



## Notes on the *Rhyacophila scissa* species group with description of two new taxa from China (Trichoptera, Rhyacophilidae)

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### Abstract

One new species, *R. meniscoides* n. sp., and 1 new subspecies, *R. morsei concaviuscula* n. sp., are described, diagnosed and illustrated. Two diagnostic species complexes within the *R. scissa* Species Group, the *R. scissa* Diagnostic Species Complex and the *R. schismatica* Diagnostic Species Complex, are recognized and delimited. The 15 previously described species and 1 new species and 1 new subspecies described in this article are assigned to the complexes accordingly. Distribution maps of all 17 members in the Species Group are presented.

**Key words:** male genitalia, species complex, distribution map, Oriental Biogeographic Region

### Introduction

The *Rhyacophila scissa* Species Group was erected within Branch 6 by ROSS (1956), with 5 species. SCHMID (1970) divided ROSS' *R. scissa* Species Group into three Species Groups (the *R. burmana*, *R. obscura*, and *R. scissa* Species Groups) and put them in his *R. philopotamoides* Branch (MORSE 2015). The *R. scissa* Species Group (*s. str.*) then contained two species, each with two subspecies (*R. s. scissa* MORTON 1900 and *R. scissa niyampa* SCHMID 1970; *R. s. scissoides* KIMMINS 1953 and *R. scissoides thailandica* SCHMID 1970). Subsequently, 7 Chinese, 2 Nepalese and 2 Vietnamese species were described and were assigned to the Group (SUN & YANG 1995; MALICKY & SUN 2002; KISS 2013; OLÁH 2013). Moreover, OLÁH (2013) raised *R. scissa niyampa* SCHMID 1970 and *R. scissoides thailandica* SCHMID 1970 to species rank. As a result, the *R. scissa* Species Group now includes 15 species.

OLÁH (2013) recognized two species complexes within the group, the *R. scissa* Species Complex (including *R. domba* OLÁH 2013, *R. fides* MALICKY & SUN 2002, *R. homora* OLÁH 2013, *R. niyampa* SCHMID 1970, *R. scissa* MORTON 1900) and the *R. scissoides* Species Complex (including *R. scissoides* KIMMINS 1953, *R. thailandica* SCHMID 1970, *R. eurystheus* MALICKY & SUN 2002, *R. euterpe* MALICKY & SUN 2002, *R. flora* MALICKY & SUN 2002, *R. morsei* MALICKY & SUN 2002, and *R. schismatica* SUN & YANG 1995). However, OLÁH did not present any diagnostic characteristics for the two Species Complexes; moreover, *R. wuyiensis* SUN & YANG 1995, *R. kisszoltani* KISS 2013, and *R. steinmanni* KISS 2013 were not assigned to either complex.

The genus *Rhyacophila* is one of the most speciose caddisfly genera in the world, with about half its members recorded in the Oriental Region (52%), the other half in Holarctic Biogeographic Regions (DE MOOR & IVANOV 2008). The Oriental Biogeographic Region certainly includes most of mainland Southeast Asia, including Myanmar, Thailand, Laos, Vietnam, and Cambodia, along with Borneo and most of the Islands of Indonesia. The northern part of the Oriental Region covers southern China, most of India, Bangladesh, Nepal, Pakistan, and Bhutan. HOFFMANN (2001) considered that the middle altitude foothills of the Himalaya, about 1500–2500 m a.s.l., form the boundary between the Palearctic and Oriental Regions in those countries; moreover, HOFFMANN pointed out that there is a transition zone between the two Regions. Based on an analysis of caddisfly endemism at the family and generic/subgeneric levels and on a comparison of Sorensen's coefficient of biotic similarity among biogeographic regions, DE MOOR and IVANOV (2008) inferred that the Trichoptera distribution patterns may be different from those of Wallace (1876), ascribing southern China to the Palearctic Region as "East Palearctic"

and northern China to a “Beringian” Region. Though the distribution patterns of the aquatic organisms are certainly different from those of the terrestrial organisms, they are affected mainly by the major factors of the landmasses on which they live, such as climate, geology, etc. Furthermore, since the Trichoptera “larvae are almost always aquatic and the adults seldom move far from the water-source on which they are dependent for production of future generations” (DE MOOR & IVANOV 2008), their distribution patterns should follow those of Wallace (1876).

## Material and methods

The specimens studied in this article were collected during expeditions to the Chinese provinces of Guang-dong and Guang-xi in 2004 and to Jiang-xi Province in 2005. Caddisfly adults were collected into 100% ethanol using pan traps with 15-w ultraviolet light tubes set near streams. Rhyacophilid adults were then sorted and stored also in 100% alcohol.

For each genitalia preparation, the male abdomen was cut from the body, as close as possible to the basal region of the abdomen. The separated abdomen with its terminal genitalia was cleared using a 10% sodium hydroxide (NaOH) solution at 80°C for about 30 minutes and transferred into distilled water to flush away the remainder of the NaOH. Then the abdomen was mounted on a depression slide with 85% glycerin for examination.

The structures of the male genitalia were traced in pencil using a Nikon Eclipse 80i microscope equipped with a drawing tube. Original pencil drawings were inked on parchment paper to produce illustrations. Each male abdomen was then transferred to a microvial with 80% ethanol and stored together with the remainder of the specimen in a larger jar.

For the distribution maps, the Chinese Biogeographic Regions of ZHANG (1999) were adopted, and a double-dotted line was drawn on the map to show the boundary between the Palearctic and Oriental (also known as Indomalayan) Regions in China. Locality coordinates for new species described in this article were from collection data, either directly from the locality records, or indirectly by searching the locality description using Google Earth®. Distribution maps were made by QGIS Desktop® free version 2.8.2 for Windows®.

Terminology for male genitalia follows that of SCHMID (1970). Type specimens have been deposited in the Insect Collection, Nanjing Agricultural University.

