





https://doi.org/10.11646/zootaxa.5652.1.18

http://zoobank.org/urn:lsid:zoobank.org:pub:7E48EDC7-C6AA-47BA-8926-B343A761ED2B

Two new species of *Baetis* s. l. (Ephemeroptera, Baetidae) from Yintiaoling Nature Reserve of Chongqing, China

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Abstract

Two new species of *Baetis* s. l. are described and illustrated based on nymphal materials. *Baetis chongqingensis* **sp. nov.** is characterized by the elongated labrum, the presence of stout setae on scape, the absence of apical scale on segment II of maxillary palp, the well-developed projection on segment II of labial palp, and the absence of chagrin and spatulate setae on abdominal terga. *Baetis (Rhodobaetis) qianlei* **sp. nov.** can be differentiated from the other species of subgenus *Rhodobaetis* by the number of spatulate setae on the scape and pedicel, the shape of labial palp and tergalii, and the length of paracercus.

Key words: Mayfly, taxonomy, morphology, COI, Baetofemorata

Introduction

Baetis Leach, 1815 is the most diverse genus of Baetidae, comprising more than 150 species to date (Sartori & Brittain 2015). This complex genus has undergone numerous revisions and has been split into several species groups, subgenera or genera (e.g. Muller-Liebenau 1969; Novikova & Kluge 1987; Waltz & McCafferty 1985). Although the infrageneric classification within *Baetis* s. l. remains unresolved and controversial, at least three subgenera besides *Baetis* s. s. have been accepted, namely *Tenuibaetis* Kang & Yang (in Kang *et al.*), 1994, *Patites* Thomas & Dia, 2000 and *Rhodobaetis* Jacob, 2003 (e.g. Tiunova *et al.* 2021; Kluge 2022). However, many species within *Baetis* s. l. have never been formally assigned to any subgenus yet, and most of them have ambiguous phylogenetic positions.

Before this study, only 12 valid species of *Baetis* had been reported from China. Navás (1931) described *B. vaillanti* Navás from northwestern China, known only from the male imago. Ulmer (1936) described *B. chinensis* Ulmer based on the male imago from Beijing. Imanishi (1940) reported an informal species, *Baetis* nla, from North Korea and northeastern China, which was later identified as *B. fuscatus* Linnaeus by Bae *et al.* (1998); shortly after, Bae & Liu (1999) confirmed its distribution in northeastern China, and reported a new record species, *B. pseudothermicus* Kluge, 1983, from the same area. Müller-Liebenau (1985) reported three new species of *Baetis* from Taiwan Island, viz. *B. taiwanensis* Müller-Liebenau, *B. tatuensis* Müller-Liebenau (transferred to the genus *Nigrobaetis* Novikova & Kluge by Fujitani *et al.* 2004) and *B. pseudofrequentus* Müller-Liebenau. Kang *et al.* (1994) described nine new *Baetis* species from Taiwan Island, of which most were transferred to other genera except for *B. inornaturs* Kang & Yang and *B. arduus* Kang & Yang, which were assigned to the subgenus *Tenuibaetis* along with the type species *B. pseudofrequentus*. Additionally, *B. pseudofrequentus* and *B. arduus* were reported from Hong Kong and Japan later (Tong & Dudgeon 2000; Fujitani *et al.* 2022). She *et al.* (1995) described *B. hainanensis* She *et al.* from Hainan Island based on the male imago. Braasch (1999) mentioned the distribution of *B. oreophilus* Kluge in northwestern China. Wang *et al.* (2011) described a new species, *B. rutilocylindratus* Wang *et al.*, from Jiangsu

Accepted by Z.-S. Zhang: 30 Jul. 2024; published: 24 Jun. 2025

Province, eastern China. The most recent report of a new species was from Tong *et al.* (2014), who described *B. maculosus* Tong *et al.*, which is probably widespread in southern China and known from the nymph, male and female imagos.

