



This work is licensed under a Creative Commons Attribution License (CC BY 4.0).

## Research article

[urn:lsid:zoobank.org:pub:FBFD2E52-C902-4F61-9EB4-A8BADF997F0B](https://zoobank.org/pub/FBFD2E52-C902-4F61-9EB4-A8BADF997F0B)

# The species of *Tibetisoperla* (Plecoptera: Perlodidae)

Yan-Hua YAN<sup>1</sup>, Zhen-Ning CHEN<sup>2</sup>, Hakan BOZDOĞAN<sup>3</sup> & Wei-Hai LI<sup>4,\*</sup>

<sup>1,4</sup>Henan International Joint Laboratory of Taxonomy and Systematic Evolution of Insecta Henan Institute of Science and Technology, Xinxiang, Henan 453003, China.

<sup>2</sup>Key Laboratory of Medicinal Animal and Plant Resources of Qinghai-Tibetan Plateau in Qinghai Province, School of Life Science, Qinghai Normal University, Xining, 810008, China.

<sup>3</sup>Kırşehir Ahi Evran University, Vocational School of Technical Sciences, Department of Plant and Animal Production, 40100, Kırşehir, Turkey.

\*Corresponding author: [lwh7969@163.com](mailto:lwh7969@163.com)

<sup>1</sup>Email: [18738538807@163.com](mailto:18738538807@163.com)

<sup>2</sup>Email: [149470880@qq.com](mailto:149470880@qq.com)

<sup>3</sup>Email: [hakan.bozdogan@ahievran.edu.tr](mailto:hakan.bozdogan@ahievran.edu.tr)

<sup>1</sup>[urn:lsid:zoobank.org:author:71B21647-7F2B-44B1-B209-63D130F8BA13](https://zoobank.org/author/71B21647-7F2B-44B1-B209-63D130F8BA13)

<sup>2</sup>[urn:lsid:zoobank.org:author:A59CA329-2B14-4F4E-8F5D-736514923C75](https://zoobank.org/author/A59CA329-2B14-4F4E-8F5D-736514923C75)

<sup>3</sup>[urn:lsid:zoobank.org:author:589E46D8-0F7D-47F5-A1D8-3ED4B2147022](https://zoobank.org/author/589E46D8-0F7D-47F5-A1D8-3ED4B2147022)

<sup>4</sup>[urn:lsid:zoobank.org:author:81D57DE5-E00B-4F6B-A0B3-E81D3C865208](https://zoobank.org/author/81D57DE5-E00B-4F6B-A0B3-E81D3C865208)

**Abstract.** Two new species of the hitherto monotypic *Tibetisoperla* Huo & Du, 2021, *T. elongata* sp. nov., *T. sclerotica* sp. nov., are described, illustrated and compared with the type species and other Isoperlinae. *Tibetisoperla* and *T. wangluyui* Huo & Du, 2021 are newly recorded for Qinghai Province.

**Keywords.** Isoperlinae, new taxa, stoneflies, *Tibetisoperla elongata* sp. nov., *Tibetisoperla sclerotica* sp. nov.

Yan Y.-H., Chen Z.-N., Bozdoğan H. & Li W.-H. 2022. The species of *Tibetisoperla* (Plecoptera: Perlodidae). *European Journal of Taxonomy* 823: 125–140. <https://doi.org/10.5852/ejt.2022.823.1821>

## Introduction

The perlodid genus *Tibetisoperla* Huo & Du, 2021 was recently erected as a monotypic genus for *Tibetisoperla wangluyui* Huo & Du, 2021 under the subfamily Isoperlinae Frison, 1942 (DeWalt *et al.* 2021). The males of this genus were characterized by having a simplified aedeagus, a spiny apical sclerite of paraproct, divided tergum 10 and reduced vesicle (Huo & Du 2021), presently it is confined to Tibet Autonomous Region of southwestern China. The females cannot be distinguished from related genera. In the present paper, two additional new species of *Tibetisoperla*, *T. elongata* sp. nov. and *T. sclerotica* sp. nov., are described. Yang & Li (2018) list only one perlodid genus from Qinghai Province, therefore these new species and *T. wangluyui* also represent the first record of this genus for Qinghai.

