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Species of the pleasing lacewing genus *Dilar* Rambur (Neuroptera, Dilaridae) from islands of East Asia

Wei Zhang[1], Xingyue Liu[1], Horst Aspöck[2], Shaun L. Winterton[3], Ulrike Aspöck[4,5]

1 *Department of Entomology, China Agricultural University, Beijing 100193, China*

2 *Institute of Specific Prophylaxis and Tropical Medicine, Medical Parasitology, Medical University of Vienna, Kinderspitalgasse 15, A-1090 Vienna, Austria*

3 *California State Collection of Arthropods, California Department of Food & Agriculture, 3294 Meadowview Rd. Sacramento, California, USA*

4 *Naturhistorisches Museum Wien, Zweite Zoologische Abteilung, Burgring 7, A-1010 Vienna, Austria*

5 *Department of Integrative Zoology, University of Vienna, Althanstraße 14, A-1090 Vienna, Austria*

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Corresponding author: *Xingyue Liu* (xingyue_liu@yahoo.com)

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Abstract

Six species of the pleasing lacewing genus *Dilar* Rambur, 1838, are recorded from several islands of East Asia, including Hainan, Taiwan, and Japan. Five species, i.e. *Dilar formosanus* (Okamoto & Kuwayama, 1920), *Dilar hikosanus* Nakahara, 1955, *Dilar japonicus* McLachlan, 1883, *Dilar pallidus* Nakahara, 1955 and *Dilar taiwanensis* Banks, 1937, are herein redescribed. *Dilar distinctus* Nakahara, 1955, and *Dilar kanoi* Nakahara, 1955, are synonymized with *Dilar taiwanensis* Banks, 1937. *Dilar insularis* **sp. n.** from Hainan and Taiwan is described as new to science. A key to these insular species of *Dilar* is also provided.

Introduction

The Dilaridae, a small neuropteran family comprising about 80 valid species, are sorted in five genera of two subfamilies, i.e. Dilarinae (only occur in the Old World) and Nallachiinae (mainly occur in the New World, with two species recorded from Vietnam and southern Africa) (Engel 1999; Monserrat 1988, 1989, 2005; Oswald 1998, 2013). The genus *Dilar* Rambur, 1838 is the most species rich genus of Dilaridae, belonging to the subfamily Dilarinae, with 52 described species (Oswald 1998; Oswald and Schiff 2001; Yang 1992, 1999, 2001; Aspöck et al. 2001; Zhang et al. 2014a). Majority of *Dilar* species occur in the Eurasia continent, while a few species are distributed in some islands of Asia and Europe. For instance, Sri Lanka harbours an endemic species, *Dilar nietneri* Hagen, 1858, and two species, i.e. *Dilar grandis* (Banks, 1931) and *Dilar macleodi* Oswald & Schiff, 2001 only occur in Borneo. In East Asia, there are many islands along the coast, including Hainan (second largest island of China), Taiwan (the largest island of China), Ryukyus, and Japanese archipelago. Hitherto, seven species of *Dilar* have been recorded from some of these islands (McLachlan 1883; Okamoto and Kuwayama 1920; Banks 1937; Nakahara 1955a, b). Among these species, two of them are distributed in Japan, while, remarkably, five species were described and endemic to Taiwan. However, all these seven *Dilar* species were poorly described and lack a clear, modern redescription and illustrations. In this paper, we revise the insular species of *Dilar* from East Asia. Six valid species are herein recorded and

described from Hainan, Taiwan, and Japan, with one new species. A key to the insular species of *Dilar* from East Asia is also given.

Material and methods

Specimens for the present study are deposited in the Natural History Museum (BMNH), London, U.K.; the Entomological Museum of China Agricultural University (CAU), Beijing, China; the Museum of Comparative Zoology (MCZ), Cambridge, U.S.A; Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin (MNB), Berlin, Germany; National Museum of Natural History (NMNH), Smithsonian Institutions, Washington, D.C., U.S.A.; the National Museum of Nature and Science (NSMT), Tsukuba, Japan; the National Institute for Agro-Environmental Sciences (NIAES), Tsukuba, Japan; and the Entomological Collection of Hokkaido University Museum (SEHU), Sapporo, Japan. Genitalic preparations were made by clearing the apex of the abdomen in a cold, saturated KOH solution for 3-4 h. After rinsing the KOH with acetic acid and water, the apex of the abdomen was transferred to glycerin for further dissection and examination. Habitus photos of adults were taken by using a Nikon D90 digital camera with Nikon MICRO NIKKOR 105 mm lens, and the genitalic figures were made by hand drawing under a Motic SMZ168 stereo microscope. The terminology of the genitalia generally follows U. Aspöck and H. Aspöck (2008).

Taxonomy

Genus *Dilar* Rambur

Dilar Rambur, 1838: 9. Type species: *Dilar nevadensis* Rambur, 1838 (monotypy).
Cladocera Hagen, 1860: 56. Nomen nudum.
Lidar Navás, 1909: 153. Type species: *Dilar meridionalis* Hagen, 1866: 295, original designation.
Fuentenus Navás, 1909: 154. Type species: *Dilar campestris* Navás, 1903: 380, original designation.
Nepal Navás, 1909: 661. Type species: *Nepal harmandi* Navás, 1909: 661, original designation.
Rexavius Navás, 1909: 664. Type species: *Dilar nietneri* Hagen, 1858: 482, subsequent designation by Navás, 1914: 10.
Didar Navás, 1913: 6. An incorrect subsequent spelling of *Dilar*.
Lider Kuwayama, 1962: 376. An incorrect subsequent spelling of *Lidar*.

Diagnosis. Male antennae pectinate, except 2 proximal and more than 3 distal simple antennomeres, branch of 1st flagellomere short, with only one dentate process. Wings broad, generally with numerous dark markings; costal area broad with crossveins simple except several ones forked; subcostal area obviously narrower than costal area, having several crossveins; more than 5 crossveins between R and Rs, MA fused with R at wing base, proximally with no crossvein connecting to MP, and arising from R prior to separation between R and Rs; MP with 2 main branches; nygmata present; trichosors present along wing margin. Male ninth tergite in dorsal view with a truncate or arcuate anterior incision and a deeply V- or U-shaped posterior incision, leaving a pair of broad hemitergites, which are obtuse distally and densely haired. Male ninth sternite generally much shorter than ninth tergite. Male ectoproct highly specialized, largely covered by ninth tergite, without callus cerci and any macrosetae. Male gonocoxite complexes 9, 10 and 11 comprising two pairs of sclerites (i.e. ninth and tenth gonocoxites) and a transverse sclerite (i.e. gonarcus = eleventh gonocixites); gonarcus laterally connecting to bases of ninth gonocoxites. Hypandrium internum generally trapezoidal, with lateral margins slightly arcuate.

