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Four New Species of the Genus *Nemophora* Hoffmannsegg (Lepidoptera, Adelidae) from China

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Abstract. Four new species of the genus *Nemophora* Hoffmannsegg, 1798, *N. sichuana* sp. nov., *N. tenuimaculata* sp. nov., *N. tadauchii* sp. nov., and *N. kozlovi* sp. nov. are described from mountainous areas of high elevation (2,495-3,750m) in Sichuan and Yunnan Provinces, China.

Key words: taxonomy, Adelidae, *Nemophora*, Sichuan, Yunnan, China, new species.

Introduction

The genus *Nemophora* includes about 350 species world-wide, among which some 150 species remain to be described (Kozlov, 2004). In China, about 20 species have been recorded from the mainland (*e.g.* Li-Zhong, 2005; Kozlov, 1997; Kozlov & Hirowatari, 1997). In Taiwan, about 20 species have also been recorded (*e.g.* Heppner, 1992; Wang *et al*., 2000), but the study of Adelidae is obviously insufficient.

Surveys on the insect fauna in Sichuan and Yunnan Provinces were conducted as a cooperative research project between Chinese and Japanese institutions in 1993 and 1996 (organized by Prof. H. Shima of Kyshu Univ.), and as a result, some Lepidoptera, including unknown material of adelid species, were collected. In the present paper, four new species of *Nemophora* are described for basic faunal information on the family Adelidae in southwest China.

Materials and methods

Surveys were conducted in several mountainous localities of high elevation (2,495-3,750m) in Sichuan and Yunnan Provinces, China. Most materials were collected by sweeping, and some flying individuals were captured with insect nets in daytime. Measurements for eye size, antennal length, forewing length, and wing expanse are given for the all collected specimens. Eye size index: "horizontal eye diameter (hd) / minimum distance between eyes in dorsal view (md)" (sensu Hirowatari, 1997) and interocular index: "vertical eye diameter (vd) / interocular distance (id)" (sensu Davis, 1975) were calculated.

Terminology follows Nielsen (1980, 1985) and Hirowatari (1997). Specimens examined here are deposited in Kunming Institute of Zoology, Kunming, China (KIZ) and Osaka Museum of Natural History, Osaka, Japan (OMNH).

***Nemophora sichuana* sp. nov.** (Figs 1A, 2, 3)

Male. Forewing 5.7–6.3 mm (holotype: 5.7 mm); wing expanse 11.2–12.7 mm (holotype: 11.2mm).

Head with raised black hairs, mixed with pale yellow; face with smooth silver scales, dorsal part near antennal socket with raised black and pale yellow hairs. Eyes small, widely separated dorsally; eye size index: 0.64–0.82, interocular index: 0.61-0.71. Labial palpus moderate in length, *ca* 2.0 × vertical eye diameter, dorsally with smooth pale yellow scales mixed with dark brown; second segment with dark brown hairs ventrally. Antenna 13.0–18.5 mm, 2.5–2.9× forewing length, smooth; basal 1/3 blackish brown with metallic blue luster, mostly silvery white. Legs bronze; hind tibia creamy white, densely covered with long raised pale brown hairs dorsally; hind