## Systematics

The *R. scissa* Species Group is characterized by the following characteristics of male genitalia: (1) The apicodorsal lobe of segment IX is short or vestigial; (2) the upper portion of segment X is large, biconcave dorsally and caudally, with the lower portion small and vertical; (3) the anal sclerites are tiny with short roots; (4) the tergal strap is large, in lateral view somewhat triangular, with crinkles; (5) the apical band is slender in lateral view and U-shaped in caudal view; (6) the tenons are slender and connected with relatively broad tendons of the inferior appendages; (7) the aedeagus is simple, tubular, with a tubular dorsal process and a trifurcate ventral plate; (8) each paramere has its basal half membranous, its distal half bulging and covered with dense spines; and (9) the second joint of each inferior appendage is divided into an upper branch and a lower one.

Two diagnostic species complexes (without implication of monophyly) are recognized in this research based on characteristics of male genitalia, mainly features of segment X and the inferior appendages, as OLÁH (2013) indicated that the shapes of segment X and the inferior appendages can be used to diagnose the members of the Group effectively. The first one, the *R. scissa* Diagnostic Species Complex was created by OLÁH (2013), but is redefined in this research. The second complex, the *R. schismatica* Diagnostic Species Complex is first recognized here, for its members share characteristics in segment X and the inferior appendages that are different from those of the *R. scissa* Diagnostic Species Complex.

### *R. scissa* Diagnostic Species Complex

The *R. scissa* Diagnostic Species Complex can be distinguished by the following male genitalic characteristics: (1)

segment X in dorsal view has its apex deeply incised; (2) the upper branch of the second joint of each inferior appendage is slender, about 1/3 as wide as the lower branch. This Complex contains 9 previously described species.

Seven species of the Complex are distributed without doubt in the Oriental Region (Fig. 1). Two Nepalese species, *R. steinmanni* at an elevation of 1850 m and *R. kisszoltani* at 2835 m (KISS 2013), occur only in HOFFMANN's (2001) transition zone.

### ***Rhyacophila domba* OLÁH 2013**

*Rhyacophila domba* OLÁH, 2013, 90–92, figs. 91–93, male.

**Distribution.** Vietnam (Tam Dao).

### ***Rhyacophila fides* MALICKY & SUN 2002**

Figs. 2A–I

*Rhyacophila fides* MALICKY & SUN, 2002, 544, plate 2, male.

**Materials examined.** CHINA: **Guang-dong Province**, Luo-fu-shan, Gui-shan, Ye-qu-gou, 18 km southwest of He-yuan city, 400 m upstream of Xiang-shui-ping Falls, 23.7021°N, 114.609°E, elev. 350 m, 29 May 2004, collected by John C. MORSE, SUN Chang-hai and ZHOU Xin, 4 males; Ru-yuan County, Nan-ling National Nature Preserve, unnamed tributary of Lao-peng-keng, Route X327, marker 17.45km, 24.9128°N, 113.0342°E, elev. 935 m, 21–22 May 2004, collected by John C. MORSE and SUN Chang-hai; Wu-hua County, Qi-mu-zhang-shan, 9 km northeast of Da-tian town, east fork of unnamed stream 300 m upstream, 23.8303°N, 115.3794°E, elev. 426 m, 30 May 2004, collected by YANG Lian-fang, John C. MORSE, SUN Chang-hai and Christy J. GERACI, 2 males. **Guang-xi Province**, Hua-jiang County, Jiu-wan-da-shan Provincial Nature Preserve, unnamed tributary of Yang-mei-ao stream, 100 m upstream of County Road 5309 marker 124.9 km, 25.1975°N, 108.6494°E, elev. 1155 m, 15 June 2004, collected by John C. MORSE and Christy J. GERACI 1 male; Shang-si County, Shi-wan-da-shan National Forest Park, Shi-tou-he stream at second tributary, 3.4 km southwest of main entrance to Park, 21.8921°N, 107.9073°E, elev. 392 m, 6 Jun 2004, collected by YANG Lian-fang and Christy J. GERACI, 1 male. **Jiang-xi Province**, Jiu-lian-shan National Nature Reserve, unnamed tributary 1 of Xia-gong-tang stream, 24.5347°N, 114.4689°E, elev. 630 m, 7 June 2005, collected by ZHOU Xin and SUN Chang-hai, 1 male; Wu-yi-shan National Nature Reserve, Tong-mu river upstream of Wu-yi-shan Station, 27.8338°N, 117.7194°E, elev. 989 m, 1 June 2005, collected by SUN Chang-hai, 4 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 18 km upstream of Wu-yi-shan Station, 27.8275°N, 117.7436°E, elev. 1450 m, 2 June 2005, collected by SUN Chang-hai, 2 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 17 km upstream of Wu-yi-shan Station, 27.8342°N, 117.7386°E, elev. 1105 m, 2 June 2005, collected by YANG Lian-fang, 1 male; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 13 km upstream of Wu-yi-shan Station, 27.8178°N, 117.7269°E, elev. 1181 m, 2 June 2005, collected by ZHOU Chang-fa, 4 males. **Zhe-jiang Province**, Lin-an County, Mt. Tian-mu-shan, at scenic spot of Bing-chuan Gorge, Xian-yuan-tan pond, 30.3687°N, 119.4345°E, elev. 721m, 27 July 2011, light trap, collected by XU Ji-hua and LI Dan, 1 male.