Distribution. This genus ranges from northern Africa, through Europe, to Asia, and is recorded in the following countries: Afghanistan, Algeria, Andorra, Bulgaria, China, France, Greece, India, Iran, Italy, Japan, Korea, Kyrgyzstan, Lebanon, Malaysia, Nepal, Pakistan, Portugal, Russia, Spain, Sri Lanka, Tajikistan, Thailand, Turkey, Turkmenistan, Vietnam all countries of former Yugoslavia.

Key to males of insular *Dilar* species from East Asia[1]

1 Forewings nearly hyaline, with no obviously markings ..... *D. pallidus* Nakahara
– Forewings yellowish brown, with distinct brown markings 2
2 Male (Fig. 24, 26) with ninth tergite in dorsal view with posteromedial portion protruding into a projection..... ..... *D. insularis* **sp. n.**
– Male with ninth tergite in dorsal view without projection posteromedially 3
3 Male (Fig. 17) with ectoproct in dorsal view with a strong sclerotized projection at tip and with gonarcus beam-shaped, which is bifid on both ends..... *D. taiwanensis* Banks
– Male with gonarcus beam-shaped, which is not bifid on both ends 4
4 Male (Fig. 13) with ectoproct in dorsal view with a pair of parallel prolongations which are truncatus and serrate at tip..... ..... *D. hikosanus* Nakahara
– Male (Fig. 7) with ectoproct in dorsal view with three projections at tip which is sparsely haired .... *D. japonicus* McLachlan

[1] *Dilar formosanus* (Okamoto & Kuwayama) is not included in this key because the male of this species is unknown. Moreover, the specific identity of *D. formosanus* is still unclear (see remarks of *D. formosanus*).

Dilar japonicus McLachlan, 1883

Figs. 1, 7–12

Dilar japonicus McLachlan, 1883: 220. Type locality: Japan (Fukushima).
Dilar nohirae Nakahara, 1914: 297. Type locality: Japan (Nara).
Dilar japonicus var. gracilis Kuwayama, 1921: 71. Type locality: Japan (Fukushima).

Diagnosis. This species is characterized by the forewings with numerous pale brown markings, and the male ectoproct in dorsal view with three projections at tip which is sparsely haired.

Description. Male. Body length 4.3-5.3 mm; forewing length 10.0-11.4 mm, hindwing length 8.8-9.4 mm.

Head pale yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal seven flagellomeres simple.

Prothorax pale yellow, pronotum pale yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly smoky brown, with numerous brown spots. Forewing ~2.1 times as long as wide, densely spotted, with markings on proximal half much darker, arranging as transversely arcuate pattern, a broad immaculate area present on either side of median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.0 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown, crossveins much paler than longitudinal veins. Forewing with trichosors present along wing margin between R and CuA; Rs with three main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellow, pregenital segments dorsally yellowish brown. Ninth tergite in dorsal view with an arcuate anterior incision and a deeply V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, truncately posteriad. Ectoproct in dorsal view with three projections at tip which is sparsely haired, posteroventrally with a pair of subsemicircular and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite with anterior half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally; tenth gonocoxite slenderly elongate, much longer ninth gonocoxite, with incurved base and spinous tip, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, slightly expanded on both ends, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

Female. Body length 6.5 mm; forewing length 14.0 mm, hindwing length 12.7 mm.

Seventh sternite (Fig. 11) in lateral view subtrapezoidal, in ventral view nearly rectangular and slightly convex on posterior margin. Eighth abdominal segment ventrally without subgenitale. Bursa copulatrix (Fig. 11) with colleterial gland tubular and elongate, sinuate medially; basal part of bursa copulatrix sac-like in lateral view and nearly ovoid in ventral view, posteriorly slightly sclerotized on both sides; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Materials examined. Holotype ♂, "Japan, Fukushima [37º44'N, 140º28'E]/28.7.[18]81/Type/*japonicus* McL[achlan]" (BMNH). JAPAN: 1f#, Aomori, Tsuta-onsen [40º13'N, 140º30'E], 6.VIII.1953, K. Sadanaga (NIAES); 1♀, Gunma, Kuni-mura [36º38'N, 138º38'E], 10.VIII.1992, K. Konishi (NIAES); 1♂, Gunma [36°23'N, 139°03'E], 3.VIII.1960, K. Fujimoto (NIAES); 1♂, Shikoku, Mt. Sara [33°45'N, 133°30'E], 27.VII.1955, Toshiro Yano (NIAES); 1♂, Yamanashi, Shojiko [35°29'N, 138°36'E], 23.VII.1969, P. H. Hasegawa (NIAES); 1f#, Fukushima, Yokomuki Onsen [37°53'N, 140°33'E], 26.VII.1964, H. Kobayashi (NIAES).

Distribution. Japan (Honshu, Kyushu, Shikoku).

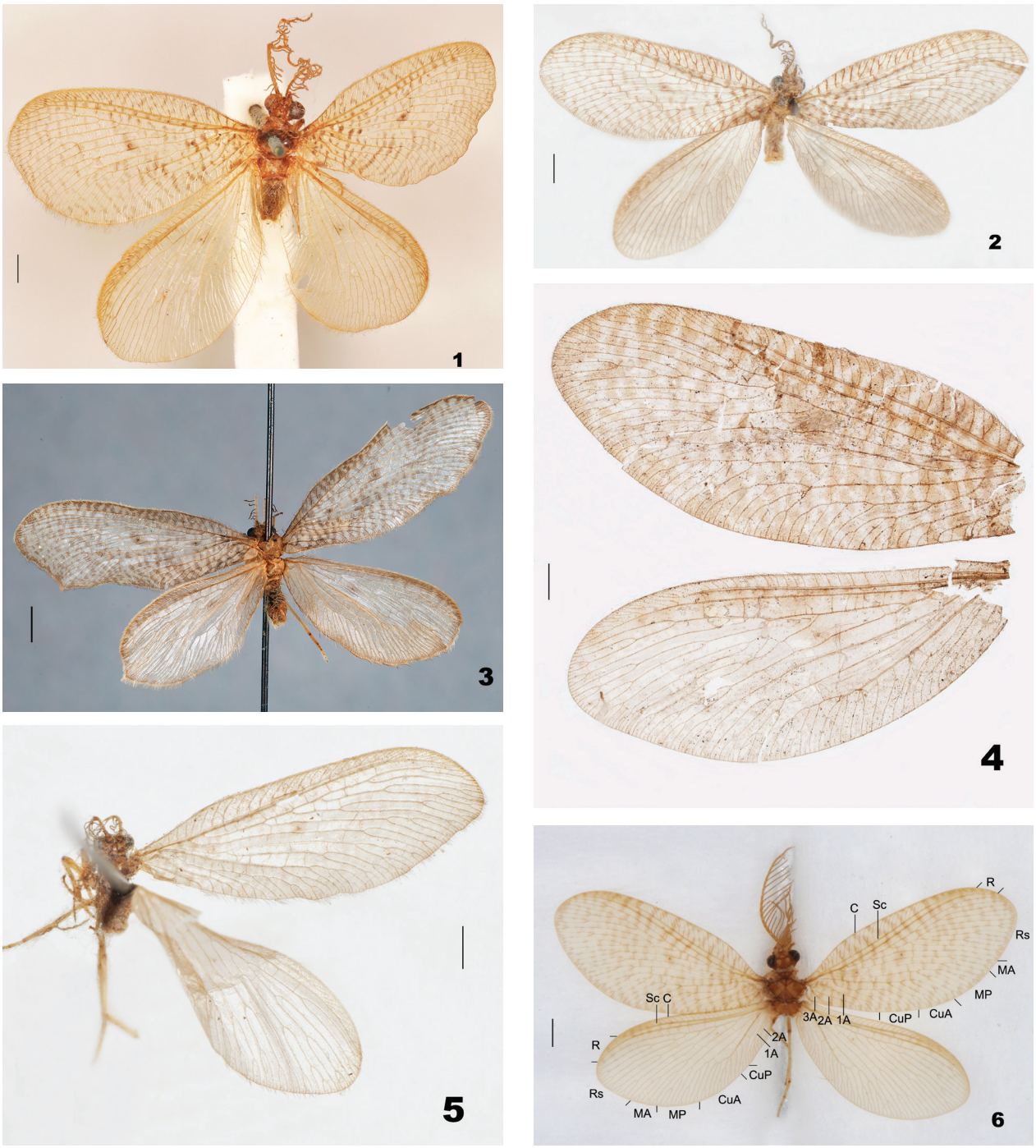
Remarks. This species appears to be very closely related to *D. hikosanus* Nakahara in having similar wing marking patterns and male genitalia. The only difference between these two Japanese species refers to the male ectoproct. In *D. japonicus*, the male ectoproct distally bears three projections which are sparsely haired. However, in *D. hikosanus* the ectoproct has a pair of parallel projections which are truncate and serrate at tip. Primarily we even suspected *D. hikosanus* to be conspecific with *D. japonicus* due to the remarkable similarity of the external morphological and genitalic characters. Nevertheless, we examined several males of both species, and the difference of the male ectoproct mentioned above is stable. Therefore, we consider *D. hikosanus* and *D. japonicus* to be different species. *Dilar japonicus* is a widely distributed species in Honshu, Kyushu and Shikoku, while *D. hikosanus* seems to be endemic to Kyushu, and more exactly to the Mt. Hikosan.