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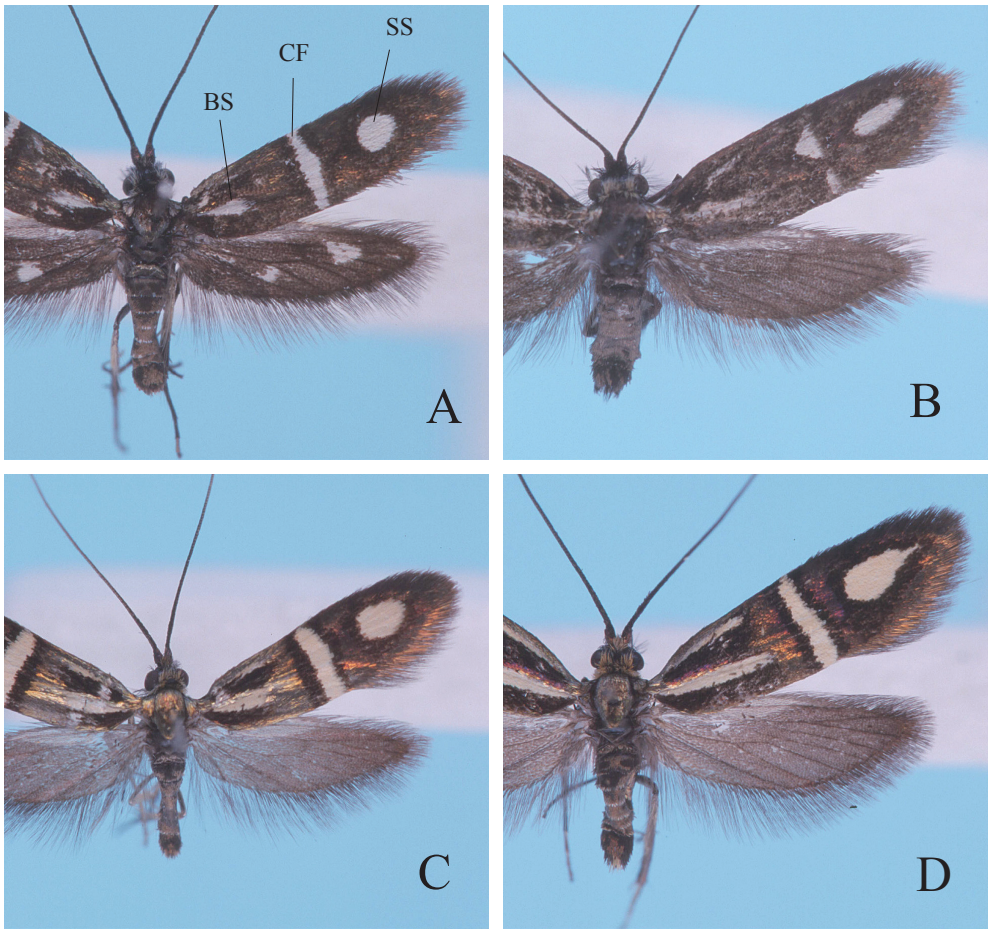

Fig. 1. Adults of *Nemophora* species from China. A: *N. sichuana* sp. nov. Holotype ♂ from Sichuan. B: *N. tenuimaculata* sp. nov. Holotype ♂ from Sichuan. C: *N. tadauchii* sp. nov. Holotype ♂ from Yunnan. D: *N. kozlovi* sp. nov. Holotype ♂ from Yunnan. BS: Basal stria, CF: Central fascia, SS: Subapical spot.

tarsus bronze. Tegula and thorax (dorsum) dark bronze with golden luster. Forewing dark brown with golden luster, basal stria short, central fascia white and narrow, subapical dot circular. Hindwing dark brown, irregular shaped white spots at basal 1/3 and 2/3, sometimes indistinct or absent; cilia dark brown.

Female. Forewing 5.3–5.5 mm; wing expanse 10.6–11.7 mm.

Head with raised pale yellow hairs, mixed with dark brown. Eyes small, eye size index: 0.40–0.45, interocular index: 0.43–0.52. Labial palpus *ca* 2.1× vertical eye diameter, dorsally with smooth pale yellow scales mixed with dark brown; second segment with dark brown hairs ventrally. Antenna 7.2–7.4 mm, 1.3–1.4× forewing length; basal 1/2 thickened with dark bronze scales; distal 1/2 silvery white, smooth and slender. Tegula and thorax (dorsum) silvery bronze. Wing as in male, but white spot on hindwing sometimes indistinct or absent.

Male genitalia (Fig. 2). Uncus short with a weak median keel. Vinculum moderate about 2.0× as long as valva. Valvae triangular, acutely angled apically, separated ventrally; sacculus basally swollen with dense hairs; suspensorium triangular, anterior part slightly beyond posterior margin of vinculum or almost same level in ventral view. Transtilla wide in lateral part; median process long, pointed. Aedeagus moderate in length, slender; basal 3/5 weakly curved dorsally; apical portion with an indistinct lamellate keel dorsally; manica with a patch of minute spines dorsally. Juxta arrow-shaped; arrow head sickle-shaped, rather small.