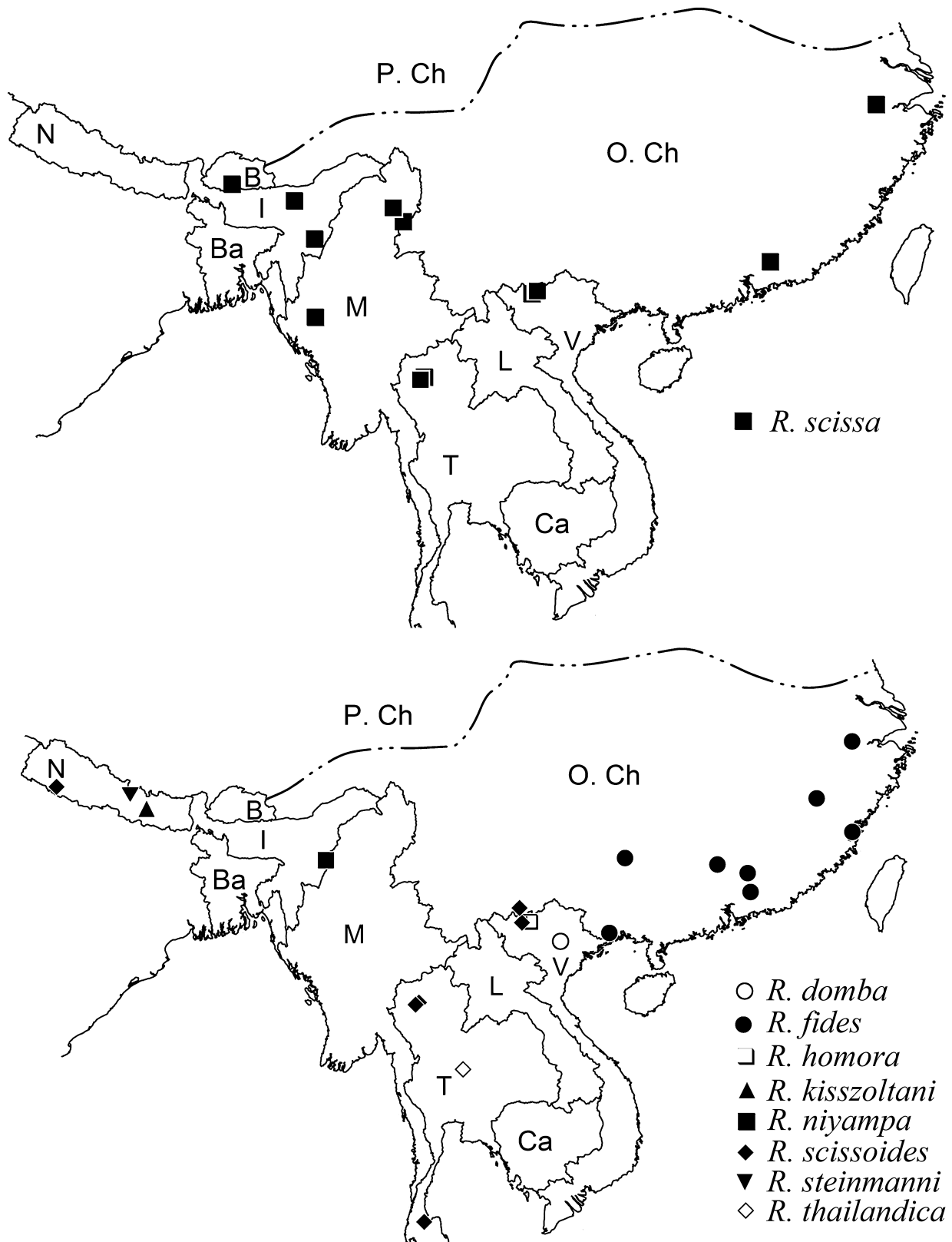
**Distribution.** China (Guang-dong, Guang-xi, Jiang-xi, Zhe-jiang).

**Remarks.** The individuals of this species from different localities show some tiny variations in the shapes of segment X and the upper lobe of the apical joint of each inferior appendage, but their phallic apparatus is identical with that of the holotype. Illustrations for the variations are presented here (Fig. 2).

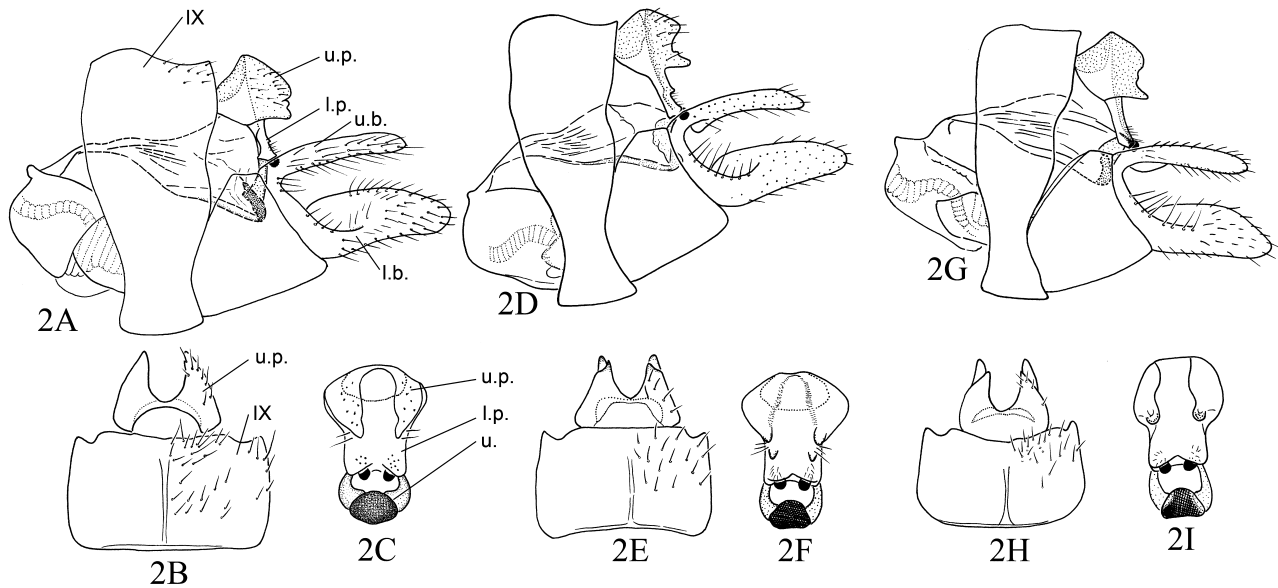
### ***Rhyacophila homora* OLÁH 2013**

*Rhyacophila homora* OLÁH, 2013, 93–94, figs. 98–100, male.

**Distribution.** Vietnam (Lao Cai).



**FIGURE 1.** Distribution map of species in the *Rhyacophila scissa* Diagnostic Species Complex of the *R. scissa* Species Group. B = Bhutan; Ba = Bangladesh; Ca = Cambodia; Ch = China (P. Ch = Palaearctic China, O. Ch = Oriental China); I = India; L = Laos; M = Myanmar; N = Nepal; T = Thailand; V = Vietnam. — · — = boundary between the Palaearctic and Oriental Regions in China. Most of Palaearctic China is omitted in the map.