Dilar hikosanus Nakahara, 1955

Figs. 2, 13–16

Dilar hikosanus Nakahara, 1955b: 137. Type locality: Japan (Fukuoka).

Diagnosis. This species is characterized by the forewings with numerous brown stripes, and the male ectoproct in



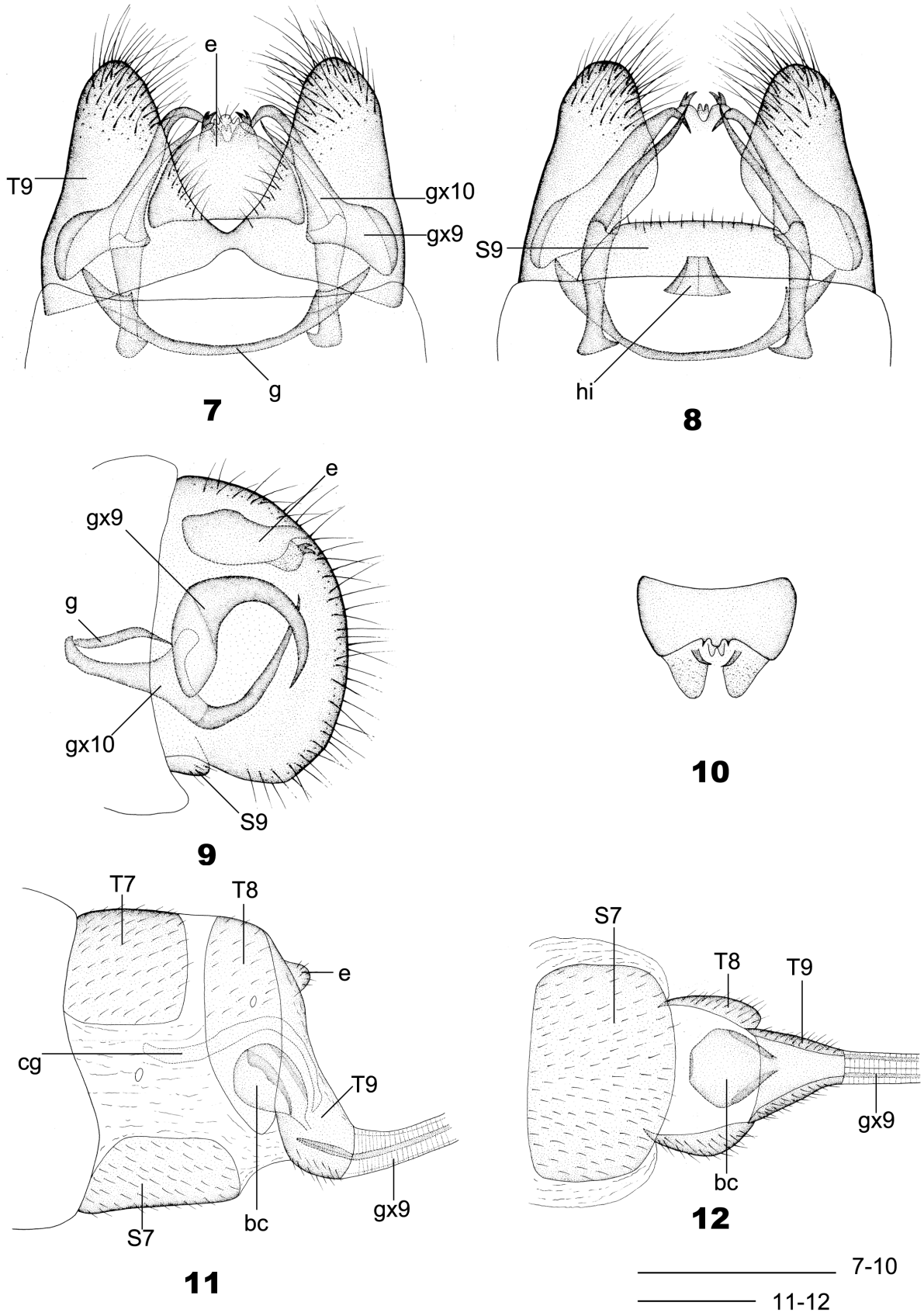
Figures 1–6. Adults of *Dilar* spp. **1**. *D. japonicus* McLachlan, holotype male; **2.** *D. hikosanus* Nakahara, male; **3.** *D. taiwanensis* Banks, holotype male; **4.** *D. formosanus* (Okamoto & Kuwayama), holotype female, fore- and hindwing; **5.** *D. pallidus* Nakahara, holotype male; **6.** *D. insularis* sp. n., holotype male. Scale bars: 1.0 mm.

dorsal view with a pair of parallel prolongations which are truncate and serrate at tip.