Female genitalia (Fig. 3). Apophyses posteriores and anteriores long and slender. Vestibulum entirely membranous, except attachment point of guywire. Bursa copulatrix short, membranous.

Holotype ♂, Erdao-ban, Jiuzhaigou, Songpan Xian, Aba Zangzu Zizhizhou, Sichuan. [四川省松潘県九塞溝二道班] Alt. 3,000m. [33.1738N, 103.7293E] 4. viii. 1993, H. Shima & I. Kanazawa leg. (KIZ). Paratypes: 1♂,

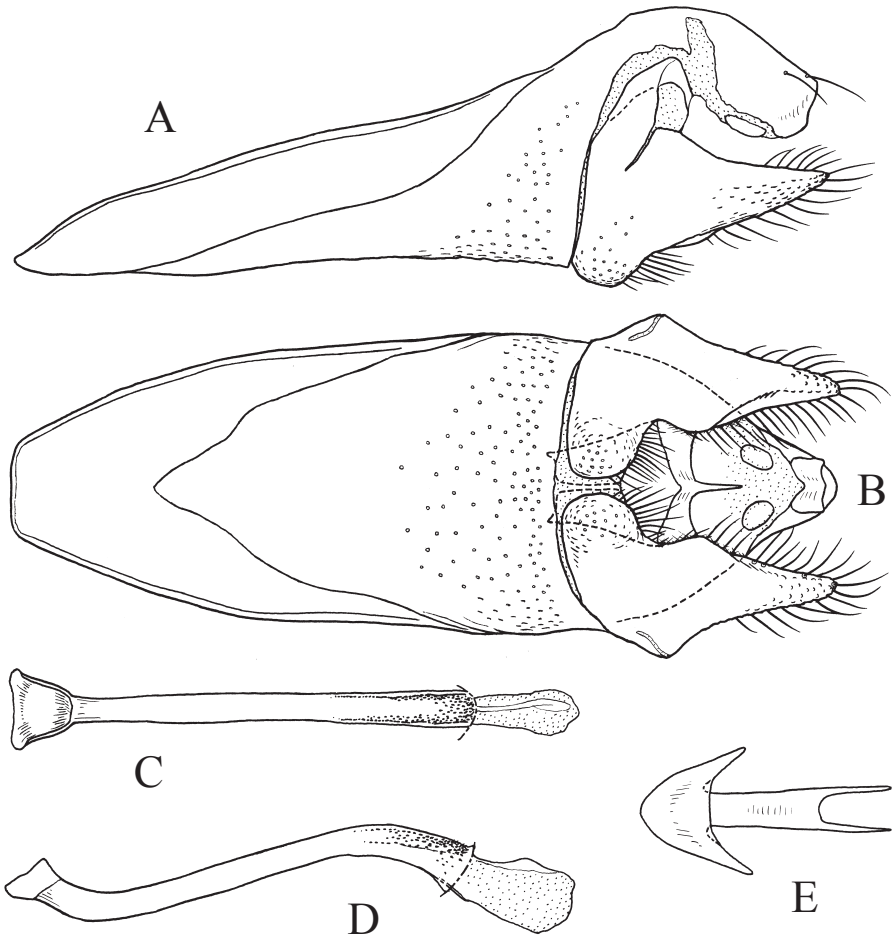

Fig. 2. Male genitalia of *Nemophora sichuana* sp. nov. Holotype. A: Whole genitalia except phallus (lateral view). B: *Ditto* (ventral view). C: Phallus (dorsal view). D: *Ditto* (lateral view). E: Juxta (ventral view).