**FIGURE 2.** Variations in male genitalia of *Rhyacophila fides* individuals from different localities. 2A, 2D, 2G, left lateral; 2B, 2E, 2H, segments IX and X, dorsal; 2C, 2F, 2I, segment X, caudal; 2A–2C, Guang-xi; 2D–2F, Jiang-xi; 2G–2I, Guang-dong. IX= segment IX; l.b. = lower branch of an inferior appendage; l.p. = lower portion of segment X; u. = apical band; u.b. = upper branch of an inferior appendage; u.p. = upper portion of segment X.

### ***Rhyacophila kisszoltani* KISS 2013**

*Rhyacophila kisszoltani* KISS 2013, 218–221, figs. 13–18, male.

**Distribution.** Nepal (Kalinchok, Yamphudin).

### ***Rhyacophila niyampa* SCHMID 1970**

*Rhyacophila scissa niyampa* SCHMID 1970, 123, 150, Pl. 24 fig. 14, male.

*Rhyacophila niyampa* SCHMID 1970; OLÁH 2013, 91, elevated to species rank.

**Distribution.** India (Manipur).

### ***Rhyacophila scissa* MORTON 1900**

*Rhyacophila scissa* MORTON 1900, 5–6, Pl. 1 figs. 15–16, male and female; ULMER 1926 (“1925”), 24–26, fig. 7, male; KIMMINS, 1953, 518–519, figs. 10, 11a–c, male and female; ARMITAGE & AREFINA 2003, 119–120, figs. 21, 22, male and female; ARMITAGE, et al. 2005, 26, list; MEY 2005, 280, list; MALICKY 2007, 477, list; YANG et al. 2005, 460, list; OLÁH & MALICKY 2010, 14, list; BUNLUE et al. 2012, 15, list; WITYI et al. 2015, 52, list.

*Rhyacophila scissa scissa* MORTON 1900; SCHMID 1970, 149, Pl. 24 figs. 9–13.

**Material examined.** CHINA: **Zhe-jiang Province**, Lin-an county, Mt. Tian-mu-shan, at scenic spot of Bingchuan Gorge, Xian-yuan-tan pond, 30.36°N, 119.43°E, elev. 723m, 27 July 2011, light trap, collected by SUN Chang-hai, 1 male.

**Distribution.** China (Guang-dong, Zhe-jiang); Bhutan (Tsirang); India (Himalaya, Khasi Hills, Manipur); Myanmar (Kambaiti); Thailand (Doi Suthep-Pui and Doi Inthanon National Parks); Vietnam (Fan Si Pan, Lào Cai, Tamdo).

### ***Rhyacophila scissoides* KIMMINS 1953**

*Rhyacophila scissoides* KIMMINS 1953, 520, figs. 11d–f, male; SUN & YANG 1995, 32, list and comparison with *R. schismatica*

SUN & YANG 1995; ARMITAGE et al. 2005, 26, list; MEY 2005, 280, list; YANG et al. 2005, 460, list; MALICKY 2006, 252, list; LAUDEE & PROMMI 2011, 281, list; BUNLUE et al. 2012, 15, list; KISS 2013, 216, list.

*Rhyacophila scissoides scissoides* KIMMINS 1953; SCHMID 1970, 52, 123, 150.

**Distribution.** China (Yun-nan); India (Himalaya, Khasi Hills, Manipur, Lushai Hills); Vietnam (Fan Si Pan); Nepal (Bardia National Park); Thailand (Doi Suthep-Pui and Doi Inthanon National Parks, Surat Thani).

***Rhyacophila steinmanni* KISS 2013**

*Rhyacophila steinmanni* KISS 2013: 218, figs. 7–12, male.

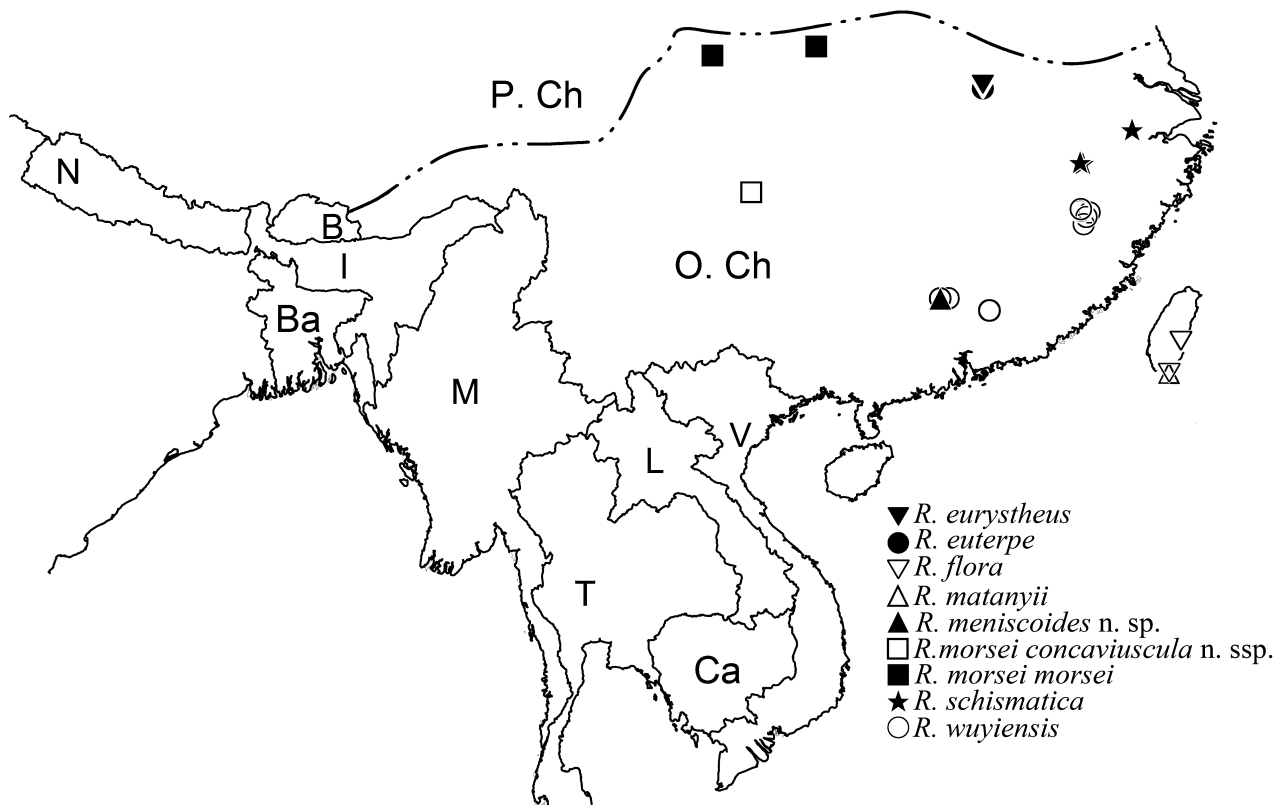
**Distribution.** Nepal (Ganesh Himal).