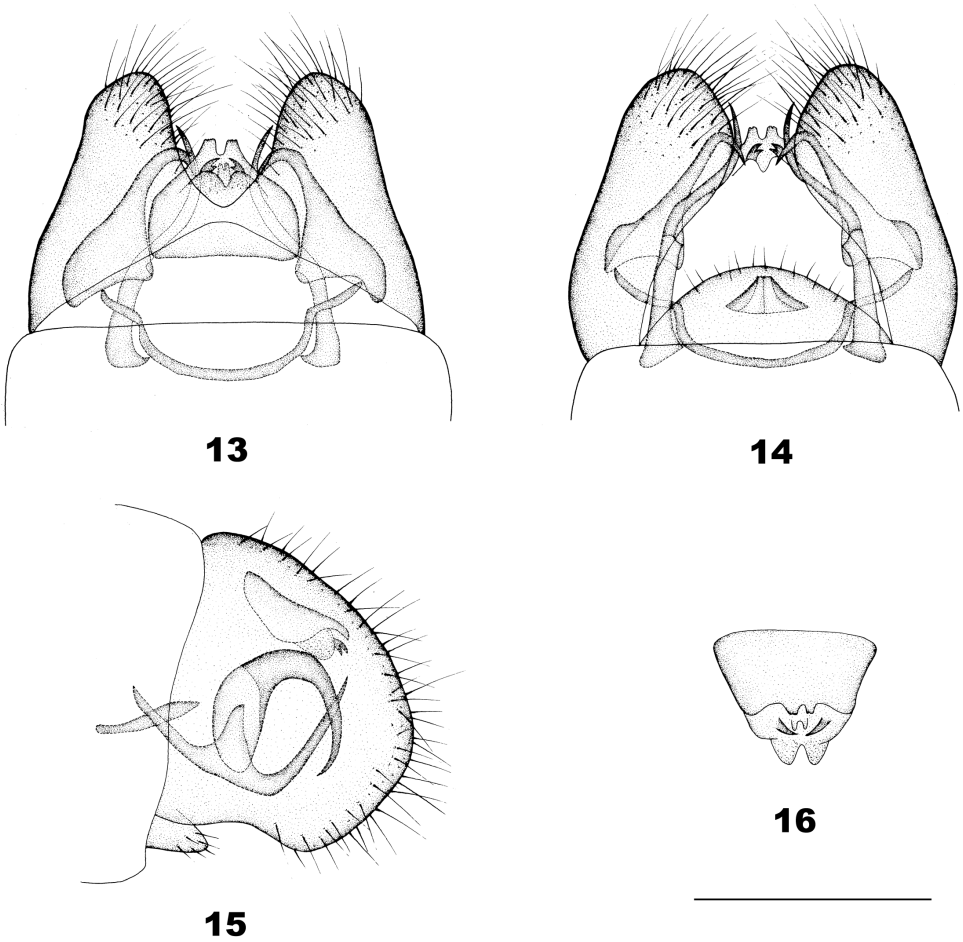
Description. Male. Body length 4.7 mm; forewing length 8.3 mm, hindwing length 6.8 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous brown



Figures 7–12. *Dilar japonicus* McLachlan. **7.** Male genitalia, dorsal view; **8.** Male genitalia, ventral view; **9.** Male genitalia, lateral view; **10.** Male ectoproct, caudal view; **11.** Female genitalia, lateral view; **12.** Female genitalia, ventral view. bc: bursa copulatrix; cg: colleterial gland; e: ectoproct; g: gonarcus = eleventh gonocoxites; gx9: ninth gonocoxite; gx10: tenth gonocoxite; hi: hypandrium internum; S7-9: sternite 7-9; T7-9: tergite 7-9. Scale bars: 0.5 mm.



Figures 13–16. *Dilar hikosanus* Nakahara. **13.** Male genitalia, dorsal view; **14.** Male genitalia, ventral view; **15.** Male genitalia, lateral view; **16.** Male ectoproct, caudal view. Scale bars: 0.5 mm.

spots. Forewing ~2.2 times as long as wide, densely spotted, with markings on proximal half much darker, most markings connected with each other, generally arranging into several arcuate transverse stripes, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriad. Ectoproct in dorsal view with a pair of parallel prolongations which are truncate and serrate at tip, posteroventrally with a pair of subsemicircular and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite with anterior half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally; tenth gonocoxite slenderly elongate, much longer ninth gonocoxite, with incurved base and spinous tip which is curved outward, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

Female. Unknown.

Materials examined. Holotype ♂, "HIKOSAN [33°01'N, 131°01'E], Kyushu, Aug. 3, 1934, S. Hiroyama/*Dilar hikosanus* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II/*Dilar hikosanus* n.sp. W. NAKAHARA (Holotype)/NSMT-I-Nr No. 4302" (NSMT). 2♂, JAPAN: Kyushu, Hikosan, Buzen, 19.VII.1963, H. Kuroko (NIAES).

Distribution. Japan (Kyushu).

Remarks. See Remarks under *Dilar japonicus* McLachlan, 1883.

Dilar taiwanensis Banks, 1937

Figs. 3, 17–20

Dilar taiwanensis Banks, 1937: 276. Type locality: China (Taiwan: Jiayi).
Dilar distinctus Nakahara, 1955b: 139. Type locality: China (Taiwan: Tattaka). **syn. n.**
Nepal kanoi Nakahara, 1955a: 6. Type locality: China (Taiwan: Tattaka). **syn. n.**

Diagnosis. This species is characterized by the male ninth gonocoxite with anterior half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally, and by the slenderly elongate tenth gonocoxite which has a lobe connecting to ninth gonocoxite medially.

Description. Male. Body length 3.4–5.5 mm; forewing length 6.4–9.0 mm, hindwing length 5.5–7.6 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slight darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous dark spots. Forewing ~2.2 times as long as wide, densely spotted, with markings on proximal half much darker, most markings fused with each other, generally arranging into several arcuate transverse stripes, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriad. Ectoproct in dorsal view with a strong sclerotized projection medially, which is bifid at tip, posteroventrally with a pair of short and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite strongly inflated and spoon-shaped on anterior half, with posterior half slenderly elongate and curved posteroventrally, which is with a slenderly short projection extended subterminally; tenth gonocoxite slenderly elongate, much longer than ninth gonocoxite, with incurved base and spinous tip which is curved outward, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, bifid on both ends, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