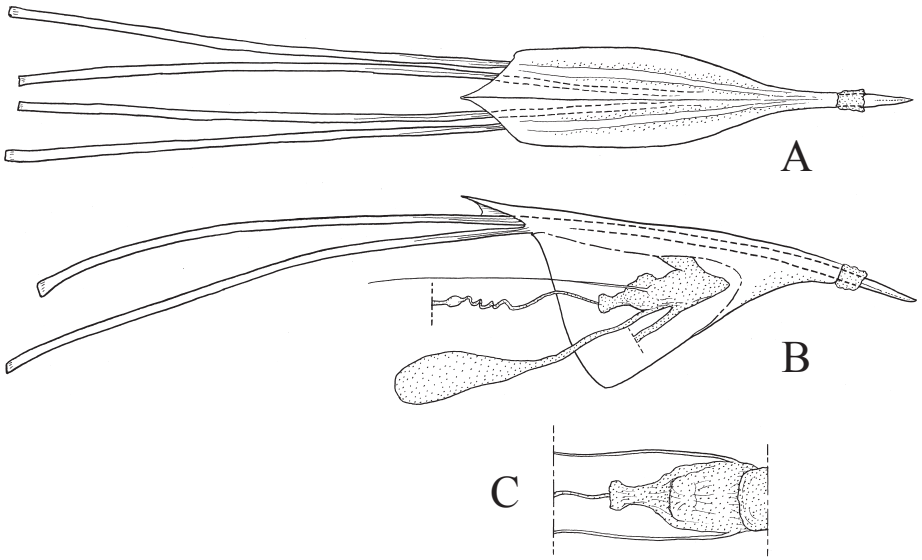

Fig. 3. Female genitalia of *Nemophora sichuana* sp. nov. Paratype. A: Terminalia (dorsal view). B: *Ditto* (lateral view). C. Vestibulum (dorsal view).

same data as holotype (OMNH); 1♂1♀, Xing du qiao, Kang din xian, Ganzi Zangzu Zizhizhou, Sichuan, [四川省康定県新都橋] Alt. 3,750m. 22. viii. 1993 (OMNH); 4♂2♀, Ya jiang xian, Ganzi Zangzu Zizhizhou, Sichuan. [四川省雅江県] Alt. 3,100m. 23. viii. 1993 (2♂1♀in OMNH, 2♂1♀in KIZ).

Distribution. Sichuan, China.

Etymology. From the name of the province in which the type locality is situated.

Remarks. This is a small-sized moth, occurring in some mountainous areas of high elevation (Alt. 3,000-3,750m) in Sichuan province. The wing markings may vary individually and also geographically in each locality.

***Nemophora tenuimaculata* sp. nov.** (Figs 1B, 4)

Male. Forewing 6.4 mm (holotype: 6.4 mm); wing expanse 13.3 mm (holotype: 13.3 mm).

Head with raised black hairs, posterior margin with raised yellow hairs; face with smooth golden scales, dorsal part near antennal socket with raised blackish brown hairs. Eyes small, widely separated dorsally; eye size index: 0.74, interocular index 0.60. Labial palpus moderate in length, *ca* 2.3× vertical eye diameter, dorsally with smooth pale yellow scales mixed with long pale yellow hairs; second and third segments with long dark brown hairs ventrally. Antenna 13.8+ mm, 2.2× forewing length, smooth; blackish brown basally with metallic blue luster, mostly silvery pale brown. Legs bronze mixed with yellow; hind tibia bronze mixed with yellow, covered with long raised dark brown hairs dorsally; hind tarsus ochreous. Tegula and thorax (dorsum) dark bronze with golden luster. Forewing dark brown, two indistinct basal stria present; central fascia discontinuous represented by a central triangular spot and a short dorsal stria; subapical spot white, slender oval. Hindwing dark brown; cilia dark brown.

Female. Unknown.

