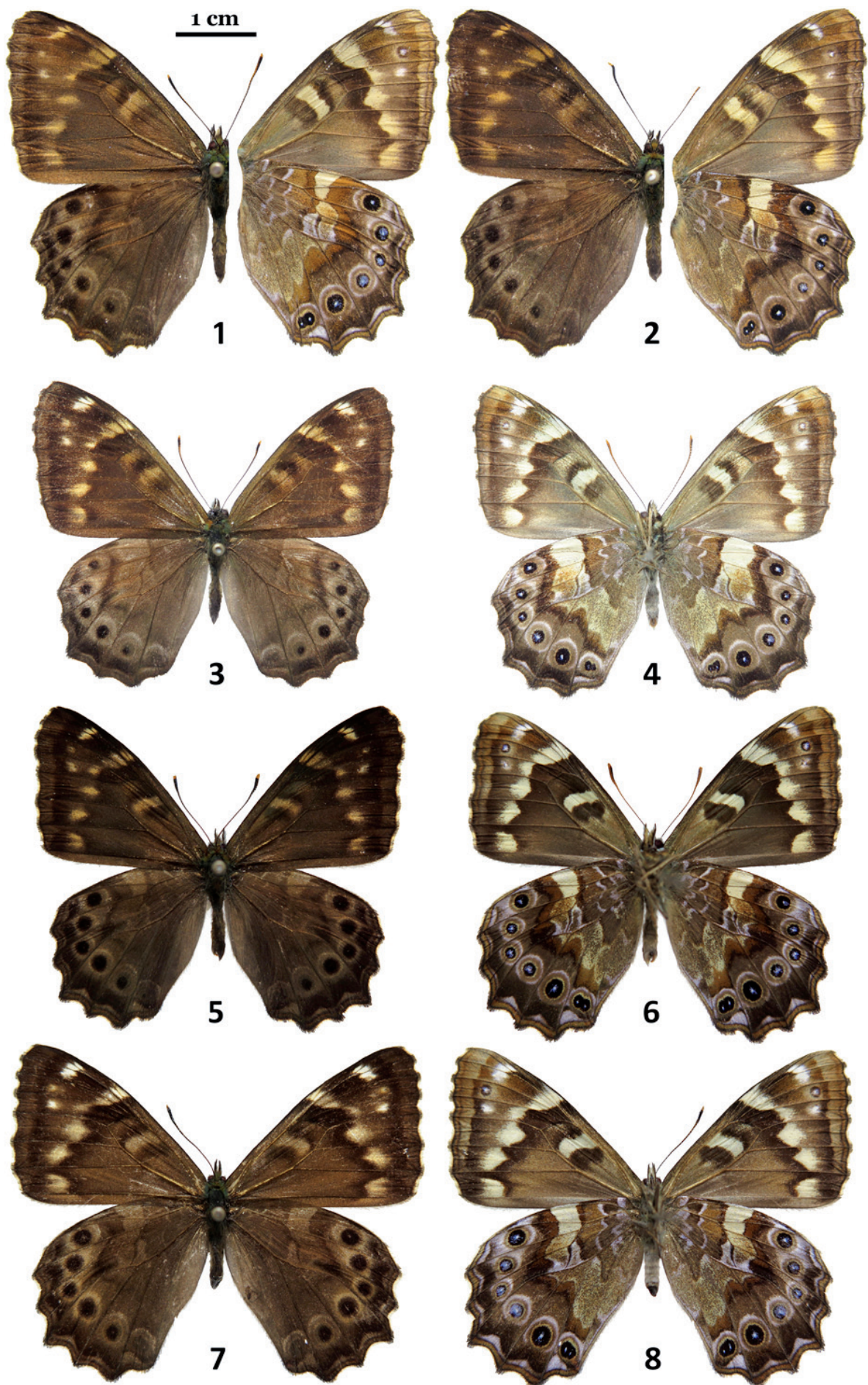


Fig. 1: *Lethe procne* (LEECH, 1891), ♂, China, Sichuan, Omei, LSY, upper- and underside.
 Fig. 2: *Lethe procne* (LEECH, 1891), ♂, China, Sichuan, Ebian, LSY, upper- and underside.
 Fig. 3, 4: *Lethe procne abaensis* subsp. nov., holotype ♂, China, Sichuan, Maoxian, LSY, upper- and underside.
 Fig. 5, 6: *Lethe procne shunana* subsp. nov., holotype ♂, China, Sichuan, Yanbian, LSY, upper- and underside.
 Fig. 7, 8: *Lethe procne shunana* subsp. nov., paratype ♀, China, Sichuan, Puge, LSY, upper- and underside.