The Yintiaoling Nature Reserve (YNR) is located in the northeastern part of Chongqing, southwestern China, extending from 31°23′52″ to 31°33′37″N and 109°41′19″ to 109°57′42″E, and with a large elevational span from 450.2 m to 2796.8 m. A comprehensive survey of insects and spiders was performed in the nature reserve since April 2022, and more than 2,000 insect species and 300 spider species have been collected and identified into families, genus or species so far (Deng *et al.* 2023). However, the mayfly fauna of YNR had never been investigated before. In August 2022, we conducted a preliminary investigation of mayflies in YNR and recorded 32 species. In this article, we describe and photographed two new *Baetis* species collected from YNR, and more information on the mayfly fauna of the reserve will be presented in the future.

Material and methods

All specimens used in this study are preserved in 95% ethanol, and are deposited in the State Key Laboratory of Ecological Pest Control for Fujian and Taiwan Crops, College of Plant Protection, Fujian Agriculture and Forestry University (FAFU).

Specimens were examined using Nikon SMZ18 stereomicroscope. The microphotographs were taken using a computer-connected Nikon set: Nikon eclipse Ci-L upright microscope, 16MP digital camera with 0.55X adapter and imaging software NIS-Elements D Ver4.60.00. The photos were treated with Adobe Photoshop CC 2019.

Total DNA was extracted from legs of nymphs using DNeasy Blood & Tissue Kit (Qiagen, Hilden, Germany). A 658 bp fragment of the cytochrome c oxidase subunit I (COI) gene was amplified using the following primers: LCO1490 (5'-ggtcaacaaatcataaagatattgg-3') and HCO2198 (5'-taaacttcagggtgaccaaaaaatca-3') (Folmer *et al.* 1994). The COI gene fragment amplification was carried out with the following conditions: 30 sec of initial denaturation at 98 °C, a total of 35 cycles with denaturation at 98 °C for 10 sec, annealing at 52 °C for 30 sec and an extension at 72 °C for 30 sec, and 2 min of final extension at 72 °C. The products of PCR were bidirectionally sequenced at Tsingke Biotechnology (Beijing, China).

The sequences were assembled using BioEdit (Hall 1999), and the genetic distance was estimated using MEGA 11 (Tamura *et al.* 2021) with Kimura 2-parameter model (K2P, Kimura 1980). The information of sequenced specimens with GenBank accession numbers are given in Table 1, and the nomenclature of gene sequences follows Chakrabarty *et al.* (2013). To calculate the interspecific distances between *Baetis* (*Rhodobaetis*) *qianlei* **sp. nov.** and the consubgeneric species, we downloaded all available sequences (> 630 bp) of the *Rhodobaetis* species distributed in Asia from GenBank. Some species had markedly different sequences, and in this case we selected the sequence with the closest location to the type locality. The final results and the GenBank accession numbers of the sequences we used are shown in Table 2.

The terms are used according to Kluge (2004).

Species	Locality	Coordinates	Altitude	Date	Genbank #	GenSeq	
						Nomenclature	
B. chongqingensis sp. nov.	YNR,	31.509231N,	1124 m	10.VIII.2022	PP054269	genseq-2 COI	
	Chongqing	109.819583E					
B. qianlei sp. nov.	YNR,	31.509231N,	1124 m	10.VIII.2022	PP054265	genseq-2 COI	
	Chongqing	109.819583E					
		31.482522N,	939 m	12.VIII.2022	PP054266	genseq-2 COI	
		109.822281E					
	Pengzhou,	31.233117N,	1154 m	10.II.2022	PP054267	genseq-3 COI	
	Sichuan	103.775778E					
		31.202492N,	922 m	9.II.2022	PP054268	genseq-3 COI	
		103.911736E					

TABLE	1. Sec	juenced	specimens	of Baetis.
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TABLE 2. Interspecific COI genetic distances (K2P) between Baetis (Rhodobaetis) qianlei sp. nov.	, and other Rhodobaetis
species.	

	Species	1	2	3	4	5	6	7	8
1	Baetis qianlei sp. nov.								
2	B. bicaudatus MH841875	0.249							
3	B. braaschi ON738462	0.205	0.242						
4	B. molecularis MT027030	0.228	0.165	0.233					
5	<i>B. noa</i> MH827949	0.212	0.209	0.207	0.203				
6	B. pseudothermicus MT945961	0.213	0.226	0.208	0.226	0.235			
7	B. rhodani MF458626	0.225	0.211	0.226	0.176	0.145	0.256		
8	B. silvaticus MT231287	0.188	0.219	0.187	0.211	0.207	0.199	0.203	
9	B. thermicus KF563030	0.232	0.201	0.223	0.227	0.228	0.231	0.226	0.209

Taxonomy

Baetis chongqingensis sp. nov.