***Rhyacophila thailandica* SCHMID 1970**

*Rhyacophila scissoides thailandica* SCHMID 1970, 123, 150, Pl. 24 figs.15–18, male.

*Rhyacophila thailandica* SCHMID 1970; OLÁH 2013, 91, elevated to species rank.

**Distribution.** Thailand (Siam).



**FIGURE 3.** Distribution map of the *Rhyacophila schismatica* Diagnostic Species Complex of the *R. scissa* Species Group. B = Bhutan; Ba = Bangladesh; Ca = Cambodia; Ch = China (P. Ch = Palaeartic China, O. Ch = Oriental China); I = India; L = Laos; M = Myanmar; N = Nepal; T = Thailand; V = Vietnam. — · · — = boundary between the Palearctic and Oriental Regions in China. Most of Palaeartic China is omitted in the map.

***R. schismatica* Diagnostic Species Complex**

The *R. schismatica* Diagnostic Species Complex can be distinguished by the following male genitalic characters: (1) Segment X in dorsal view has its apex shallowly incised, or straight or slightly convex distally; (2) the upper

branch of the second joint of each inferior appendage is broad, at least 1/2 as wide as the lower branch or the same width as the lower branch in some species. It now contains 7 previously described species and 1 new species and 1 new subspecies. All members (including 1 new species and 1 new subspecies) occur in China, with *R. morsei morsei* distributed in the most northern part of the Oriental Biogeographic Region (Fig. 3).

***Rhyacophila eurystheus* MALICKY & SUN 2002**

*Rhyacophila eurystheus* MALICKY & SUN 2002, 544, Pl. 2, male.

**Distribution.** China (He-nan).

***Rhyacophila euterpe* MALICKY & SUN 2002**

*Rhyacophila euterpe* MALICKY & SUN 2002, 544, Pl. 2, male.

**Distribution.** China (He-nan).

***Rhyacophila flora* MALICKY & SUN 2002**

*Rhyacophila flora* MALICKY & SUN 2002, 543, Pl. 2, male and female.

**Distribution.** China (Tai-wan).

***Rhyacophila matanyii* KISS 2013**

*Rhyacophila matanyii* KISS 2013, 216–217, figs. 1–6, male.

**Distribution.** China (Tai-wan).

**Remarks.** This species was considered as a synonym of *R. flora* by Malicky (2014), but it has some differences from *R. flora* in the shapes of segment X, the ventral plate of the aedeagus, and the upper branch of the apical joint of each inferior appendage. It is probably a distinct species.