Male genitalia (Fig. 4). Uncus short with an indistinct

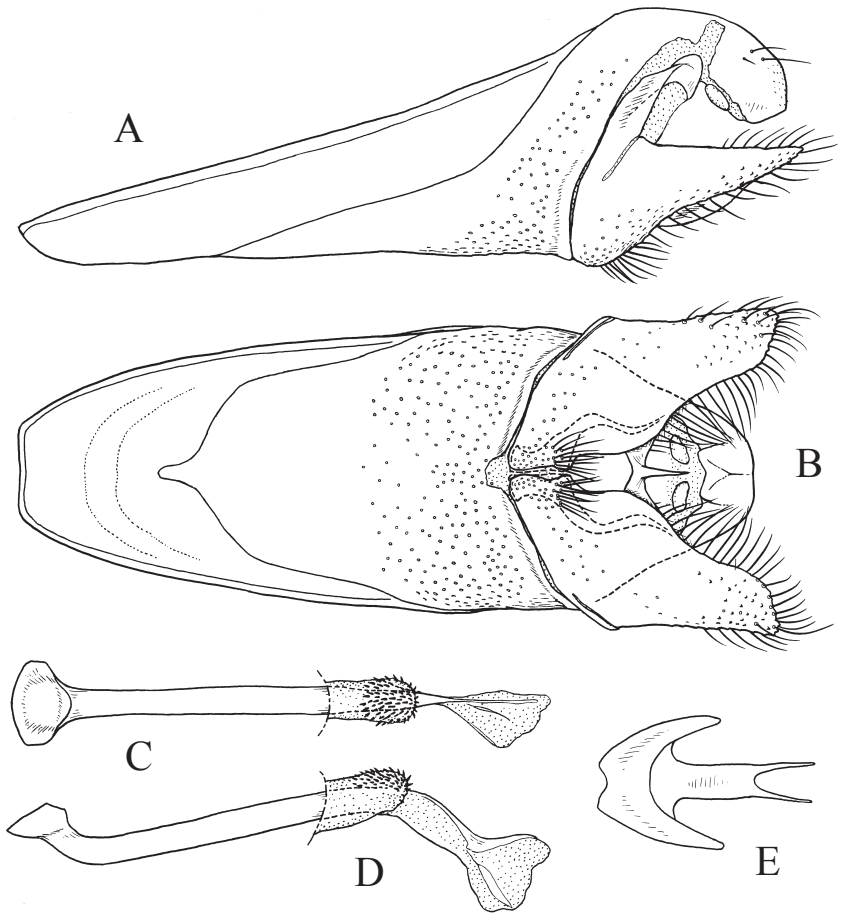

Fig. 4. Male genitalia of *Nemophora tenuimaculata* sp. nov. Holotype. A: Whole genitalia except phallus (lateral view). B: *Ditto* (ventral view). C: Phallus (dorsal view). D: *Ditto* (lateral view). E: Juxta (ventral view).

median keel. Vinculum moderate, about 1.8× as long as valva. Valvae nearly quadrate, apically broad in ventral view, narrowly separated ventrally; sacculus basally weakly swollen with dense hairs; suspensorium triangular, anterior part almost same level as posterior margin of valva in ventral view. Transtilla wide in lateral part, but narrower than in *N. sichuana*; median process long, pointed. Aedeagus moderate in length, slender; basal 7/10 weakly curved dorsally; apical portion with a weak long lamellate keel dorsally; manica with a patch of heavy spines dorsally. Juxta arrow-shaped; arrow head sickle-shaped, large.

Holotype ♂, Xueshan-kou, Jiuzhaigou, Jiuzhai, Aba Zangzu Zizhizhou, Sichuan. [四川省九塞溝雪山口] Alt. 3,400m. [33.0261N, 103.7135E] 31. vii. 1993, I. Kanazawa leg. (KIZ).

Distribution. Sichuan, China.

Etymology. From the Latin *tenuis* (slim) and *maculata* (marked), referring to the slender oval subapical spot of the forewing.

Remarks. This species is described based on a single male specimen. It is characteristic in having a discontinuous central fascia and a slender oval subapical spot in the forewing, a quadrate valva in ventral view, and a manica with a patch of heavy spines dorsally.

***Nemophora tadauchii* sp. nov.** (Figs 1C, 5)

Male. Forewing 5.5–6.2 mm (holotype: 5.7 mm); wing expanse 11.7 mm (holotype: 11.7 mm).

Head with raised pale yellow hairs, mixed with black; face with smooth silver scales, dorsal part near antennal socket with raised black and yellow hairs. Eyes moderate in size; eye size index: 1.00–1.07, interocular index: 0.76–0.82. Labial palpus short, *ca* 1.3 × vertical eye diameter, dorsally with smooth pale yellow scales; second segment with dark brown hairs ventrally. Antenna 15.0-17.2 mm, 2.6–3.2× forewing length, smooth; blackish brown basally with metallic blue luster, mostly silvery pale brown. Legs bronze; hind tibia creamy white, sparsely covered with long raised pale yellow hairs dorsally; hind tarsus bronze with golden luster. Tegula and thorax (dorsum) bronze with golden luster. Forewing dark brown with golden luster, two distinct basal striae present, which are connected basally, but often separated; central fascia white, margined with dark purple; subapical spot oval. Hindwing brown, cilia brown.