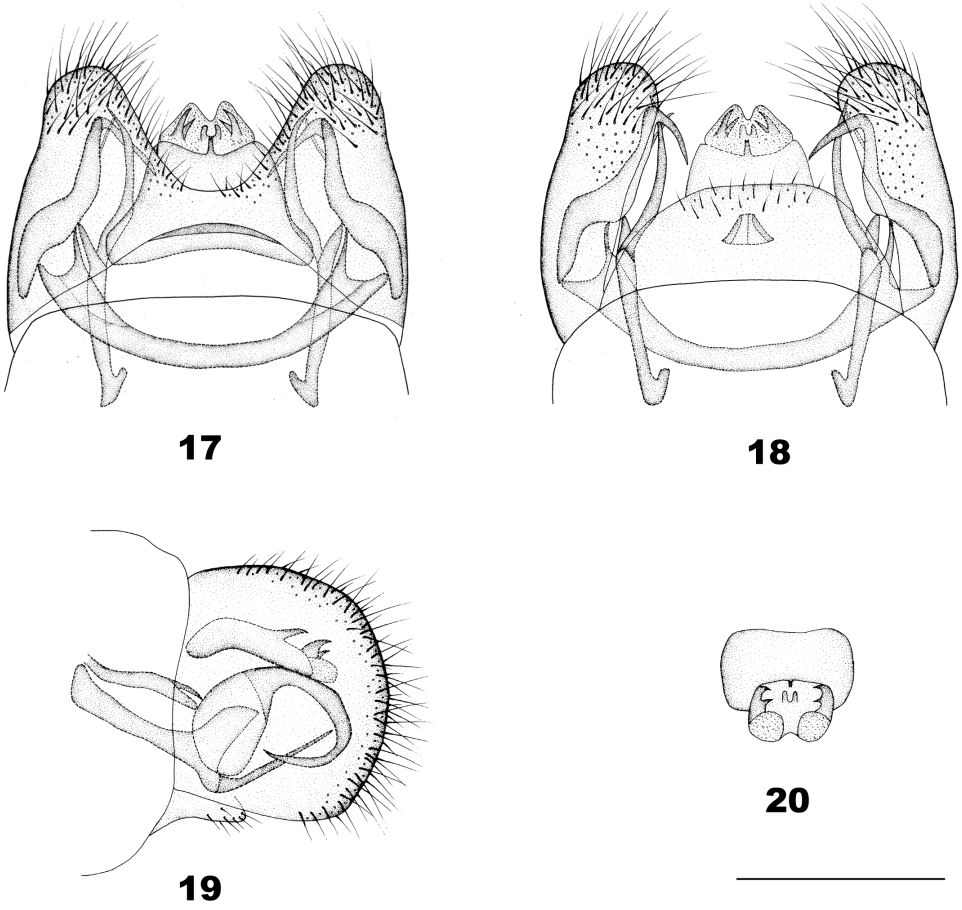
Female. Forewing length 12.5 mm, hindwing length 11.5 mm.

Abdomen yellow, ovipositor yellowish brown, seventh sternite ruptured during maceration, eighth abdominal segment without subgenitale. Colleterial gland apparently also ruptured, not visible. Bursa copulatrix sac-like in lateral view, with an elongated bowl-like sclerite and a paired sclerotized domed structure distally behind it; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Materials examined. Holotype ♂, "Formosa, Arizan [= Mt. Alishan, Taiwan, 23°31'N, 120°48'E], June 4, Gressitt, Type, M.C.Z. No. 20229" (MCZ). CHINA: 2♂, Taiwan, Taoyuan, Mt. Tamanshan [24°42'N, 121°27'E], 1600 m, 11.VI.2013, Feiyang Liang (CAU); 1♂, Taiwan, Taipei, Mt. Yangmingshan, Datun Park [25°09'N, 121°32'E], 900 m, 17.VI.2012, Lihua Wang (CAU); 2♂, Taiwan, Taipei, Mt. Yangmingshan, Datun Park, 900 m, 17.VI.2012, Luxi Liu (CAU); 5♂1f#, Taiwan, Nantou, Tayuling [23°55'N, 120°40'E], 2500 m, 8-18.VI.1998, D. R. Davis (NMNH); 1♂, "Formosa, Taihorin [Taiwan: Chiayi County, Dalin (= Taihorin), 23°35'N, 120°28'E], VI.10. [= June 1910], H. Sauter" (MNB); 2♂ [Holotype and a paratype of *Dilar distinctus*], "Formosa, T. Kano/*Dilar distinctus* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II" (NSMT); 1♂ [Holotype of *Dilar kanoi*], "Formosa, T. Kano/*Dilar kanoi* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II/NSMT-I-Nr No. 4340" (NSMT); 1♂, CHINA: Taiwan, 29.VII.1928, T. Kano (NSMT); JAPAN: 1♂, Iriomote Island, Upper Nakara River [24°20'N, 123°49'E], 12.III.1964, Y. Miyatake (NSMT).

Distribution. China (Taiwan), Japan (Iriomote Island).

Remarks. This species was originally described by Banks (1937) based on external morphology only. After our examination of the holotype of this species, we found that this species is identical with *Dilar distinctus* Nakahara and *Dilar kanoi* Nakahara based on the comparison of its male genitalia with the original genitalic illustrations of the latter two species. Therefore, we treat *D. distinctus* and *D. kanoi* as junior synonyms of *D. taiwanensis.* Nevertheless, it should be noted that the collecting labels of the primary types of *D. distinctus* and *D. kanoi* lack the information of the precise data of the collecting sites and dates, which however were indicated in the original descriptions (Nakahara 1955a, b).



Figures 17–20. *Dilar taiwanensis* Banks. **17.** Male genitalia, dorsal view; **18.** Male genitalia, ventral view; **19.** Male genitalia, lateral view; **20.** Male ectoproct, caudal view. Scale bars: 0.5 mm.

It is interesting that this species is polymorphic. Some individuals (See Figs. 28, 30) have dark wings, while some individuals (See Figs. 29, 31) have much paler wings. Therefore, it is difficult to identify the Taiwanese *Dilar* species only based on external morphology because of its significant intraspecific variations. Possibly, *D. formosanus* and *D. pallidus* are individual variations of *D. taiwanensis*, which, however, needs further clarification.

Considering the distribution, this species is firstly recorded in Iriomote Island, which is the southernmost island of Ryukyus, Japan.

Dilar formosanus (Okamoto & Kuwayama, 1920)

Figs. 4, 21–22

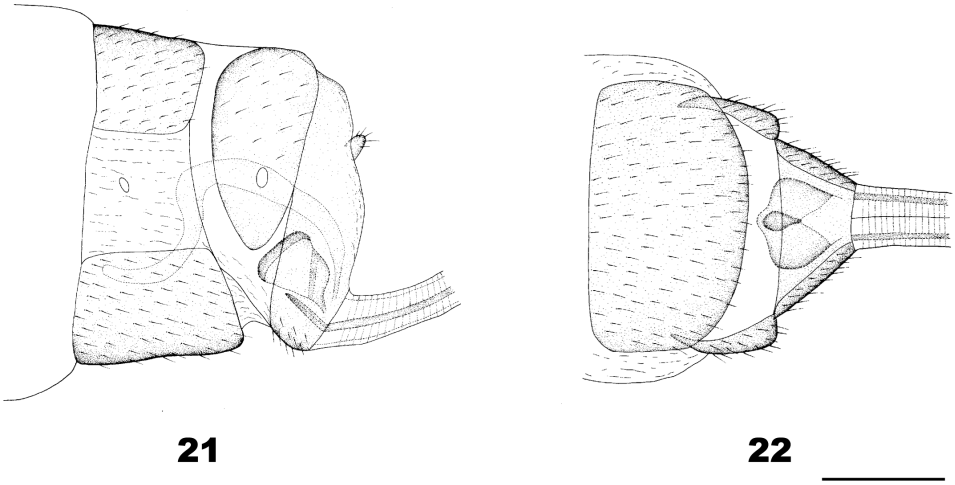
Lidar formosanus Okamoto & Kuwayama, 1920: 341. Type locality: China (Taiwan: Jiayi).