(Figs 1-4)

Type-material. *Holotype.* Mature nymph, **CHINA, Chongqing, Wuxi County, Yintiaoling Nature Reserve**, Baiguo Forest Farm, Yangxi River (31.509231N, 109.819583E, alt. 1124 m), 10.VIII.2022, leg. Pengxu Mu; in ethanol; FAFU. *Paratypes.* **CHINA, Chongqing:** 28 nymphs, same information as holotype; in ethanol; FAFU.

Description. Nymph. Male: body length 5.2–5.5 mm; cerci 3.4–4.3 mm, paracercus 0.6–0.7× length of cerci. Female: body length 6.4–6.7 mm; cerci 3.3–3.7 mm, paracercus 0.7–0.8× length of cerci.

Colouration (Figs 1A–B, 3A–C, 4D): general body color yellowish brown. Head yellowish with irregular brown markings along epicranial suture; gena sometimes distinctly paler than lateral area. Pronotum yellowish brown, darker in anteromedial area and lateral margins. Mesonotum brown with yellowish spots. Legs pale yellow, dorsal surfaces of all femora slightly darker. Abdominal terga I–III & VI–VIII with similar trapezoidal brown pattern and three pale spots; terga IV–V pale laterally, medial area brown but with pale spot at center; terga IX–X pale, slightly brown medially. Abdominal sterna yellowish except sterna VI–VIII brown. Cerci and paracercus uniformly yellowish, without transversal bands.

Scape & pedicel (Figs 2I–K): both of scape and pedicel with more than 20 fine, short setae on ventral surface, but with no more than 5 such setae on dorsum. 1–5 stout setae located on inner-apical corner of scape, rarely absent (Fig. 2K).

Labrum (Fig. 2A): strongly elongated anteriorly (width/length ratio of 1.2). Dorsal surface with 1+4–5 submarginal setae (2 long and 2–3 short sublateral setae arranged in inverted V-shape). Anteromedial margin bordered with strongly feathered setae, and lateral margins bordered with multifurcate long setae.

Right Mandible (Fig. 2B): incisor and kinetodontium fused. Incisor with 3 teeth, outermost tooth truncated apically and slightly broader than another two blunt teeth. Kinetodontium with 4 relatively acute teeth. Prostheca slender, apically pectinate.

Left Mandible (Fig. 2C): incisor and kinetodontium fused. Incisor with 3 teeth, outermost tooth truncated apically and slightly broader than another two blunt teeth. Kinetodontium with 3 teeth. Prostheca robust, apically with 6 stout, short denticles and basally with 4 slender, long denticles.

Hypopharynx & superlinguae (Fig. 2D): lingua broad, apically conical; superlingua slightly longer than lingua, apically truncated.

Maxillae (Fig. 2E): maxillary palp ca $1.6 \times$ length of galea-lacinia; two-segmented, and segment II ca $1.1 \times$ length of segment II; apex of segment II round and without scales or stout bristles; surface of both segments covered with short hairs.

Labium (Figs 2F–H): labial palp three-segmented, segment I nearly equal to length of segments II and III combined, and segment II ca 2/3 of segment I; inner-apical projection of segment II well developed, and widest width in segment II $1.6-1.7\times$ length of the base of segment III; segment III slightly asymmetric, cupola-shape.

Paraglossa ca $2.0 \times$ wider than glossa, apically with three rows of long, stout setae, and dorsal surface with row of 8 long, slender setae near inner margin. Glossa slightly shorter than paraglossa, apically with 3 long, stout setae.

Legs (Figs 3A–J): villopore equally developed on all femora (Fig. 3H). Ratio of foreleg segments as follow: femur (1.1 mm): tibia : tarsus = 1.0:0.8:0.4; short, apically truncated or rounded spatulate setae occurring on both surfaces of all segments; femur with sparse row of long, stout, apically round or slightly pointed setae along outer margin (Fig. 3E), and with stout, tubercle-like subapical setae on ventral surface (Fig. 3G); tibia with stout, apically pointed setae on ventral surface. Midleg similar to foreleg. Hindleg similar to foreleg, except subapical tubercle-like setae on ventral surface of femur absent. Claws of all legs with row of 10–12 denticles increasing in length toward the apex; subapical setae absent (Fig. 3D).