Female. Unknown.

Male genitalia (Fig. 5). Uncus short with a median keel. Vinculum moderate about 2.0× as long as valva. Valvae triangular, bifurcate in lateral view, separated ventrally; sacculus basally swollen with dense hairs, ventrally produced, spatulate; suspensorium triangular, anterior part almost same level as posterior margin of vinculum in ventral view. Transtilla wide in lateral part, widely separated by narrow slit from valva; median process long, pointed. Aedeagus moderate in length, slender; basal 3/5 weakly curved dorsally; apical portion with a weak short lamellate keel dorsally; manica with a patch of minute spines dorsally. Juxta arrow-shaped; arrow head triangular, large.

Holotype ♂, Mt. Habaxue-shan, Deqen Zangzu Zizhizhou, Yunnan. [雲南省哈巴雪山麓] Alt. 2,495 m. [27.3340N, 99.9831E] 24. viii. 1996, I. Kanazawa (KIZ). Paratypes: 4♂, same data as holotype (1♂in KZI, 3♂ in OMNH).

Distribution. Yunnan, China.

Etymology. The name is dedicated to Dr. Osamu Tadauchi who contributed to insect database construction in Kyushu University, and gave instructive guidance to the authors (Hirowatari and Kanazawa) when they were graduate students.

Remarks. This species superficially resembles *N. sichuana* sp. nov., but is distinguished from the latter by the shape of the male valva, which is bifurcate in lateral view. This species has relatively large eyes, eye size index of ca 1.0, while in the other three species, the eyes are small, with eye size index of ca 0.6–0.8.

***Nemophora kozlovi* sp. nov.** (Figs 1D, 6)

Male. Forewing 7.0 mm (holotype: 7.0 mm); wing expanse 14.0–14.1 mm (holotype: 14.0 mm).

Head with raised yellow hairs, mixed with black; face with smooth golden scales, dorsal part near antennal socket with raised black hairs. Eyes small, widely separated dorsally; eye size index: 0.60–0.64, interocular index: 0.62-0.68. Labial palpus relatively short, *ca* 1.5 × vertical eye diameter, dorsally with smooth pale yellow scales mixed with dark brown; second segment with dark brown hairs ventrally. Antenna 21.2–21.9 mm, 3.1–3.5× forewing length, smooth; blackish brown basally with metallic blue luster, mostly silvery white. Legs bronze; hind tibia creamy white, bronze terminally, scarsely covered with long raised pale yellow hairs dorsally; hind tarsus bronze, mixed with yellow. Tegula and thorax (dorsum) bronze with golden luster. Forewing dark brown with golden luster, a pair of distinct long basal striae present; central fascia white, margined with dark purple; subapical spot guttiform. Hindwing brown, cilia brown.

Female. Unknown.

Male genitalia (Fig. 6). Uncus short, with an indistinct

median keel. Vinculum moderate, about 2.0× as long as valva. Valvae triangular, moderately angled apically, separated ventrally; sacculus basally distinctly swollen with dense hairs; suspensorium triangular, anterior part not beyond posterior margin of valva in ventral view. Transtilla very wide in lateral part; median process long, pointed. Aedeagus moderate in length, slender; basal 3/5 weakly curved dorsally; apical portion with a weak lamellate keel dorsally; manica with a patch of minute spines dorsally. Juxta arrow-shaped; arrow head trapezoidal, large.

Holotype ♂, Baishui, Mt. Yulong Xueshan, Lijiang Diqu, Yunnan. [雲南省玉龍雪山白水] Alt. 2,775 m. [27.1335N, 100.2668E] 28. viii. 1996, H. Shima & I. Kanazawa leg. (KIZ). Paratype: 1♂, Mt. Habaxue-shan, Deqen Zangzu Zizhizhou, Yunnan. Alt. 2,495 m. 24. viii. 1996 (OMNH).

Distribution. Yunnan, China.

Etymology. The name is dedicated to Dr. Mikhail Kozlov who contributed so much to the systematics of the Adelidae.