## Material and methods

All adults were collected using an aerial net. The aedeagi were everted by squeezing the abdomen of live males before they were preserved in 95% ethanol. The male terminalia were cleared in 10% NaOH. The types and other examined specimens are deposited in the Entomological Museum of China Agricultural University (CAU), and in the Henan Institute of Science and Technology, Xinxiang (HIST). Specimens were examined with the aid of a Leica S8APO dissecting microscope and the color photographs were made with a Leica M205FA. The morphological terminology follows that of Huo & Du (2021).

### Abbreviations for morphological terms used in figures

as = apical setae  
ce = cerci  
pp = paraproct  
S7 = seventh abdominal sternum (and so forth for other segments)  
sas = spiny apical sclerite  
sgp = subgenital plate  
T1 = first abdominal tergum (and so forth for other segments)  
V = vesicle  
vs = ventrobasal sclerite

## Results

### Taxonomy

Class Insecta Linnaeus, 1758  
Order Plecoptera Burmeister, 1839  
Family Perlidae Latreille, 1802

Genus *Tibetisoperla* Huo & Du, 2021

*Tibetisoperla* Huo & Du, 2021: 343.

### Type species

*T. wangluyui* Huo & Du, 2021.

### Diagnosis

Small sized. Macropterous. General color brown or black. Triocellate, anterior ocellus smaller. Tergum 10 with bilobate tip, covered with several large apical setae; paraprocts with spiny apical sclerite. Aedeagus membranous, covered by fine spines.

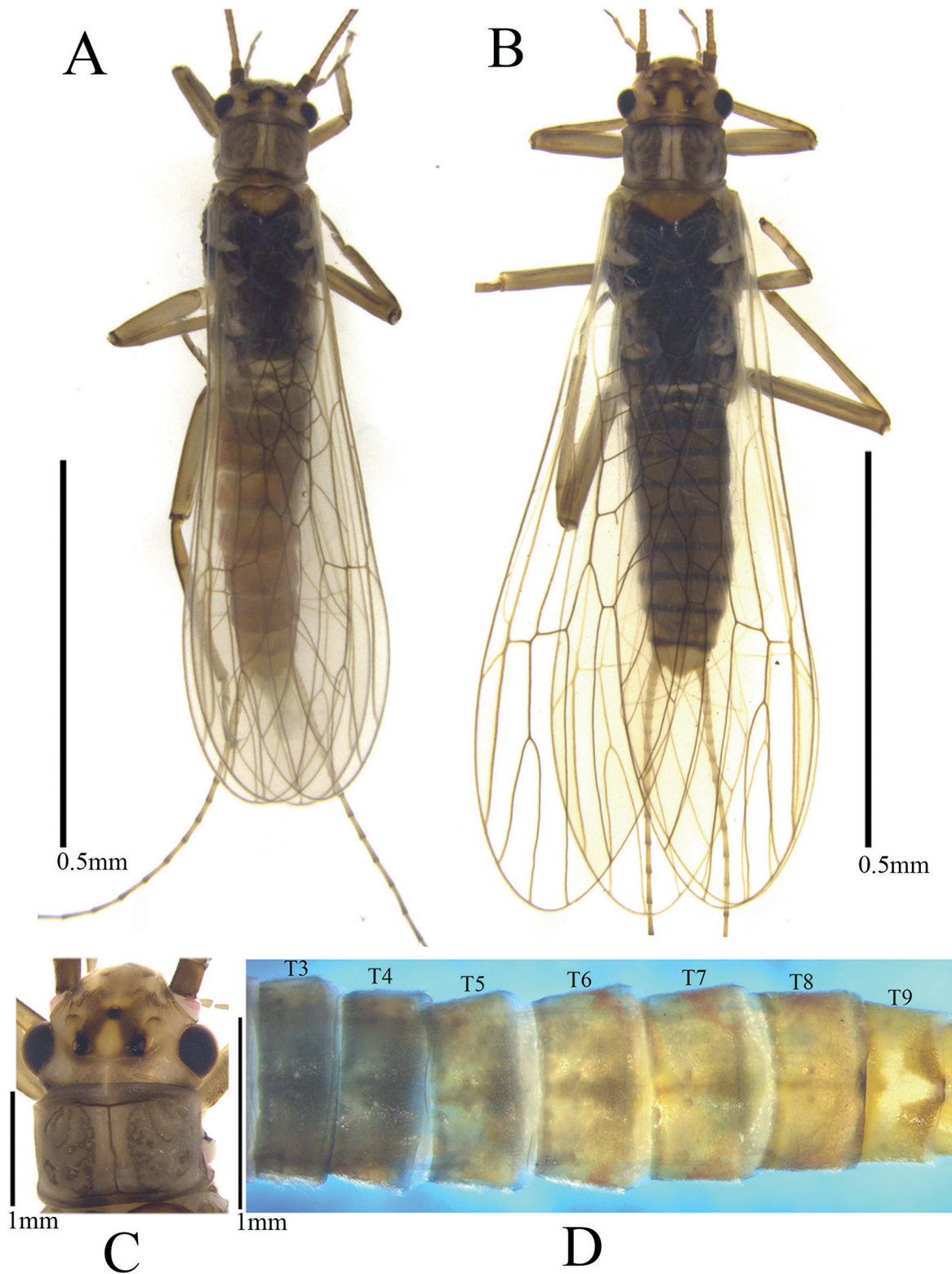
*Tibetisoperla elongata* sp. nov.