Hindwing pads: well-developed.

Tergalii (Figs 4A–C): tracheae with trunk visible only, occurring in tergalii I–VI. Tergalius I smallest, more slender than other tergalii; tergalius II–V with similar shape, distinctly asymmetric; tergalius V $1.5-1.6 \times$ length of terga V; tergalii VI–VII drop-shaped. Both margins of all tergalii serrated in apical half and without spine-like setae.

Abdominal terga (Figs 4D–G): surface covered by scale bases and slight fine setae. Posterior margins with triangular spines, those on terga IX–X acuter.

Abdominal sterna (Figs 4H–I): surface covered by scale bases and fine setae. Posterior margins of sterna I–VII without spines; sterna VIII with triangular spines on medial part of posterior margin, and sterna IX with triangular spines on whole posterior margin.

Paraproct and cercotractor (Fig. 4J): paraproct with 2–3 apically acute spatulate setae near inner margin, and with numerous fine setae but few scale bases on surface; inner margin with 13–15 acute spines. Posterior margin of cercotractor with 14–17 spines, shorter than those on paraproct.



FIGURE 1. *Baetis chongqingensis* sp. nov., habitus of mature nymph: A dorsal view; B lateral view. Scale bar: 1.0 mm (A–B).

Diagnosis. The nymphs of *Baetis chongqingensis* **sp. nov.** can be distinguished from the other *Baetis* s. l. species by the following combination of characters: A) labrum distinctly elongated anteriorly (width/length ratio of 1.2); B) inner-apical corner of scape with 1–5 stout setae (rarely absent); C) inner-apical projection on segment II of labial palp well developed; D) surface of abdominal terga covered by scale bases and slight fine setae, without spatulate setae; E) paracercus well developed, ca $0.7 \times$ length of cerci.



FIGURE 2. *Baetis chongqingensis* **sp. nov.**, nymphal structures: **A** labrum (left: dorsal view; right: ventral view); **B**–C mandibular canines: **B**: right canines; **C** left canines (dotted lines show the outline of the outermost tooth of next instar); **D** hypopharynx; **E** maxilla; **F** labium (left: ventral view; right: dorsal view); **G**–H glossa and paraglossa; **I** scape and pedicel, dorsal view; **J** scape and pedicel, ventral view; **K** inner-apical corner of scape (black arrow: stout setae).

Distribution. China (Chongqing).

Etymology. The new species is named after Chongqing Municipality, the type locality of the new species.

Genetics. We used nucleotide BLAST in NCBI GenBank (nucleotide collection database) and animal identification in BOLD systems (all Barcode records on BOLD database) to search for the species that share the most similarity with *Baetis chongqingensis* **sp. nov.** in COI gene sequence composition. As a result, both searches showed a similarity less than 85% in the closet species (*Labiobaetis sulawesiensis* (MN167327) in GenBank and an unidentified Baetidae species (private) in BOLD systems).

Remarks. *Baetis chongqingensis* **sp. nov.** is not assigned to any subgenera within *Baetis* s. l. at present. The well-developed paracercus and the non-blade-like canines of both mandibles exclude it from *Patites* (Thomas & Dia 2000; Gattolliat *et al.* 2023). Its stout setae on scape resemble those of *Rhodobaetis*, but such setae are absent on abdominal terga and paraproct of the new species (Jacob 2003). The shape of labrum of the new species is reminiscent of *Tenuibaetis*; however, according to Kluge *et al.* (2023), the shape of labial palp and the setae pattern on dorsal surface of femora of the new species are not typical of *Tenuibaetis*. Besides *Tenuibaetis*, similar elongated labrum is also found in *B. alius* group (sensu Wiersema *et al.*, 2004) which contains two representatives in North America (Webb *et al.* 2018), but the apical part of paraglossa of the new species is relatively acute (distinctly wider in *B. alius* group).