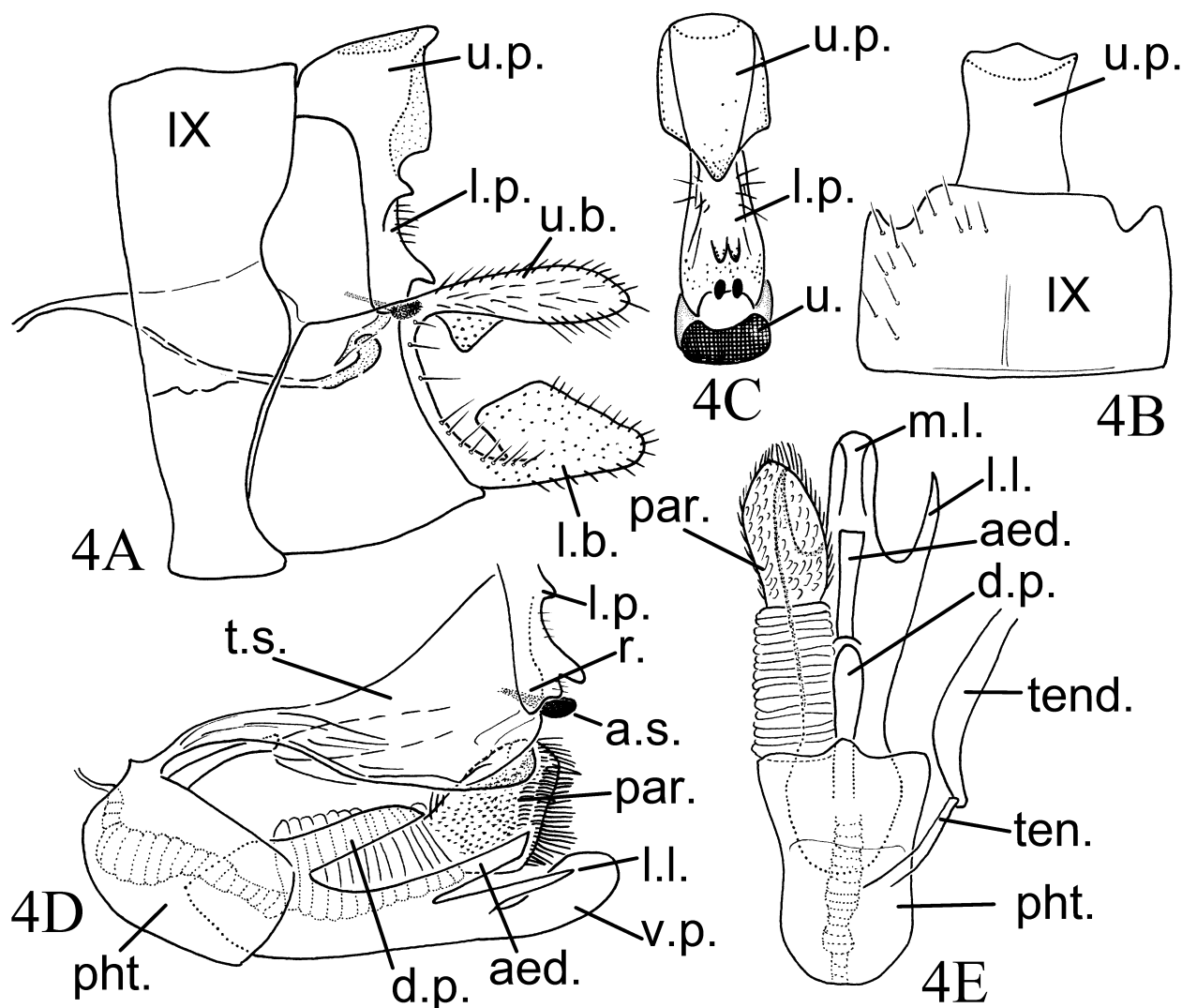
***Rhyacophila meniscoides* n. sp.**

Figs. 4A–E

Length of each forewing 6.0 mm. Body (in alcohol) yellowish brown. Head yellowish brown; antennae pale, each flagellum with brown ring; palpi light brown. Thorax yellowish brown dorsally and yellow lateral and ventrally; legs yellowish brown, spurs dark brown; wings yellowish brown. Abdomen dark brown dorsally and pale ventrally.

**Male genitalia.** Segment IX (IX) with upper portion longer than its lower portion in lateral view (Fig. 4A), upper margin nearly straight, anterior margin straight, posterior margin sinuate; rectangular in dorsal view (Fig. 4B), wider than long. Segment X in dorsal view subrectangular (Fig. 4B), its apex slightly convex; upper portion (u.p.) large, shallowly biconcave dorsomesally and caudally, in lateral view irregular (Fig. 4A); lower portion (l.p.) vertical, slender, base and subapex produced into pair of small lobes, lower margin shallowly concave in caudal view (Fig. 4C). Anal sclerites (a.s.) small, button-like, with long roots (r.). Apical band (u.) irregular in lateral view (Figs. 4A, 4D), nephroid in caudal view (Fig. 4C), with lateral arms curved. Tergal strap (t.s.) in lateral view triangular (Fig. 4D), with its base slender and progressively enlarged to distal end. First joint of each inferior appendage trapezoidal in lateral view (Fig. 4A), dorsal margin about 2/3 as long as ventral margin, distal margin slightly concave; second joint separated into two branches in lateral view (Fig. 4A): Upper branch (u.b.) clavate with triangular tooth at inner base, lower branch (l.b.) short, trapezoidal. Phallic apparatus complicated: Phallic sheath (pht.) rectangular in lateral view (Fig. 4D), cup-shaped in dorsal view (Fig. 4E) with posterior margin produced in middle; dorsal process (d.p.) and aedeagus (aed.) tube-like, equal in length but dorsal process thicker than aedeagus; ventral plate (v.p.) of aedeagus trifurcate, middle lobe (m.l.) broad with round apex, pair of lateral

lobes (l.l.) pointed and slightly shorter than middle lobe. Single paramere (par.) large, its base membranous, distal half in lateral view triangular with apical fringe of setae.



**FIGURE 4.** Male genitalia of *Rhyacophila meniscoides* n. sp. 4A, left lateral; 4B, segments IX and X, dorsal; 4C, segment X, caudal; 4D, apical band, tergal strap, and phallic apparatus, left lateral; 4E, phallic apparatus, dorsal. a.s. = anal sclerite; aed. = aedeagus; d.p. = dorsal process of aedeagus; IX = segment IX; l.b. = lower branch of an inferior appendage; l.l. = lateral lobe of ventral plate of aedeagus; l.p. = lower portion of segment X; m.l. = middle lobe of ventral plate of aedeagus; par. = paramere; pht. = phallosome; r. = root; t.s. = tergal strap; ten. = tendon of phallosome; tend. = tendon of an inferior appendage; u. = apical band; u.b. = upper branch of an inferior appendage; u.p. = upper portion of segment X; v.p. = ventral plate of aedeagus.

**Diagnosis.** The new species is similar to *R. flora* in male genitalia, but differs from the latter in that (1) the upper portion of segment X in lateral view is shallowly biconcave dorsomesally and caudally (deeply biconcave in *R. flora*); (2) the dorsal apex of the upper portion of segment X in dorsal view is slightly convex mesally (straight in *R. flora*); (3) the lower portion of segment X in lateral view has its base and subapex each produced into a pair of lobes (only the subapex is produced into a pair of lobes in *R. flora*); (4) the upper lobe of the second joint of each inferior appendage has a small triangular tooth (this tooth is obviously larger in *R. flora*).

**Holotype.** Male: **CHINA: Guang-dong Province, Lian-zhou County, Nan-ling Nature Preserve, Da-dongshan Management Station, Mao-ping stream at unnamed tributary, 1 km upstream of Shuang-shui Power Station, 24.9244°N, 112.7169°E, elev. 695 m, 19 May 2004, collected by John C. MORSE, ZHOU Xin, and Christy J. GERACI.**