[urn:lsid:zoobank.org:act:7B5313C1-F26C-41C5-88BD-7B0486372A08](https://doi.org/10.21203/rs.3.rs-12513131/v1)

Figs 1–4

### Diagnosis

General color brownish. Vesicle developed and tongue-shaped, which is almost as long as its width. Aedeagus mostly membranous, except for a v-shaped ventrobasal sclerite, generally tubular and slightly curved ventrally at apex. Subgenital plate in female produced and subquadrate, posteriorly with a broad arcuate posteromedial notch.



**Fig. 1.** *Tibetisoperla elongata* sp. nov. **A.** ♂, holotype (HIST), habitus, dorsal view. **B.** ♀, paratype (HIST), habitus, dorsal view. **C.** ♂, holotype (HIST), head and pronotum, dorsal view. **D.** ♂, holotype (HIST), terga 3–9, dorsal view. Abbreviations: see Material and methods.

### Etymology

The specific epithet refers to the vesicle being long, which was presumed to be atypical for this genus.

### Material examined

#### Holotype

CHINA • ♂; Qinghai Province, Menyuan County, Daitong River; 37°21'37.99" N, 101°36'55.30" E; alt. 2782 m; 30 Jun. 2021; Wei-Hai Li and Rong-Rong Shen leg.; HIST.

#### Paratypes

CHINA • 1 ♂; same collection data as for holotype; HIST • 3 ♀♀; same collection data as for holotype; HIST • 1 ♂; same location as for holotype; 37°18'1.38" N, 101°55'49.82" E; alt. 2643 m; 26 Jul. 2021; Wei-Hai Li and Bin Zhang leg.; HIST.

### Description

#### Male

ADULT HABITUS (Figs 1A, 1C). Forewing length 8.1–8.5 mm, hindwing length 7.0–7.2 mm (N=3). Head brown with dark brown arween ocelli and tentorial callosities. M-line dark brown. Triocellate, anterior ocellus smaller. Antennae brownish, scape brown, palpi brownish. Pronotum disc with large area of brown to dark brown rugosities and pale medial stripe. Legs brownish. Wings hyaline, veins brown.

ABDOMEN (Figs 1D, 2). Abdominal terga brownish and terga 1–4 darkly sclerotized. Terga 2–9 each with a pair of small dark spots medially and dark medial strip (obscure in young individual). Tergum 9 bearing two paramedial patches of sensilla on darker posterior margin, patches separated by pale T-shaped mesal membrane. Tergum 10 bilobate, distally upcurved with 3–4 thick apical setae. Vesicle located on posterior margin of sternum 8, generally tongue-shaped, ca almost as long as its width, basally brown but apex paler, covered with hairs. Paraprocts sclerotized, with partially separated apical sclerite covered by small terminal spines.

AEDEAGUS (Fig. 3). Membranous except for a v-shaped ventrobasal sclerite, tubular and slightly curved ventrally at apex, mostly covered by fine spinules, dorsoapical and ventroapical portions bald.

#### Female

ADULT HABITUS (Fig. 1B). Forewing length 9.0–9.9 mm, hindwing length 7.9–8.2 mm. Body coloration similar to male.

ABDOMEN (Fig. 4). Tergum 10 unmodified. Subgenital plate sclerotized and subquadrate, produced posteriorly covering anterior half of sternum 9, with a broad arcuate posteromedial notch.