Diagnosis. This species is characterized by the forewings with numerous brown markings, and the basal part of bursa copulatrix, which is subtrapezoidal, with anteromedial portion slightly prominent and sclerotized in ventral view.

Description. Female. Body length 8.5 mm; forewing length 14.0 mm, hindwing length 12.0 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 25 segments, pale yellowish brown, medial flagellomeres much longer than those on both ends, distal eight flagellomeres short, nearly moniliform.

Prothorax pale yellowish brown, pronotum dark brown, with eight yellowish tubercles clothed with yellowish hairs; mesothorax and metathorax pale yellowish brown. Legs pale yellowish brown, with each segment blackish brown at tip. Wings hyaline, slightly pale brown, with numerous brownish spots. Forewing ~2.5 times as long as wide, densely spotted, most spots expanded and fused with each other, with markings on costal area and proximal half much darker, arranging as transversely arcuate pattern, an immaculate area present distal to median nygmata; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins brown. Forewing with 13 crossveins between Sc and R; Sc just touching R in pterostigmatic region; 12 crossveins between R and Rs; Rs with five main branches; MP with two main branches. Hindwing subcostal area slightly widened on distal half, with four crossveins; Rs with six main branches.



Figures 21–22. *Dilar formosanus* (Okamoto & Kuwayama). **21.** Female genitalia, lateral view; **22.** Female genitalia, ventral view. Scale bars: 0.5 mm.

Abdomen yellow, pregenital segments dorsally brown. Ovipositor yellowish brown, much longer than abdomen. Seventh sternite in lateral view subtrapezoidal, with slightly convex posterior margin in ventral view. Eighth abdominal segment without subgenitale. Bursa copulatrix with colleterial gland tubular and elongate, strongly curved medially; basal part of bursa copulatrix sac-like in lateral view, subtrapezoidal in ventral view with anteromedial portion slightly prominent and sclerotized; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Male. Unknown.

Material examined. Holotype f#, "Mt. Ari [23°26′N, 120°46′E], Taiwan, 2.IV.1907. S. Matsumur[a] leg./*Lidar formosanus* n. sp. 1920 Det. HANJIRO OKAMOTO SATORO KUWAYAMA (HOLOTYPE)/*Lidar formosanus* OKAMOTO et KUWAYAMA 1920 Holotype ♀" (SEHU).

Distribution. China (Taiwan).

Remarks. This species was originally described based on a single female by Okamoto and Kuwayama (1920). Due to the phenomenon that remarkable intraspecific variation of wing marking patterns is present in Dilaridae (see Zhang et al. 2014b and the remarks on *D. taiwanensis*), it is difficult to clarify the specific identity of *D. formosanus* based on the external morphology with the other Taiwanese *Dilar* species, of which the females are unknown. Nevertheless, it is highly possible that *D. formosanus* is conspecific with one of the other three *Dilar* species from Taiwan, i.e. *D. pallidus*, *D. taiwanensis*, and *D. insularis*. This may be clarified by DNA barcoding, when fresh material is available.

Dilar pallidus Nakahara, 1955

Figs. 5, 23

Dilar pallidus Nakahara, 1955b: 140. Type locality: China (Taiwan: Tattaka).

Diagnosis. This species is characterized by the forewings with no obvious markings, and the male ectoproct in dorsal view with a subrectangular projection terminating in three sharply pointed processes of about equal length.

Description. Male. Body length 3.5 mm; forewing length 10.5 mm, hindwing length 8.5 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 24 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slight darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown. Forewing ~2.3 times as long as wide, with numerous very indistinct markings, and with a yellowish brown spot on median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ectoproct in dorsal view with a subrectangular projection which terminating in three sharply pointed processes of about equal length, posteroventrally with a pair of large, bifid, unguiform projections and a subrectangular, feebly sclerotized projection. Ninth gonocoxite with anterior half slightly inflated and with posterior half slenderly elongate and strongly incurved;

Figures 23. *Dilar pallidus* Nakahara, male genitalia, ventral view. Reproduced from Nakahara (1955b).

tenth gonocoxite slenderly elongate, with incurved base and spinous tip, submedially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum unknown.

Female. Unknown.

Material examined. Holotype ♂, "Formosa, T. Kano/*Dilar pallidus* n.sp. (Type) W. NAKAHARA/*pallidus* n. sp./Waro Nakahara Collection II/NSMT-I-Nr No. 4301/Type of *Dilar pallidus*?" (NSMT).

Distribution. China (Taiwan).

Remarks. This species is known only from the holotype male, whose genitalia have been unfortunately lost. The present redescription of the male genitalia is based on the original illustration from Nakahara (1955b). Considering the wing marking patterns, *D. pallidus* has very pale wings without distinct dark markings, while the other Taiwanese species of *Dilar* have much darker markings on forewings. Considering the male genitalia, it is obvious that *D. pallidus* is closely related to *D. taiwanensis* by having similar male gonocoxite complexes 9, 10, 11. However, in *D. pallidus* the male ectoproct differs in some details, e.g. the presence of a rectangular dorsomedian projection, and the presence of a pair of posteroventral lobes each with two widely separated claw-like projections, from *D. taiwanensis*. Nevertheless, the specific identity of *D. pallidus* needs further clarification when more materials will be available.

Dilar insularis Zhang, Liu & U. Aspöck sp. n.

http://zoobank.org/721BA7E1-F9DF-4967-822B-E46BE6AA0C96
Figs. 6, 24–27

Diagnosis. This species is characterized by the forewings with numerous yellowish brown stripes, and the male gonarcus/ninth gonocoxite complex with rather inflated ninth gonocoxites and slenderly elongate tenth gonocoxites which are angulately curved anteriorly.

