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Two new species of the *Rhyacophila anatina* Species Group from China (Trichoptera: Rhyacophilidae)

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Abstract

Two new species of the *Rhyacophila anatina* Species Group, *R. coalita* **n. sp.** and *R. bicaudata* **n. sp.** are described, diagnosed and illustrated. *Rhyacophila coalita* **n. sp.** is somewhat similar to *R. yipung* SCHMID and *R. elongata* KIMMINS in the male genitalia, but can be distinguished from them by the deep incision at the apex of the dorsal process of the aedeagus, fused anal sclerites, and a pair of membranous bulbs at the middle of the aedeagus. *Rhyacophila bicaudata* **n. sp.** is similar to *R. triangularis* SCHMID in male genitalia, but can be diagnosed by the longer preanal appendages, the slightly incised posteroventral margins of preanal appendages, and a gradually narrowed apicodorsal lobe of segment IX.

Key words: taxonomy, male genitalia, Oriental Biogeographic Region, distribution, Guang-dong, Jiang-xi

Introduction

The *Rhyacophila anatina* Species Group was first recognized by ROSS in his Branch 1 with only one species, *R. anatina* from India (ROSS 1956). SCHMID (1970) included the group with 17 species in his *R. vulgaris* Branch. Afterwards, 17 species were added to the group by various authors (DENNING & SCHMID 1971; OLÁH 1987; MALICKY & CHANTARAMONGKOL 1993; MEY 1996, 1998; SUN & YANG 1998; MALICKY & SUN 2002; MALICKY *et al.* 2004; KAUR & SAINI 2012; LAUDEE & MALICKY 2015; MORSE 2015). As a result, 34 members of the species group are now recognized, distributed in the Oriental (31 spp.) and Palearctic (3 spp.) Biogeographic Regions (Table 1).

Rhyacophila anatina MORTON 1900 was reported in China (Fu-jian, Fu-zhou) by MOSELY (1942). Although those specimens treated as *R. anatina* showed some differences from the illustrations of the type specimens, MOSELY considered "these differences are scarcely sufficient to indicate a distinct species." For that reason, YANG *et al.* (2003) also considered that *R anatina* is distributed in China. However, SCHMID (1970) pointed out that MOSELY's "*R. anatina*" was actually *R. furcata* HWANG 1957 [the name was preoccupied by DZIEDZIELEWICZ (1910) and was renamed *R. falcifera* by SCHMID]. Therefore I exclude here *R. anatina* from the Chinese Trichoptera fauna.

To date, there are 8 species of the group occurring in China. Among these, *R. nephroida* is the only species with a distribution extending south to Vietnam (ARMITAGE *et al.* 2005; MEY 2005). The other 7 species are all endemic to Oriental China. In this article, 2 new species of the group are described: *R. coalita* **n. sp.** and *R. bicaudata* **n. sp.**, both from Jiang-xi and Guang-dong Provinces. The additions bring the global number of species in the group to 36 and the Chinese species to 10.

The *R. anatina* Species Group can be diagnosed by the following characters: segment IX is short ventrally; the apicodorsal lobe of segment IX is strong and bilobed; the preanal appendages are large and closely joined to the apicodorsal lobe; segment X is vertical; the anal sclerites are usually paired, without roots; the apical band is strongly sclerotized with its two lateral arms not joined to each other at the base; the tergal band is short and membranous; the basal segments of the inferior appendages are usually long, and the apical segments are short; the phallotheca is cylindrical and the endotheca well developed; the aedeagus is slender, tubular; parameres are slender, with the distal ends heavily bristled.

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TABLE 1. Members of the *Rhyacophila anatina* species group.