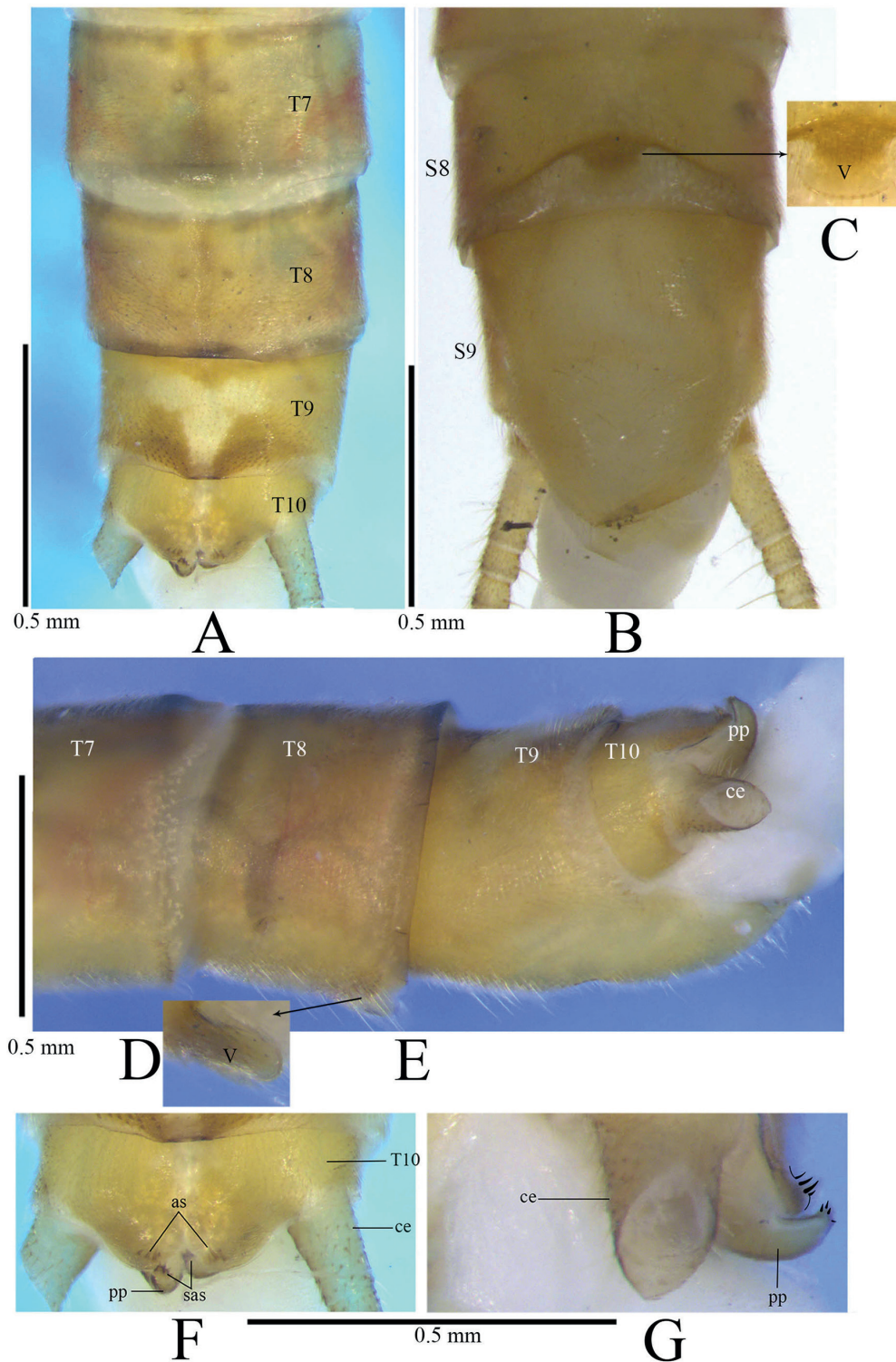
EGG. Unknown.

### Distribution

China: Qinghai Province. Presently only known from two sites along the riverside of Daitong River in Menyuan County.