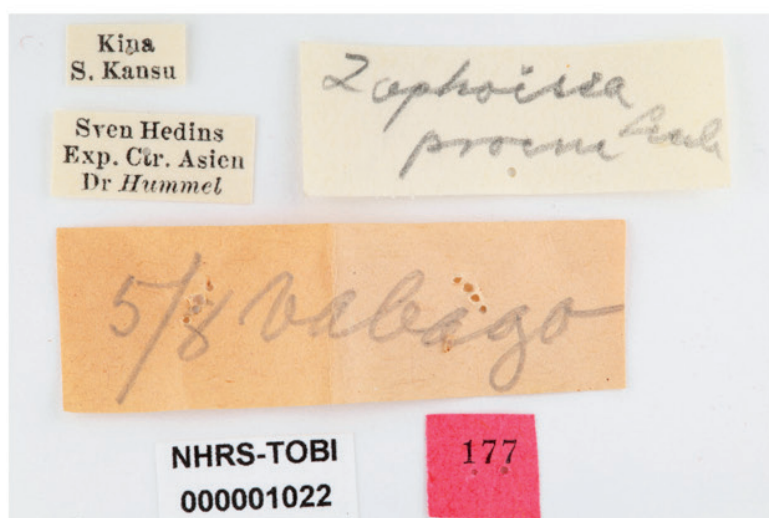
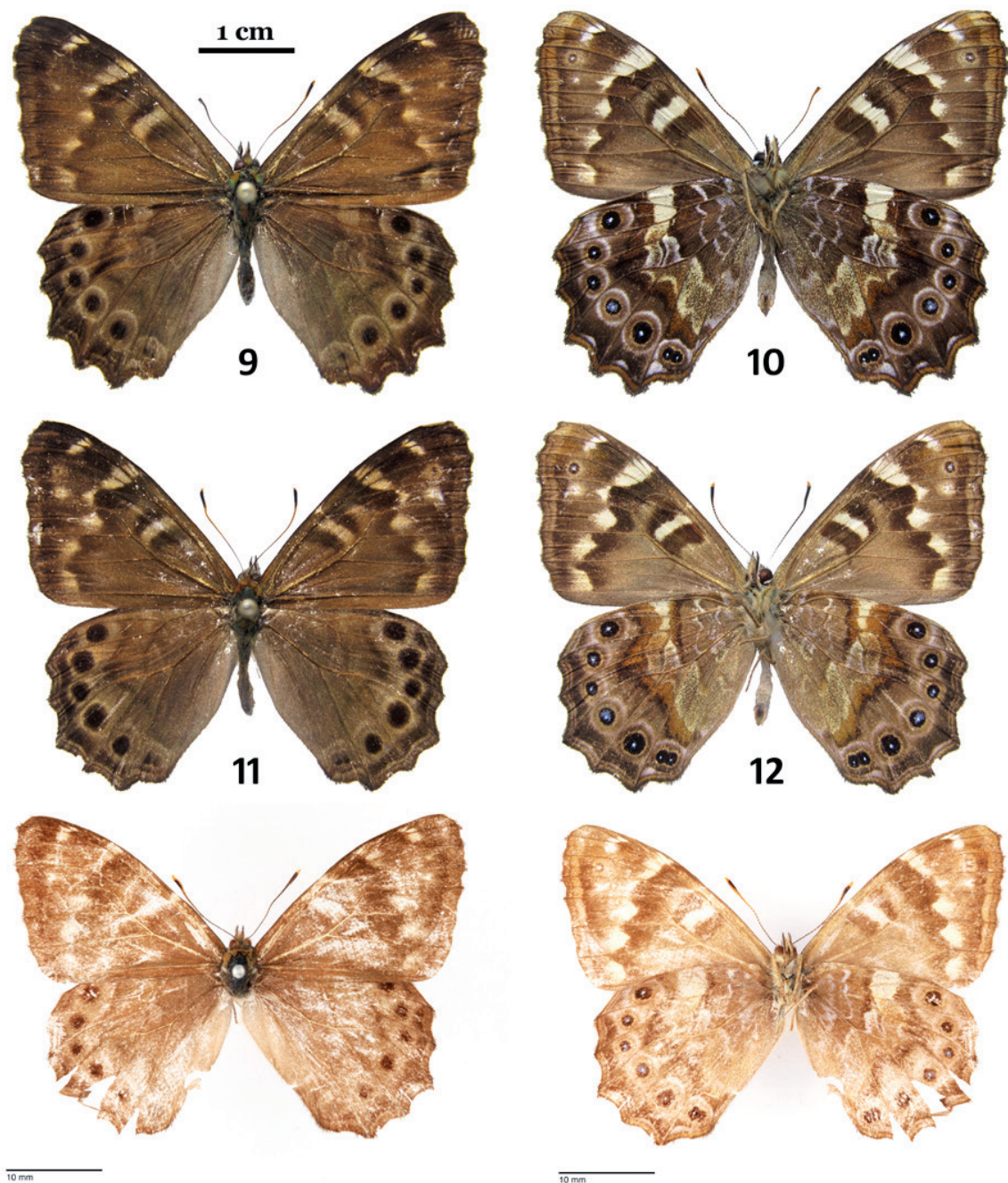