Rhyacophila anatina Morton 1900	India (Assam, Sikkim)
R. bicaudata **n. sp.**	China (Guang-dong, Jiang-xi)
R. bhotia Schmid 1970	India (Teri Garhwal)
R. bilobata Ulmer 1907	Japan (Honsu)
R. coalita **n. sp.**	China (Guang-dong, Jiang-xi)
R. dongkyapa Schmid 1970	India (Assam); Nepal; Bhutan (Wangdue Phodrang)
R. drotangpa Schmid 1970	India (Sikkim)
R. elongata Kimmins 1953	Myanmar (Kambaiti)
R. falcifera Schmid 1970	China (Fu-jian, Zhe-jiang, Tai-wan)
R. himachalensis Kaur & Saini 2012	India (Himachal Pradesh, Uttarakhand)
R. hoabinha Oláh 1987	Vietnam (Hoabinh, Nghta Binh)
R. hoangliensis Mey 1998	Vietnam (Lao Cai)
R. hydaspica Schmid 1959	Pakistan (Muzaffarabad); Nepal
R. incudis Mey 1996	Vietnam (Fan Si Pan)
R. kadampa Schmid 1970	India (Manipur)
R. lhadzongpa Schmid 1970	India (Assam)
R. mahunkai Oláh 1987	Vietnam (Fan Si Pan, Tamdao)
R. manipuri Schmid 1970	India (Manipur)
R. moneta Malicky & Changthong 2004	Thailand (Pitsanulok)
R. multispinomera Sun & Yang 1998	China (Yun-nan)
R. myrmidone Malicky & Nawvong 2004	Thailand (Phrae)
R. nagongpa Schmid 1970	India (Assam)
R. nanpingensis Sun & Yang 1998	China (Sichuan)
R. nephroida Sun & Yang 1998	China (Yun-nan); Vietnam (Fan Si Pan)
R. noeibia Malicky & Chantaramongkol 1993	Thailand (Phuket)
R. pacata Tsuda 1940	Japan (Honsu)
R. peripenis Sun & Yang 1998	China (An-hui, Jiang-xi)
R. petersorum Denning & Schmid 1971	Thailand (Chiang Mai, Surat Thani)
R. pusilla Malicky and Sun 2002	China (Gui-zhou)
R. sandalphon H Malicky, 2014	China (Tai-wan)
R. suratthaniensis Laudee & Malicky 2015	Thailand (Surat Thani)
R. tamdaona Oláh, 1987	Vietnam (Tamdao)
R. triangularis Schmid 1970	China (Hu-nan)
R. verecunda Tsuda 1940	Japan (Honsu)
R. yigrongpa Schmid 1970	India (Sikkim)
R. yipung Schmid 1970	India (Manipur)

Materials and methods

The specimens examined in this research were collected into 100% alcohol by using pan traps with 15-w ultraviolet light tubes set near streams. Rhyacophilid adults were then sorted and stored in 100% alcohol.

The genitalia preparation procedure follows that used by Xu *et al.* (2014). The structures of the male genitalia were traced in pencil using a drawing tube on a Nikon Eclipse 80i microscope. Original pencil drawings were inked on parchment paper to produce illustrations. Each male abdomen was transferred to a microvial with 80% ethanol and stored together with the remainder of the specimen in a larger jar.

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

***Rhyacophila coalita* n. sp.**
(Fig. 1A–1D)

Male. Length of each forewing 6.5–7.0 mm (n=4). Body (in alcohol) yellow. Head yellow; antennae and palpi yellow; eyes black, ocelli pale; hairs brown. Prothorax yellow, pterothorax yellowish brown dorsally, yellow laterally and ventrally; wings brown; legs yellow, with spurs yellowish brown. Abdomen dark dorsally and yellow ventrally.