FIGURE 3. *Baetis chongqingensis* sp. nov., nymphal structures: A foreleg; B midleg; C hindleg; D claw; E outer margin of forefemora; F apex of dorsal surface of forefemora; G apex of ventral surface of forefemora; H villopore of forefemora; I apex of dorsal surface of midtibia; J apex of ventral surface of hindtibia. Scale bar: 0.5 mm (A–C).



FIGURE 4. *Baetis chongqingensis* **sp. nov.**, nymphal structures: **A** tergalii (t1: tergalius I; t4: tergalius IV; t6: tergalius VI; t7: tergalius VII); **B** costal margin of tergalius IV; **C** anal margin of tergalius IV; **D** abdominal terga II–IX; **E** tergum II; **F** tergum V; **G** tergum VIII; **H** sterna VII–VIII; **I** sterna VIII–IX; **J** paraproct and cercotractor. Scale bars: 0.1 mm (**A**); 0.5 mm (**D**).

Overall, the features present in *B. chongqingensis* **sp. nov.** do not seem to conflict with the current nymphal concept of *Baetis* s. s.; nevertheless, the concept was highly variable according to different authors, and some *Baetis* s. l. species were assigned to *Baetis* s. s. by elimination in fact (e.g. Bauernfeind & Soldán 2012; Tiunova *et al.* 2021; Gattolliat *et al.* 2023). Considering the combination of several characters of *B. chongqingensis* **sp. nov.** (e.g. shape of labrum and stout setae on scape) has not been found in *Baetis* s. s., we do not ascribe the new species to *Baetis* s. s. either. Further research will give more plausible resolution when adult material is available.

Baetis (Rhodobaetis) qianlei sp. nov.

(Figs 5-8)

Type-material. *Holotype.* Mature nymph, **CHINA, Chongqing, Wuxi County, Yintiaoling Nature Reserve,** Baiguo Forest Farm, Yangxi River (31.509231N, 109.819583E, alt. 1124 m), 10.VIII.2022, leg. Pengxu Mu; in ethanol; FAFU. *Paratypes.* 30 nymphs, same information as holotype; in ethanol; FAFU. 10 nymphs, Wuxi County, Yintiaoling Nature Reserve, Daqiaoba (31.482522N, 109.822281E, alt. 939 m), 12.VIII.2022, leg. Pengxu Mu; in ethanol; FAFU. **Other material. CHINA, Sichuan:** 28 nymphs, Pengzhou City, Bailu Town, Wulong Road (31.202492N, 103.911736E, alt. 922 m), 9.II.2022, leg. Pengxu Mu; in ethanol; FAFU. 12 nymphs, Pengzhou City, Taiyangwan Scenic Spot, Baiyangou (31.233117N, 103.775778E, alt. 1154 m), 10.II.2022, leg. Pengxu Mu; in ethanol; FAFU.

Description. Nymph. Male: body length 8.0–9.8 mm; cerci 4.5–6.0 mm, paracercus ca 0.6× length of cerci. Female: body length 9.0–11.2 mm; cerci 5.0–7.0 mm, paracercus ca 0.6× length of cerci.

Colouration (Figs 5A–B, 7A–C, 8D): general body color yellowish brown. Head pale yellow, brown between compound eyes and ocelli. Pronotum yellowish brown, darker in median area. Mesonotum brown with yellowish spots. Forefemur pale yellow, except outer and inner margins and distal area brown; mid- and hindfemur similar to forefemur, except inner margins pale. Tibiae pale yellow. Tarsi pale yellow, except the base and apex brown. Abdominal terga I and terga IX–X pale; terga II–VIII with similar trapezoidal brown pattern, and terga III–VI with dark brown submedian spots. Abdominal sterna yellowish except sterna VII–IX pale brown. Cerci and paracercus yellowish, distal segments slightly darker.

Scape & pedicel (Figs 6H–I): scape with 18–23 spatulate setae, abundant on dorsal surface and near innerapical corner; pedicel with 10–13 spatulate setae (always longer than those on scape), abundant on dorsal surface and near inner-apical corner.

Labrum (Fig. 6A): distinctly wider than long (width/length ratio of 1.5). Dorsal surface with 1+7–8 long submarginal setae, arranged in one irregular row. Anteromedial margin bordered with strongly feathered setae, and lateral margins bordered with multifurcate long setae.