Fig. 13

Fig. 9, 10: *Letho paraprocné* LANG & LIU, 2014, holotype ♂, China, Sichuan, Ebian, LSY, upper- and underside.
 Fig. 11, 12: *Letho paraprocné kawagarboensis* LANG & LIU, 2014, holotype ♂, China, Yunnan, Deqin, LSY, upper- and underside.
 Fig. 13: *Letho procne abaensis* subsp. nov., paratype ♂, NHRS-TOBI 000001022, China, S. Kansu, NHRS, upper-, underside & label, photographed by Dr. TOBIAS MALM © Naturhistoriska Riksmuseet.

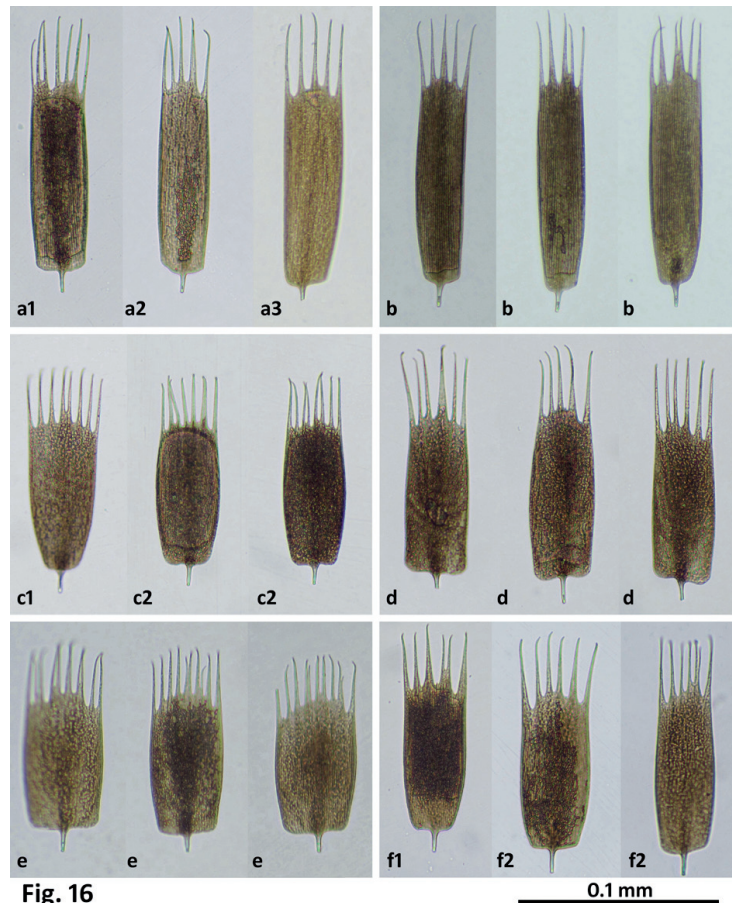


Fig. 16

0.1 mm

Fig. 16: Androconia. (a1) *Lethe procne procne* (LEECH, 1891), China, Sichuan, Ebian, LSY; (a2) ditto, China, Sichuan, Omei, LSY; (a3) ditto, China, Sichuan, Tianquan, LSY; (b) *Lethe procne abaensis* **subspec. nov.