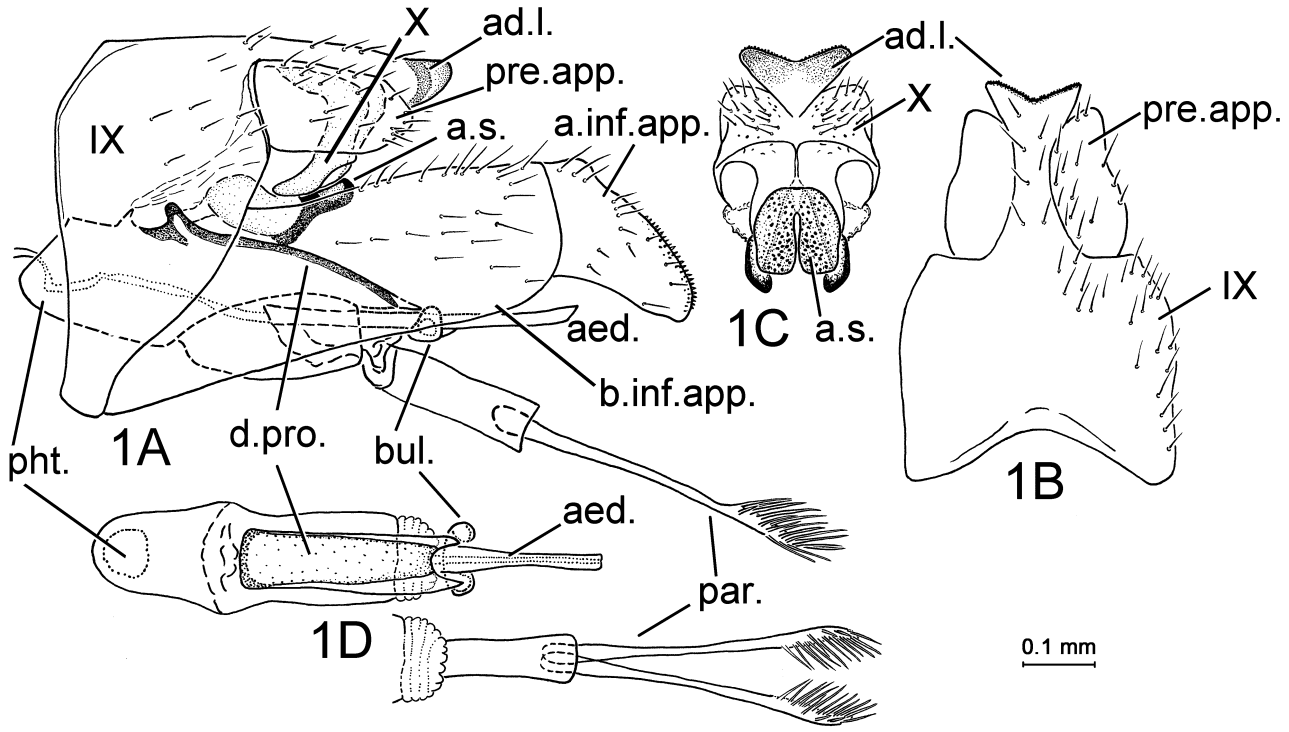

FIGURE 1. *Rhyacophila coalita* **n. sp.**, male genitalia. 1A, left lateral; 1B, segment IX and preanal appendages, dorsal; 1C, segment X and anal sclerites, caudal; 1D, phallic apparatus, dorsal. a.inf.app. = apical segment of an inferior appendage; a.s. = anal sclerites; ad.l. = apicodorsal lobe of segment IX; aed. = aedeagus; b.inf.app. = basal segment of an inferior appendage; bul.= membranous bulbs at the middle of the aedeagus; d.pro.= dorsal process of the phallic apparatus; IX = segment IX; par. = paramere; pht. = phallotheca; pre.app. = preanal appendages; X = segment X.

Male genitalia. Segment IX (IX) in lateral view short ventrally, long dorsally, dorsal margin about 9 times as long as ventral margin, its apicodorsal lobe (ad.l.) about 2/3 as long as basal segment of each inferior appendage (b.inf.app.); in dorsal view anterior margin of segment IX shallowly incised, its apicodorsal lobe constricted mesally to accommodate preanal appendages (pre.app.) and its apex shallowly incised. Preanal appendages slightly shorter than apicodorsal lobe of segment IX, in lateral view dorsal and ventral margins of each preanal appendage almost parallel to each other, apex rounded; in dorsal view preanal appendages somewhat nephroid. Segment X (X) in lateral view vertical, with dorsal and ventral ends curved cephalad; in caudal view somewhat rectangular. Anal sclerites (a.s.) in lateral view bar-shaped, oblique, posteroventral margins slightly concave; in caudal view subquadrate, with their bases fused. Basal segment of each inferior appendage long, in lateral view dorsal and ventral margins parallel to each other, anterior margin oblique, posterior margin subtruncate; apical segment (a.inf.app.) in lateral view somewhat sock-like, lower half of posterior margin with dense spinules. Phallic apparatus complex: phallotheca (pht.) in lateral view somewhat rectangular basally and triangular apically; dorsal process (d.pro.) elongate, heavily sclerotized, in dorsal view somewhat rectangular, with U-shaped apical emargination; aedeagus (aed.) tubular, in dorsal view with paired midlateral membranous bulbs (bul.); parameres (par.) slender, distal ends slightly bulging, setose, with strong mesal bristles.

Female. Unknown.