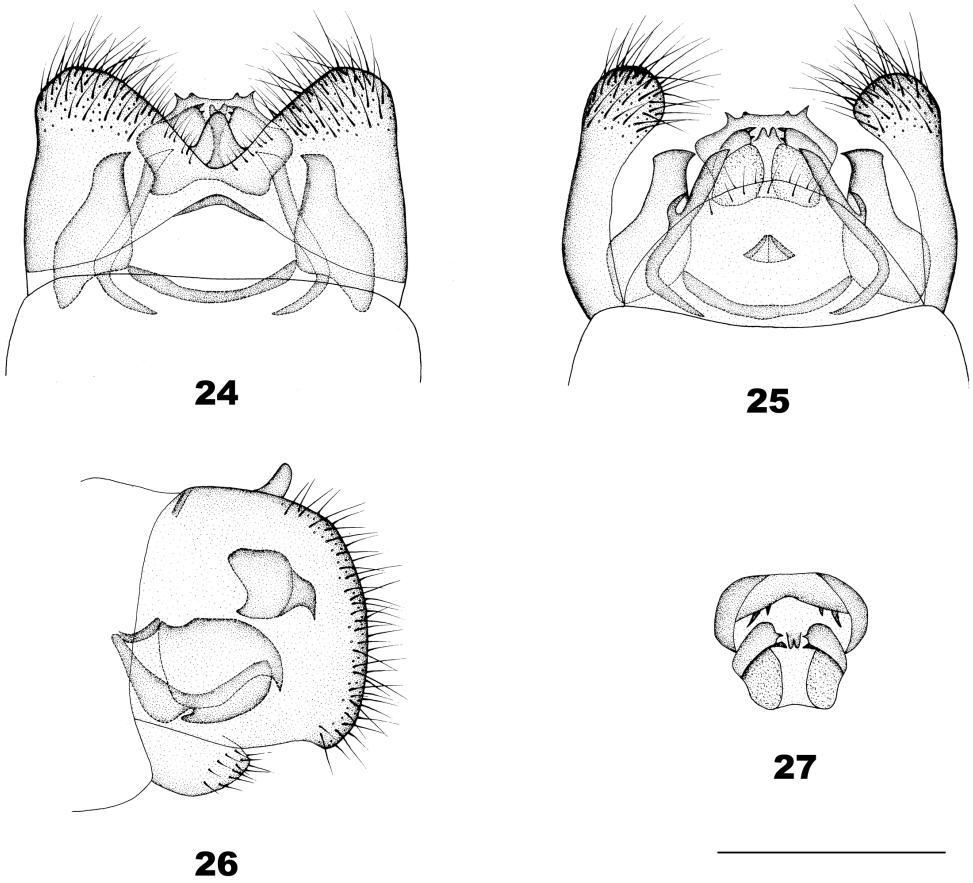
Description. Male. Body length 3.7–5.5 mm; forewing length 6.0–8.9 mm, hindwing length 5.2–7.5 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 28 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 7.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

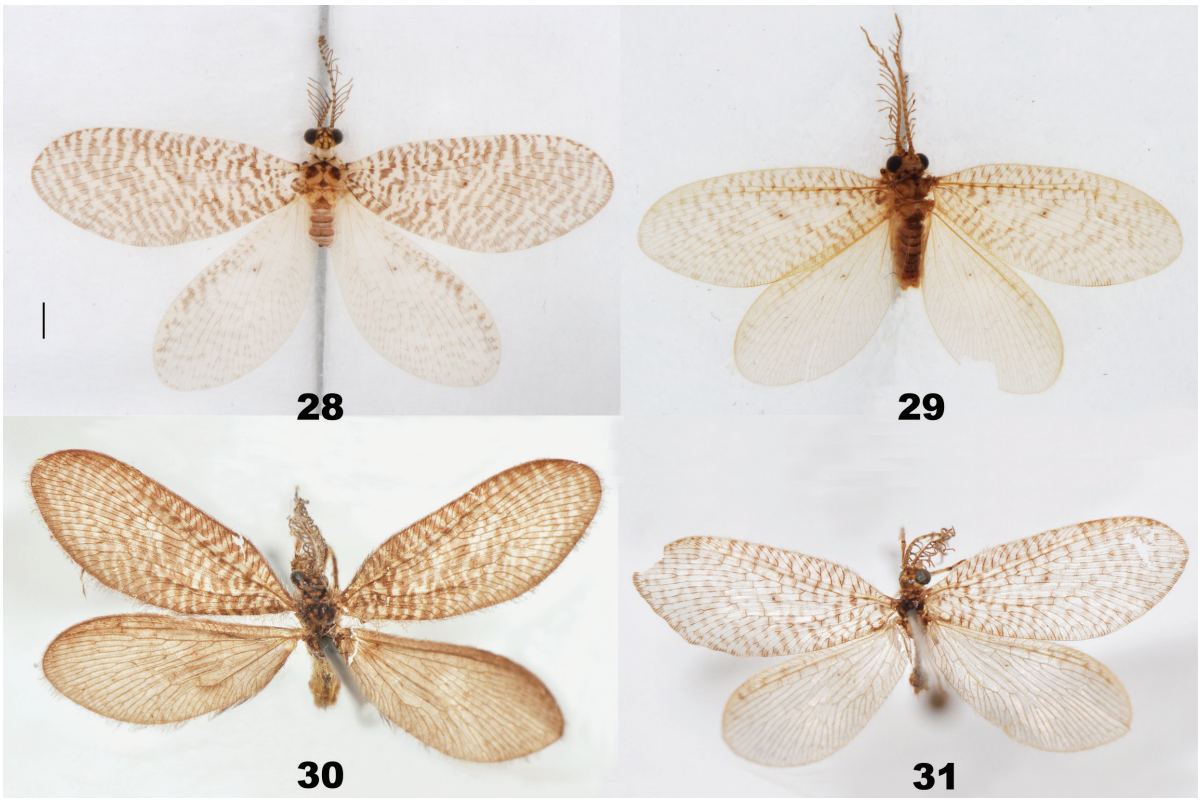
Prothorax pale yellow, pronotum pale yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum yellowish brown on anterior and lateral margins; metanotum yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous yellowish brown stripes. Forewing ~2.2 times as long as wide, proximal stripes slightly darker, arranging as transversely arcuate pattern, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Sc just touching R in pterostigmatic region, terminally leaving several weak veinlets; Rs with four or five main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with four main branches.

Abdomen pale yellowish brown, pregenital segments dorsally dark brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; posteromedial portion protruding into a projection; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriad. Ectoproct in dorsal view nearly truncate distally, with two pairs of claw-like projections, in ventral view posteroventrally with two pairs of unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite rather short and robust with acutely tapering tip; tenth gonocoxite slenderly elongate, slightly longer than ninth gonocoxite, angulately curved anteriorly, posteriorly with obtuse tip, medially with a lobe connecting to ninth gonocoxite; gonarcus slenderly beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum subtriangular, with lateral margins slightly arcuate.

Female. Unknown.



Figures 24–27. *Dilar insularis* sp. n. **24.** Male genitalia, dorsal view; **25.** Male genitalia, ventral view; **26.** Male genitalia, lateral view; **27.** Male ectoproct, caudal view. Scale bars: 0.5 mm.



Figures 28–31. Individual variations of *Dilar* spp. **28, 30.** *D. taiwanensis* Banks, male with dark wings; **29, 31.** same species, male with bright wings. Scale bars: 1.0 mm.