**, holotype, China, Sichuan, Maoxian, LSY; (c1) *Lethe procne shunana* **subspec. nov.**, holotype, China, Sichuan, Gesala, LSY; (c2) ditto, paratype, China, Sichuan, Gesala, LSY; (d) ditto, paratype, China, Sichuan, Puge, LSY; (e) *Lethe paraprocne kawagarboensis* LANG & LIU, 2014, holotype, China, Sichuan, Ebian, LSY; (f1) *Lethe paraprocne kawagarboensis* LANG & LIU, 2014, holotype, China, Yunnan, Deqin, LSY; (f2) ditto, paratype, China, Yunnan, Deqin, LSY.

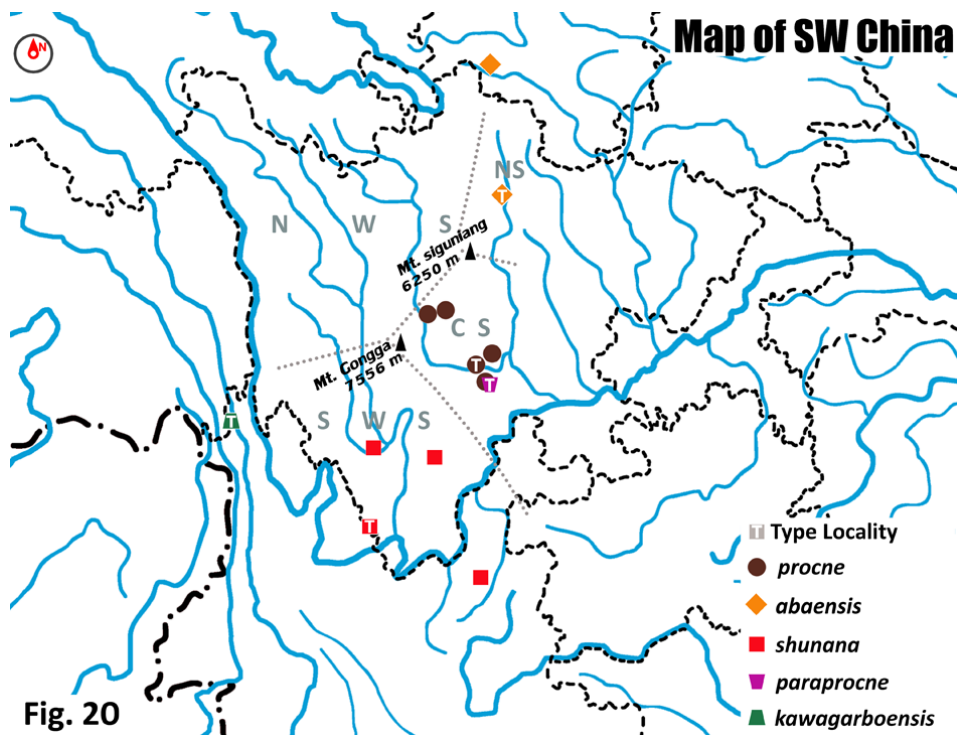


Fig. 20

Fig. 20: Map of SW China with distribution records of *Lethe procne*-complex.

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