Right Mandible (Fig. 6B): incisor and kinetodontium fused. Incisor with 3 teeth, outermost tooth elongated, blade-like, broader than another two teeth. Kinetodontium with 4 relatively acute teeth. Prostheca slender, apically pectinate.



FIGURE 5. *Baetis (Rhodobaetis) qianlei* sp. nov., habitus of mature nymph: A dorsal view; B lateral view. Scale bar: 1.0 mm (A–B).



FIGURE 6. *Baetis (Rhodobaetis) qianlei* **sp. nov.**, nymphal structures: **A** labrum (left: dorsal view; right: ventral view); **B**–C mandibular canines: **B**: right canines; **C** left canines (dotted lines show the outline of the outermost tooth of next instar); **D** hypopharynx; **E** maxilla; **F** segment II of maxillary palp (white arrow: apical scale); **G** labium; **H** scape; **I** pedicel.

Left Mandible (Fig. 6C): incisor and kinetodontium fused. Incisor with 3 teeth, outermost tooth elongated, blade-like, broader than another two teeth. Kinetodontium with 3 teeth. Prostheca robust, apically with 5 stout, short denticles and basally with 4 slender, long denticles.

Hypopharynx & superlinguae (Fig. 6D): lingua broad, apically conical; superlingua subequal to lingua, apically truncated.

Maxillae (Figs 6E–F): maxillary palp slightly longer than galea-lacinia; two-segmented, and segment II nearly equal to length of segment I; apex of segment II slightly pointed and with a stout scale; surface of both segments covered with short hairs.

Labium (Fig. 6G): paraglossa ca $2.0 \times$ wider than glossa, apically with three rows of long, stout setae, and dorsal surface with row of 6 long, slender setae near inner margin. Glossa shorter than paraglossa, apically with 3 long, stout setae. Labial palp three-segmented; inner-apical projection of segment II moderately developed, and widest width in segment II ca $1.2 \times$ length of the base of segment III; segment III nearly symmetric, cupola-shape, apically with a small cone-shape projection and one tiny scale.

Legs (Figs 7A–H): villopore well developed on all femora (Fig. 7F). Ratio of foreleg segments as follow: femur (1.5 mm):tibia:tarsus = 1.0:0.8:0.5; short, apically truncated or pointed spatulate setae occurring on both surfaces of

all segments; femur with dense row of long, pointed bristles along outer margin (Fig. 7E); tibia with stout, apically pointed setae on ventral surface. Mid– and hindleg similar to foreleg. Claws with row of 7–8 denticles increasing in length toward the apex and without subapical setae.

Hindwing pads: well-developed.

Tergalii (Figs 8A–C): tracheae visible in tergalii II–VII. Tergalius I small, asymmetric; tergalius II–V with similar shape, distinctlt asymmetric (width/length ratio of 1.8-1.9); tergalius IV $1.7-1.8 \times$ length of terga IV; tergalius VI drop-shaped; tergalius VII small, more slender than other tergalii. Both margins of all tergalii serrated in apical half and with stout setae near costal margin (Fig. 8C).

Abdominal terga (Figs 8D–H): surface covered by spatulate setae, scale bases and slight fine setae. Posterior margins of terga I–IX with sparse row of spatulate setae; posterior margins of terga II–X with triangular spines, and those on terga IX–X acuter.

Abdominal sterna (Fig. 8I): surface covered by spatulate setae, scale bases and slight fine setae. Posterior margins without spines.

Paraproct and cercotractor (Fig. 8J): paraproct with 5–7 apically acute or rounded spatulate setae near inner margin, and with slight fine setae on surface; inner margin with 19–23 acute spines. Posterior margin of cercotractor with 15–18 short, blunt spines.

Biology. The nymphs of *Baetis (Rhodobaetis) qianlei* **sp. nov.** were found in the upper reaches of clear streams, 900–1200 m above sea level, and the stony substrates of the streams were mainly cobbles and pebbles (Figs 9A–B). Mayflies collected from the same streams included *Baetiella sexta* Shi & Tong, *Baetis chongqingensis* **sp. nov.**, *Afronurus drepanophyllus* Zhang *et al.*, *Epeorus falcatus* Zhou, *Notacanthurus maculatus* Zhou, *Ephemera hsui* Zhang *et al.*, *Habrophlebiodes gilliesi* Peters and some other species.