Diagnosis. The male of the new species resembles those of *R. yipung* SCHMID 1970 from India in the shape of the preanal appendages and *R. elongata* KIMMINS 1953 from Myanmar in the shape of the apical segment of each inferior appendage. It differs from them in that (1) The apicodorsal process of segment IX is longer and narrower than in *R. ypung* and less deeply incised apically than in *R. elongata*; (2) the preanal appendages are not as long as the apicodorsal process of segment IX (subequal to that process in *R. ypung*) and are taller and more nearly rectangular than in *R. elongata*; (3) the parameres are not forked (forked in *R. ypung*); (4) the dorsal process of the aedeagus in dorsal view has its apex deeply incised (not incised in either *R. yipung* and *R. elongata*); (5) anal sclerites are paired, but fused at their base (paired but not fused in *R. yipung*, fused completely in *R. elongata*); and (6) the aedeagus has a pair of membranous bulbs at the middle (without such structures in either *R. yipung* and *R. elongata*).

Etymology. The species name comes from the Latin adjective *coalitus* meaning "combined," or "grown together," or "united," in reference to the pair of anal sclerites fused at the base when viewed caudally.

Holotype Male. CHINA: **Jiang-xi Province**, Wu-yi-shan National Nature Preserve, unnamed tributary of Tong-mu River, 27.83973°N, 117.7224°E, elev. 943 m, 3 June 2005, collected by ZHOU Chang-fa. **Paratypes.** Same collection data as holotype, 1 male; same collection data as holotype except 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, 1 male; **Guang-dong Province**, Xin-yi County, Da-cheng Town, Da-wu-ling Nature Reserve, upstream of the stream at the entrance of the Reserve, 22.2689°N, 111.1967°E, elev. 1110 m, 26 May 2004, collected by SUN Chang-hai, 1 male.

Distribution. CHINA (Guang-dong, Jiang-xi).

***Rhyacophila bicaudata* n. sp.**
(Fig. 2A–2D)

Male. Length of each forewing 7.0–9.0 mm. (n=3). Body (in alcohol) dark brown. Head dark brown, antennae brown with pale rings at basal and distal ends of each joint, palpi brown. Thorax dark brown dorsally, brown laterally and ventrally; wings brown; legs brown, with dark brown spurs. Abdomen black dorsally and yellowish brown ventrally.

Male genitalia. Segment IX in lateral view short ventrally, dorsal margin about 7 times as long as ventral margin, apicodorsal lobes about half as long as dorsal margin of basal segment of each inferior appendage; in dorsal view anterior margin broadly incised, apicodorsal lobe gradually tapered from base to shallowly incised apex. Preanal appendages about 1.5 times as long as apicodorsal lobe, somewhat triangular in lateral view with apices round; in dorsal view slender, each with lateral margin concave, apex acuminate. Segment X in lateral view vertical, dorsal and ventral ends curved cephalad. Anal sclerites in lateral view somewhat rectangular, oblique; in caudal view paired, each nephroid in shape. Basal segment of each inferior appendage long, in lateral view basal portion slightly thicker than distal portion, anterior margin oblique, posterior margin truncate; apical segment in lateral view triangular, about 1/2 as long as basal segment, gradually tapered from base to round apex. Phallic apparatus complex: Phallotheca in lateral view with basal half somewhat rectangular, distal half triangular; dorsal process elongate, heavily sclerotized, in dorsal view somewhat clavate, apex round; aedeagus tubular; parameres slender, each with distal end with strong bristles and spinules.

Female. Unknown.

Diagnosis. The new species resembles *R. triangularis* SCHMID 1970 in male genitalia, but can be distinguished in that (1) the preanal appendages are longer than the apicodorsal lobe (they are equal in length in *R. triangularis*); (2) each preanal appendage has its posteroventral margin slightly concave (posteroventral margin straight in *R. triangularis*); and (3) the apicodorsal lobe is gradually tapered from base to apex (it is gradually enlarged from base to apex in *R. triangularis*).

Holotype Male. CHINA: Guang-dong Province, Zhao-qing City, Ding-hu District, Ding-hu-shan Forest Ecosystem, Research Station of Academia Sinica, Dong-gou at Shui-lian-dong-tian Waterfall, 23.1605°N, 112.5250°E, elev. 170 m, 24 May 2004, collected by Christy J. GERACI, John C. MORSE, SUN Chang-hai. **Paratypes. Guang-dong Province**, 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, ZHOU Xin, 1 male; **Jiang-xi Province**, Jiu-lian-shan National Nature Reserve, Da-qiu-tian scenic spot, 13.2 km NW of Jiu-lian-shan Nature Reserve, Xia-gong-tang Station, Mei-hua-luo-di, main river, 24.5903°N, 114.4547°E, elev. 377 m, 10 Jun 2005, collected by YANG Lian-fang, 1 male.