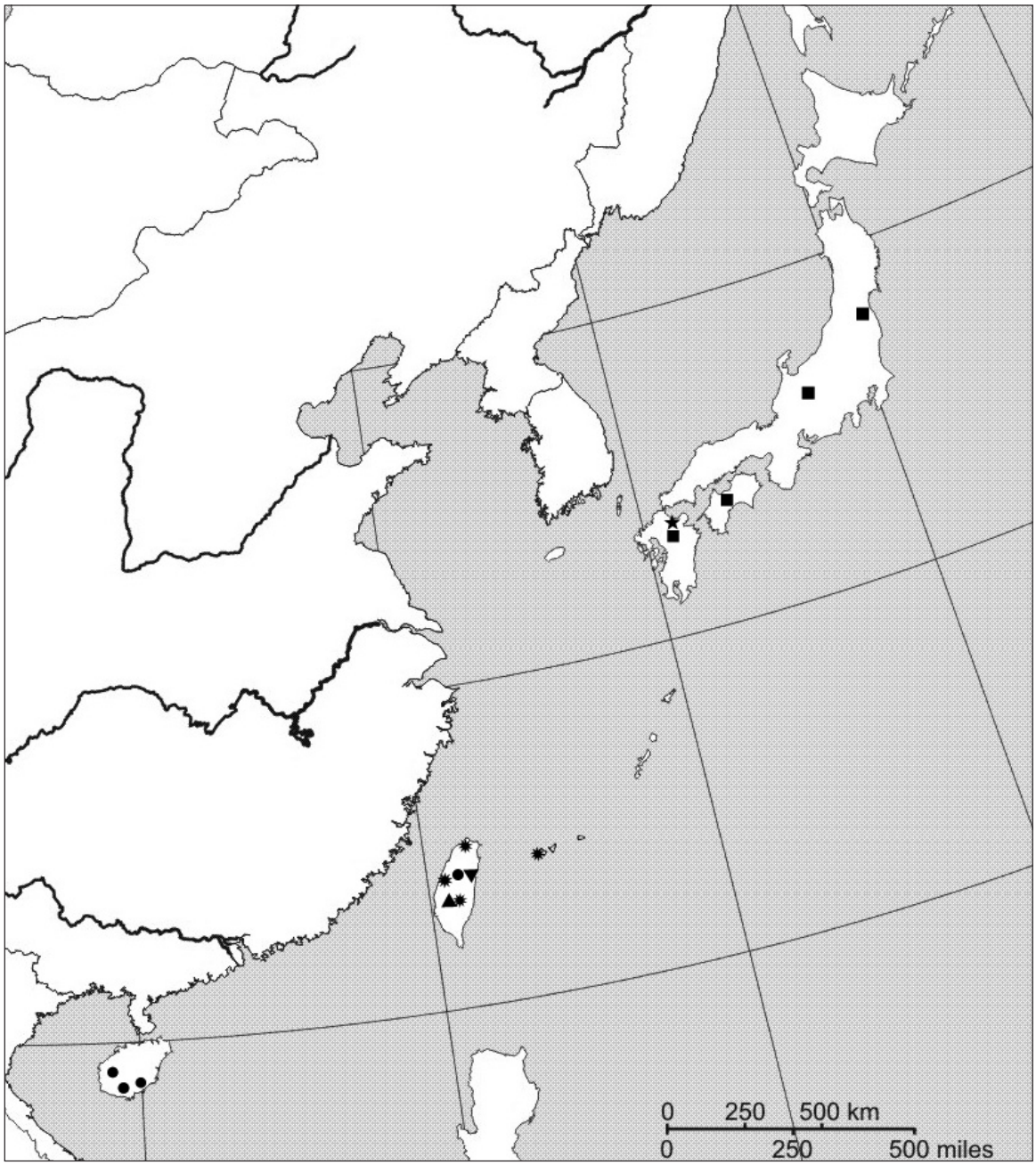


Figure 32. Geographic distribution of the species of *Dilar*. ▲ *Dilar formosanus* (Okamoto & Kuwayama); ★ *Dilar hikosanus* Nakahara; ● *D. insularis* sp. n.; ■ *Dilar japonicus* McLachlan; ▼ *Dilar pallidus* Nakahara; ✸ *Dilar taiwanensis* Banks.

Type materials. Holotype ♂, "CHINA, Hainan, Mt. Wuzhishan [18°46'N, 109°30'E], 1800 m, 23.V.1964, Sikong Liu" (CAU). Paratypes 1♂, CHINA, Hainan, Baisha, Bawangling [19°08'N, 109°15'E], 1300 m, 24.V.2007 (CAU); 1♂, CHINA, Hainan, Lingshui, Mt. Diaoluoshan [18°39'N, 109°54'E], 27.III.1964, Sikong Liu (CAU); 1♂, CHINA, Taiwan, Nantou [23°55'N, 120°40'E], 10.VII.1961, T. Shirogu (NSMT).

Distribution. China (Hainan, Taiwan).

Etymology. The specific epithet "*insularis*" refers to the fact that the new species is endemic to the islands of East Asia: Hainan and Taiwan. It is an adjective in the nominative masculine singular.

Remarks. This species can be easily distinguished from the other *Dilar* species from Taiwan by the male ninth tergite with a posteromedial projection, the male gonocoxite complex 9, 10, 11 with rather inflated and short ninth gonocoxites, and the male ectoproct distally with two pairs of claw-like projections. First, we discovered this new species in several localities on Hainan Island, but subsequently found one specimen of this species in Taiwan, which indicates that this species might be diverged much earlier than the other Taiwanese *Dilar* species when these two large islands were parts of the East Asian mainland.

Discussion

Among the presently described *Dilar* species, the two Taiwanese species (i.e. *D. pallidus* and *D. taiwanensis*) and the two Japanese species (i.e. *D. hikosanus* and *D. japonicus*) are morphologically similar and probably closely related because of the similar structure of the male gonocoxite complex 9, 10, 11, which has a strongly ventrally curved gonocoxite 9 and a proximally bifurcated gonocoxite 10. Based on these characters, the above four insular species appear to be closely related to the mainland species *Dilar septentrionalis* Navás, 1912, which is distributed in northeastern Asia (northeastern China, Korea, and Russia Far East) (Monserrat 1988a, Zhang et al. 2014a). Whether the common ancestor of these four species from the islands invaded the islands and diversified there afterwards or whether the island species result from several invaders remains open at present. Hypotheses on the separation of the islands offshore Eastern Asia have been discussed in the context of several taxa, e.g. Raphidioptera (Liu et al. 2010). The subsequent southern dispersal of the ancestral species from Japan through Ryukyus to Taiwan might account for further separation and the modern distribution of these four insular species.

Dilar insularis sp. n. is remarkably different from the other insular species from Japan and Taiwan, and it seems to be somewhat related to the *Dilar* species ranging in the Himalayas (Zhang et al. 2014b) by having the posteromedial projection of male ninth tergite, suggesting that the speciation of *D. insularis* sp. n. might be correlated with a different vicariance event, possibly the separation of Hainan and Taiwan from the southeastern Chinese mainland.

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