FIGURE 7. *Baetis (Rhodobaetis) qianlei* **sp. nov.**, nymphal structures: **A** foreleg; **B** midleg; **C** hindleg; **D** claw; **E** dorsal surface of hindfemora; F ventral surface of hindfemora (white arrow: villopore); **G** dorsal surface of hindtibia; **H** dorsal surface of hindtarsus. Scale bar: 0.5 mm (A–C).



FIGURE 8. *Baetis (Rhodobaetis) qianlei* **sp. nov.**, nymphal structures: **A** tergalii (t1: tergalius I; t4: tergalius IV; t6: tergalius VI; t7: tergalius VII); **B** costal margin of tergalius IV; **C** anterobasal part of tergalius IV (white arrow: stout setae); **D** abdominal terga I–IX; **E** tergum I; **F** tergum IV; **G** tergum IX; **H** terga X; **I** sterna VIII; **J** paraproct and cercotractor. Scale bars: 0.5 mm (**A**); 1.0 mm (**D**).

Etymology. The new species is named after Mr Qianle Lu, we thank him for his help in collection. **Distribution.** China (Chongqing, Sichuan).

Diagnosis. The nymphs of *Baetis (Rhodobaetis) qianlei* **sp. nov.** can be distinguished from the other representatives of *Rhodobaetis* by the following combination of characters: A) scape with 18–23 spatulate setae, and pedicel with 10–13 spatulate setae; B) segment III of labial palp nearly symmetric, cupola-shape; C) tergalius II–V distinctly asymmetric (width/length ratio of 1.8-1.9); D) paracercus well developed, ca $0.6 \times$ length of cerci; E) paraproct with 5–7 spatulate setae on surface, and inner margin with 19–23 acute spines. This new species is similar to *B*. (*R*.) *braaschi* Zimmermann, 1980 which is mainly distributed in Crimea Peninsula (Godunko *et al.* 2004a), but it can be differentiated with the latter by blade-like outermost tooth of mandibular canines (not blade-like in *B. braaschi*) and symmetric segment III of labial palp (asymmetric in *B. braaschi*).



FIGURE 9. Habitat and living photos: A–B Yangxi River, Baiguo Forest Farm, Yintiaoling Nature Reserve; C Baetis chongqingensis sp. nov.; D Baetis (Rhodobaetis) qianlei sp. nov.

Genetics. The intraspecific genetic distances range from 0.0015 to 0.0092 (avg 0.0064) within the four sequences of *Baetis (Rhodobaetis) qianlei* **sp. nov.** (Table 1). The interspecific genetic distances between this new species and other *Rhodobaetis* species range from 0.188 to 0.249 (avg 0.219), and genetically the closest species to *B. (R.) qianlei* **sp. nov.** was *B. sivalticus* (MT231287) from the Russia Far East. See Table 2 for details; note that we treat the four sequences of *B. (R.) qianlei* **sp. nov.** as a Molecular Operational Taxonomic Unit (MOTU) based on the low intraspecific distances mentioned above, and the interspecific distances between it and the other species are shown in average.

Remarks. *Baetis* (*Rhodobaetis*) *qianlei* **sp. nov.** can be readily assigned to the subgenus *Rhodobaetis* by the presence of spatulate setae on scape, pedicel, legs, abdominal terga, sterna and paraproct (Jacob 2003; Godunko *et al.* 2004b). The new species represents the third *Rhodobaetis* species formally reported from China (another two species are *B.* (*R.*) *oreophilus* and *B.* (*R.*) *pseudothermicus*).

Acknowledgement

We sincerely thank Prof. Zhisheng Zhang and Dr. Luyu Wang for their support, and greatly thank Mr Qianle Lu for his help in collection. Special thanks are also given to two reviewers, Prof. Xiaoli Tong and Dr. Weifang Shi for their constructive comments. This research was supported by the fund on survey of invertebrates from Yintiaoling Nature Reserve (CQS21C00739, CQS24C00333), and the Special Investigation Program for National Science and Technology Basic Resources (2022FY100500).

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