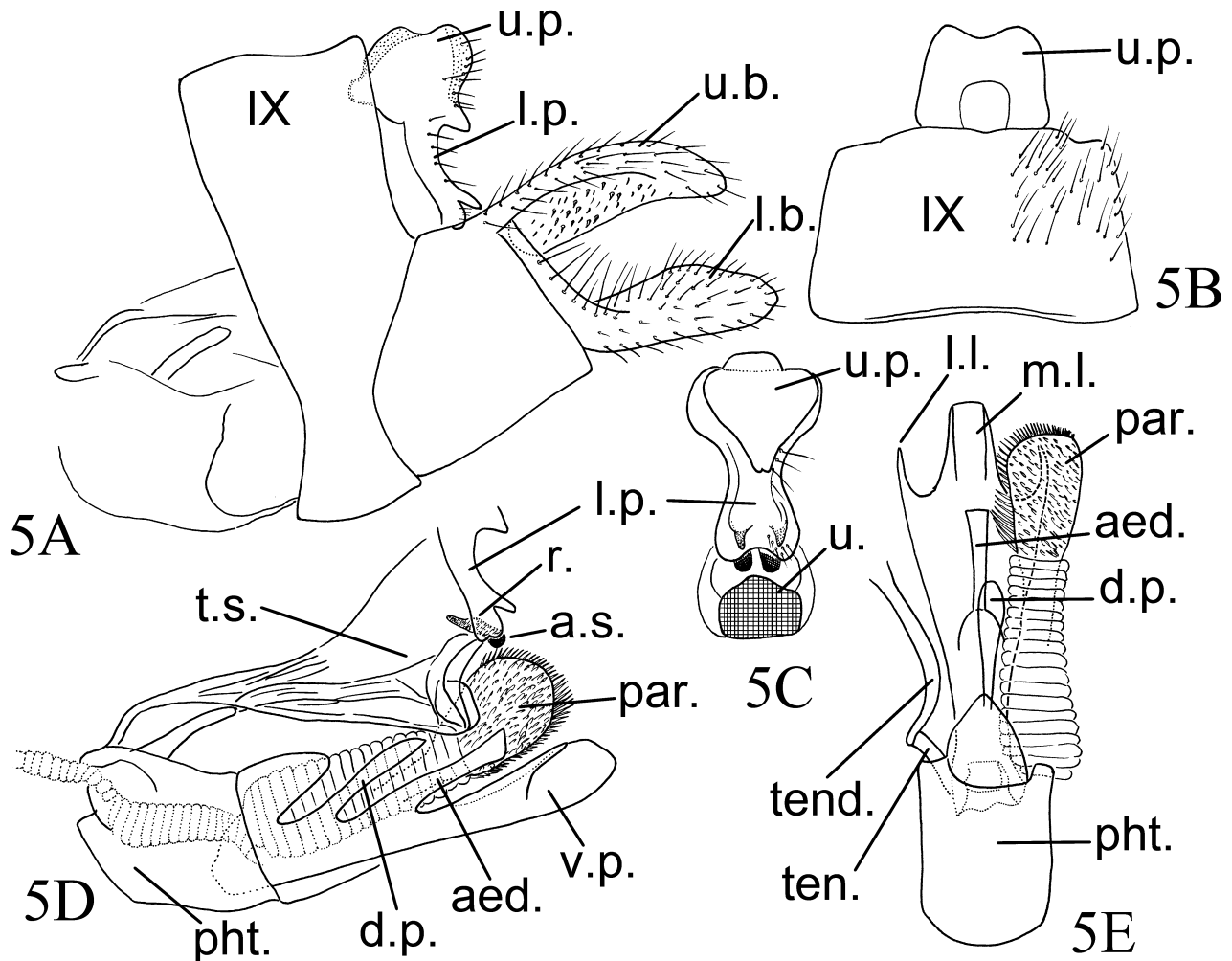
**Etymology.** The species name is the Latin word *meniscoides*, meaning “like a crescent,” in reference to the apical band which is somewhat crescentic in caudal view.



*Rhyacophila morsei concaviuscula* n. ssp.

Figs. 5A–E

Length of each forewing 8.0 mm. Body (in alcohol) yellowish brown. Head yellowish brown; antennae yellow, palpi brown. Thorax yellowish brown dorsally and light brown laterally and ventrally; legs yellowish brown, spurs dark brown; wings light brown. Abdomen dark brown dorsally and yellowish brown ventrally.



**FIGURE 5.** Male genitalia of *Rhyacophila morsei concaviuscula* n. ssp. 5A, left lateral; 5B, segments IX and X, dorsal; 5C, segment X, caudal; 5D, apical band, tergal strap, and phallic apparatus, left lateral; 5E, phallic apparatus, dorsal. a.s. = anal sclerite; aed. = aedeagus; d.p. = dorsal process of aedeagus; IX = segment IX; l.b. = lower branch of inferior appendage; l.l. = lateral lobe of ventral plate of aedeagus; l.p. = lower portion of segment X; m.l. = middle lobe of ventral plate of aedeagus; par. = paramere; pht. = phallosome; r. = root; t.s. = tergal strap; ten. = tenon of phallosome; tend. = tendon of inferior appendage; u. = apical band; u.b. = upper branch of inferior appendage; u.p. = upper portion of segment X; v.p. = ventral plate of aedeagus.

**Male genitalia.** Segment IX (IX) with upper portion longer than its lower portion in lateral view (Fig. 5A), upper margins slightly sinuate, each anterior margin almost straight with shallow incision in lower part, upper half of posterior margin straight and lower half shallowly incised; trapezoidal in dorsal view (Fig. 5B), with its anterior margin slightly concave, posterior margin irregularly convex, wider than long. Segment X in dorsal view subrectangular (Fig. 5B), apex shallowly incised; upper portion (u.p.) large, shallowly biconcave anterodorsally and posteriorly in lateral view (Fig. 5A), somewhat saddle-like, dorsal margin sinuate, posteroventral angles produced into pair of small lobes; lower portion (l.p.) vertical, slender in lateral and caudal views (Figs. 5A, 5C, 5D), with pair of small subapical lobes, lower margins shallowly concave in caudal view. Anal sclerites (a.s.) small, button-like, with long roots (r.). Apical band (u.) irregular in lateral view (Fig. 5D), pentagonal in caudal view with lateral arms curved (Fig. 5C). Tergal strap (t.s.) in lateral view triangular (Fig. 5D), with its base fine and

progressively enlarged to distal end. First joint of each inferior appendage trapezoidal, dorsal margin about half as long as ventral margin, distal margin straight in lateral view (Fig. 5A); second joint separated into two branches with equal width and rounded apices in lateral view. Phallic apparatus complicated: Phalotheca (pht.) rectangular; dorsal process (d.p.) and aedeagus (aed.) in lateral view (Fig. 5D) tube-like and equal in length and width, in dorsal view dorsal process progressively wider from base to distal end; ventral plate of aedeagus trifurcate, with middle lobe (m.l.) broad and apically truncate, pair of lateral lobes (l.l.) pointed and slightly shorter than middle lobe. Paramere (par.) large, its base membranous, distal half in lateral view somewhat elliptical, with dense fringe of setae apically.