Remarks. This species is the largest among the *Nemophora* species described here. It resembles *N. sichuana* sp. nov. and *N. tadauchii* sp. nov., but is distinguished from them by the larger size and the guttiform subapical spot of the forewing. In the male genitalia, the distinct swelling at the basal part of the sacculus is one of characteristics of the species.

Discussion

The four new species described in the present paper may constitute a monophyletic group with such species as *Nemophora pruinosa* Hirowatari, 2005 from the Ryukyus, Japan, and *N. umbripennis* Stringer, 1930 from the main islands of Japan. These species shares the following characteristics: (1) the valvae are ventrally separated; (2) the sacculus is basally somewhat swollen with dense hairs; (3) the apical portion of the aedeagus bears a weak lamellate keel dorsally, and (4) the manica has a patch of minute spines dorsally. If these species comprise a monophyletic group, the following scenario of diversification of this

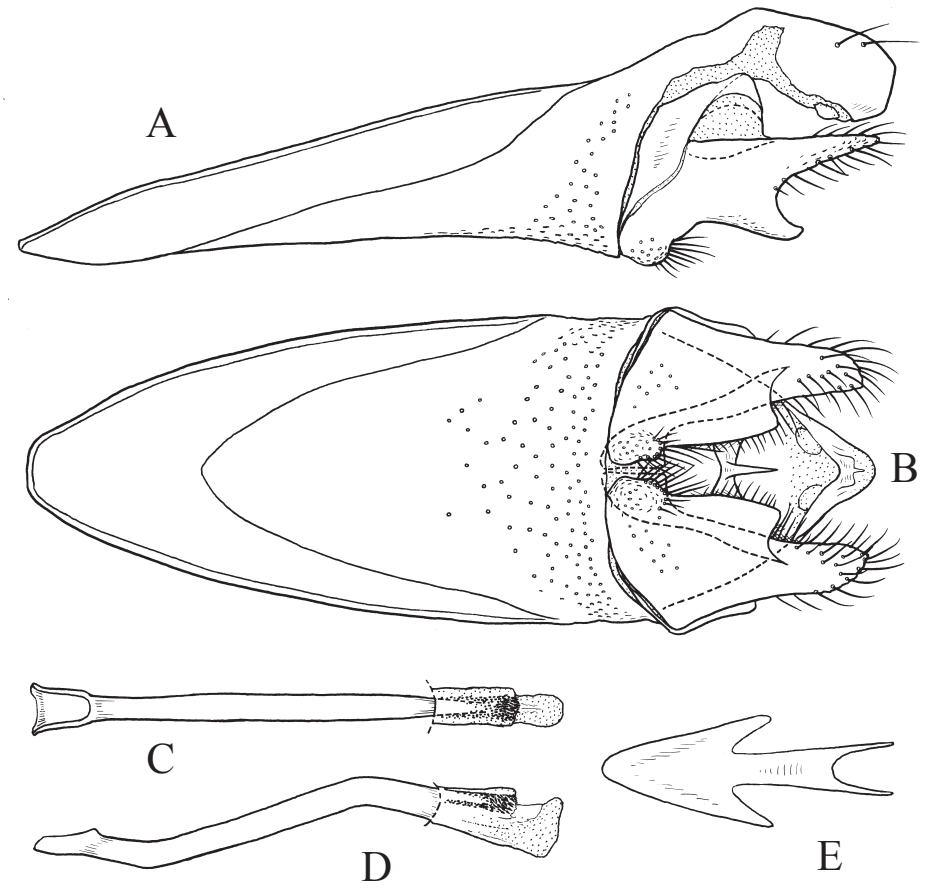

Fig. 5. Male genitalia of *Nemophora tadauchii* sp. nov. Holotype. A: Whole genitalia except phallus (lateral view). B: *Ditto* (ventral view). C: Phallus (dorsal view). D: *Ditto* (lateral view). E: Juxta (ventral view).