Etymology. The species name comes from Latin prefix *bi-* meaning "two", and Latin adjective *caudatus* meaning "having a tail," thus *bicaudata* meaning "two-tailed," in reference to the preanal appendages extending beyond the apicodorsal lobe, giving an appearance of two tails in dorsal view.

Distribution. CHINA (Guang-dong, Jiang-xi).

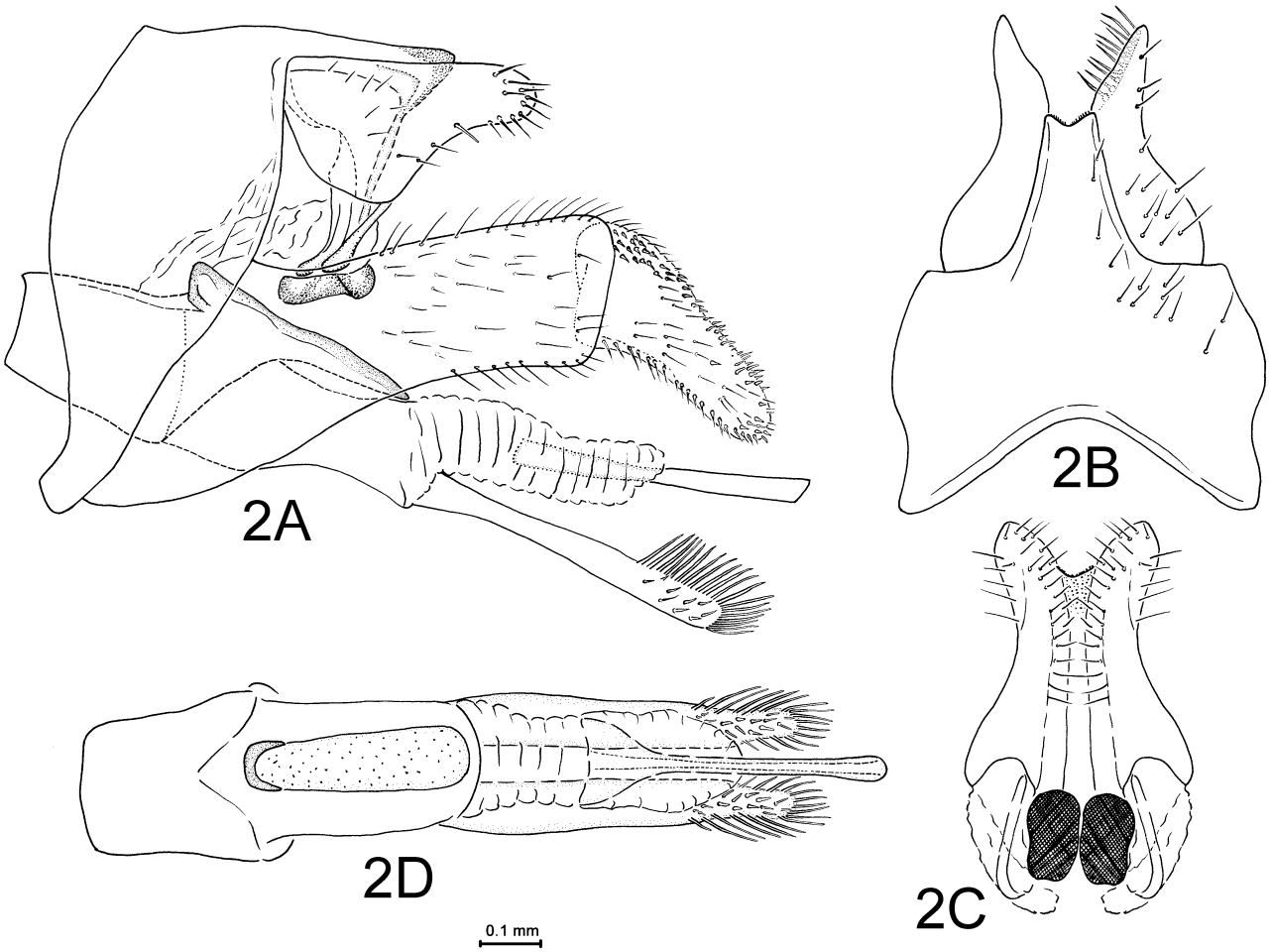

FIGURE 2. *Rhyacophila bicaudata* **n. sp.**, male genitalia: 2A, left lateral; 2B, segment IX and preanal appendages, dorsal; 2C, segment X and anal sclerites, caudal; 2D, phallic apparatus, dorsal.

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