**Holotype.** Male: **CHINA: Gui-zhou Province**, Chi-shui city, Hu-shi town, Nan-zhu-lin-fang subdivision, Jin-sha-gou work area, Gan-gou, 28.4734°N, 106.0056°E, elev. 460 m, 9 June 1995, collected by WANG Bei-xin and SUN Chang-hai.

**Diagnosis.** The male genitalia of the new subspecies are very similar to those of the more northern *R. morsei morsei*, but differ from the latter in that (1) the upper portion of segment X in lateral view has its dorsal margin slightly sinuate (almost straight in *R. morsei morsei*); (2) the upper portion of segment X in dorsal view is as wide as long (obviously wider than long in *R. morsei morsei*).

**Etymology.** The specific epithet is the Latin word *concauiusculus*, meaning “slightly concave” in reference to the upper portion of segment X with a shallow concavity in lateral view.

**Distribution.** China (Gui-zhou).

### ***Rhyacophila morsei morsei* MALICKY & SUN 2002**

*Rhyacophila morsei* MALICKY & SUN 2002, 543, Pl. 2, male.

**Distribution.** China (Gan-su, Shaan-xi).

### ***Rhyacophila schismatica* SUN & YANG 1995**

*Rhyacophila schismatica* SUN & YANG 1995, 27–28, fig. 2, male; WANG et al. 1998, 151, list; YANG et al. 2001, 506, list; SUN 2014, 236, list.

**Distribution.** China (Jiang-xi, Zhe-jiang).

### ***Rhyacophila wuyiensis* SUN & YANG 1995**

*Rhyacophila wuyiensis* SUN & YANG 1995, 27, fig. 1, male; LI et al. 1999, 408–409, fig.12, male.

**Material examined.** **CHINA: Jiang-xi Province**, Wu-yi-shan National Nature Reserve, Tong-mu river at Wu-yi-shan Station, 27.8453°N, 117.7269°E, elev. 900 m, 1 June 2005, collected by YANG Lian-fang, 10 males, 4 females; Wu-yi-shan National Nature Reserve, Tong-mu river upstream of Wu-yi-shan Station, 27.8333°N, 117.7194°E, elev. 989 m, 1 June 2005 collected by SUN Chang-hai, 23 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 13 km upstream of Wu-yi-shan Station, 27.8177°N, 117.7267°E, elev. 1181 m, 2 June 2005, collected by ZHOU Chang-fa, 15 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 27.83973°N, 117.7224°E, elev. 943 m, 3 June 2005, collected by ZHOU Chang-fa, 12 males; Wu-yi-shan National Nature Reserve, Tong-mu river at Dong-keng-cun Village, Huang-gang-shan Town, 27.86586°N, 117.73821°E, elev. 796 m, 1 Jun 2005, collected by ZHOU Xin and Christy J. GERACI, 1 male, 2 females; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 27.8492°N, 117.7314°E, elev. 877 m, 3 June 2005, collected by YANG Lian-fang, 18 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 18 km upstream of Wu-yi-shan Station, 27.8275°N, 117.7436°E, elev. 1450 m, 2 June 2005, collected by SUN Chang-hai, 2 males; Wu-yi-shan National Nature Reserve, unnamed tributary of Tong-mu river, 27.8969°N, 117.7226°E, elev. 930 m, 3 June 2005, collected by SUN Chang-hai, 20 males; Jiu-lian-shan National Nature Reserve, unnamed tributary of Xia-gong-tang Stream, 24.5347°N, 114.46889°E, elev. 630 m, 7 June 2005, collected by ZHOU Xin and SUN Chang-hai, 10 males; Jiu-lian-shan National Nature Reserve, tributary of Da-qiu-tian River, Xia-gong-tang stream at Jiu-lian-shan station hotel, 24.54056°N, 114.4661°E, elev. 590 m, 7

June 2005, collected by YANG Lian-fang and Christy J. GERACI, 3 males, 2 females; Jiu-lian-shan National Nature Reserve, unnamed tributary 2 of Xia-gong-tang stream, 24.5347°N, 114.4689°E, elev. 640 m, 7 June 2005, collected by ZHOU Chang-fa, 2 males. **Guang-dong Province**, Lian-zhou County, Nan-ling Nature Preserve, Da-dong-shan Management Station, Mao-ping stream at unnamed tributary, 1 km upstream of Shuang-shui Power Station, 24.9244°N, 112.7169°E, elev. 695 m, 19 May 2004, collected by John C. MORSE, ZHOU Xin and Christy J. GERACI, 4 males; Lian-zhou County, Nan-ling National Nature Preserve, Da-dong Shan Management Station, Shuang-shui Power Station, Jia-shui stream about 250 m below dam, 24.9314°N, 112.7139°E, elev. 670 m, 19 May 2004, collected by YANG Lian-fang, TONG Xiao-li and SUN Chang-hai, 1 male, 1 female; Ru-yuan County, Nan-ling National Nature Preserve, Lao-peng-keng at cascading tributary, Route X327, marker 22.5 km, 24.9343°N, 113.0095°E, elev. 1110 m, 18–19 May 2004, collected by John C. MORSE, TONG Xiao-li and ZHOU Xin, 13 males; Ru-yuan County, Nan-ling National Nature Preserve, Lao-peng-keng Field Station, Route X327, marker 21.5 km, Lao-peng-keng, 24.9292°N, 113.0158°E, elev. 1010 m, 21 May 2002, collected by ZHOU Xin and Christy J. GERACI, 2 males, 4 females; Ru-yuan County, Nan-ling National Nature Preserve, unnamed tributary of Lao-peng-keng, Route X327, marker 17.45 km, 24.9128°N, 113.0342°E, elev. 935 m, 21–22 May 2004, collected by John C. MORSE and SUN Chang-hai, 2 males.

**Distribution.** China (Fu-jian, Guang-dong, Jiang-xi).

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