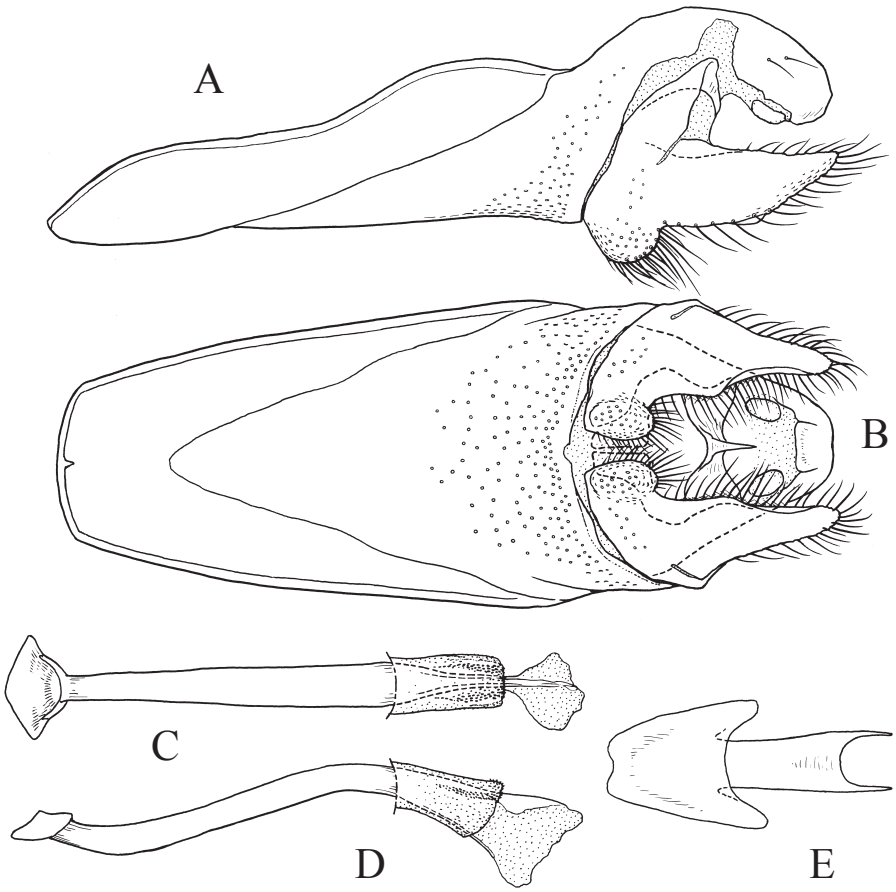

Fig. 6. Male genitalia of *Nemophora kozlovi* sp. nov. Holotype. A: Whole genitalia except phallus (lateral view). B: *Ditto* (ventral view). C: Phallus (dorsal view). D: *Ditto* (lateral view). E: Juxta (ventral view).

group may be hypothesized. From a common ancestor, some species, including the present four new ones, diverged in the high mountainous areas of central China around the Himalayas, while others diverged in the lowland areas of the Ryukyus and mainland Japan. This hypothesis should be tested by investigation of further unnamed related species from China.

As described above, the present four new species have relatively small eyes in the male. Among the four new species described here, the eyes of *N. tadauchii* are moderate in size, eye size index: ca 1.0 and interocular index: ca 0.8, while in the other three species, the eyes are small, with eye size index: ca 0.6–0.8 and interocular index: 0.6-0.7. In contrast, males of *N. pruinosa* from the Ryukyus have large eyes, eye size index: 1.5-1.7 and interocular index: ca 0.9-1.1 (Hirowatari, 2005). Males of *N. umbripennis* have much larger eyes, eye size index: ca 2.5 and interocular index: 0.8. Thus, the size of the male eyes differs in each species from China and Japan. Many adelid species with large eyes are known to swarm (e.g. Nielsen, 1980). *Nemophora ahenea* Stringer, 1930 from Japan, which is known to swarm, has large eyes in the male with eye size index: ca 2.2 and interocular index: ca 1.1 (Hirowatari & Kametani, 1999). Males of *N. pruinosa* were observed flying over the flowers of *Castanopsis* species, which may be regarded as swarming. *N. umbripennis* is known as a swarming species (Hirowatari, 1998), while no such swarming behavior was observed in the four new species with small eyes from the high mountainous areas of central China. The moderate sized eyes of *N. tadauchii* may indicate that the mating behavior of this species is different from that of the other three species from China, but further observations are required to clarify the relationship between eye size and mating behavior.

Acknowledgments

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