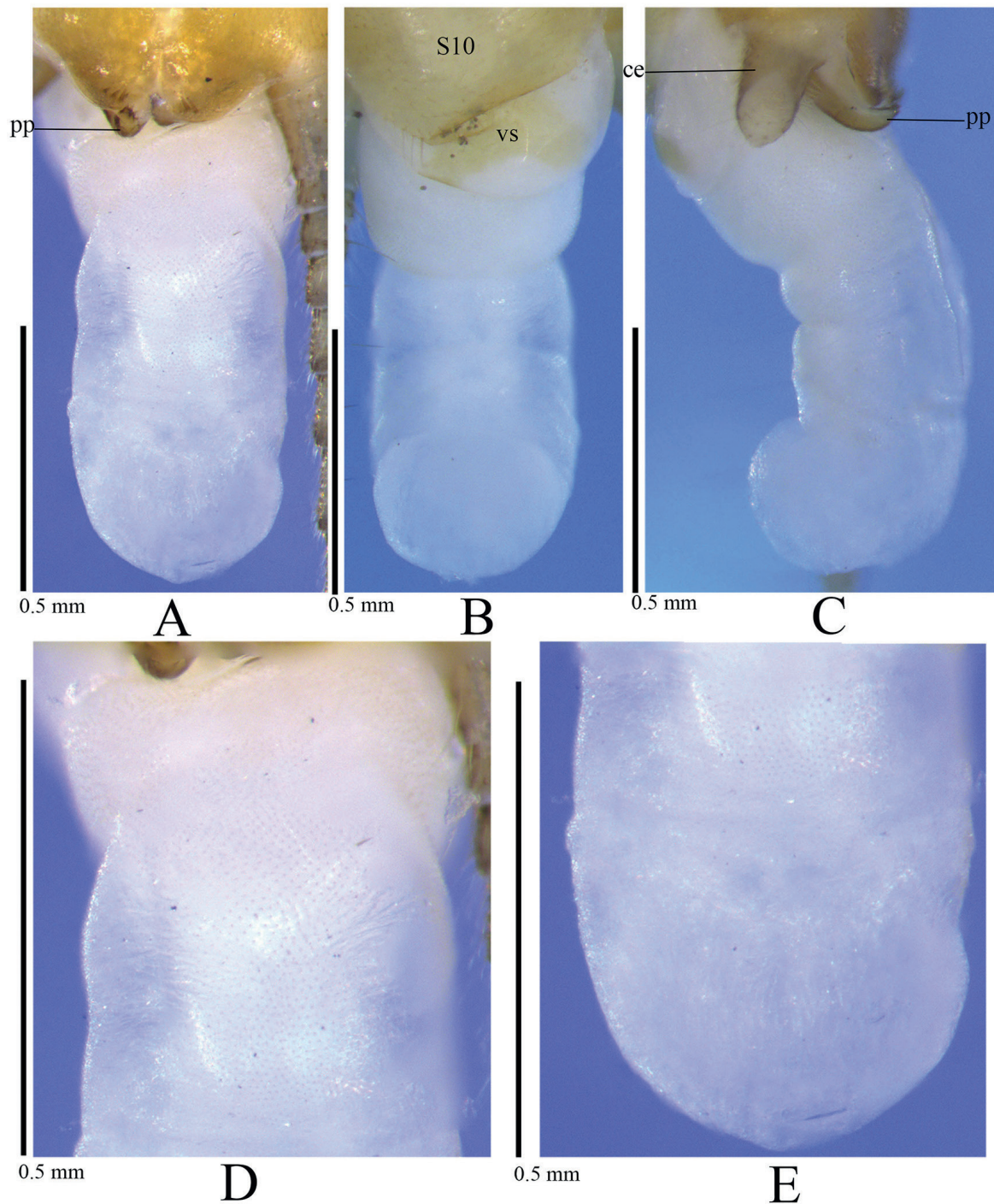
### Remarks

The type species of *Tibetisoperla*, *T. wangluyui* Huo & Du, 2021 is a dark species and has a reduced vesicle on sternum 8, but the new species is a brownish species and has a developed vesicle which is present in typical *Isoperla* Banks, 1906 (Teslenko & Zhiltzova 2009; Murányi 2011; Szczytko & Kondratieff 2015; Cao *et al.* 2020), another genus of Isoperlinae in China. However, the large apical setae of tergum 10 and spiny apical sclerite of paraproct clearly show its placement in *Tibetisoperla*.

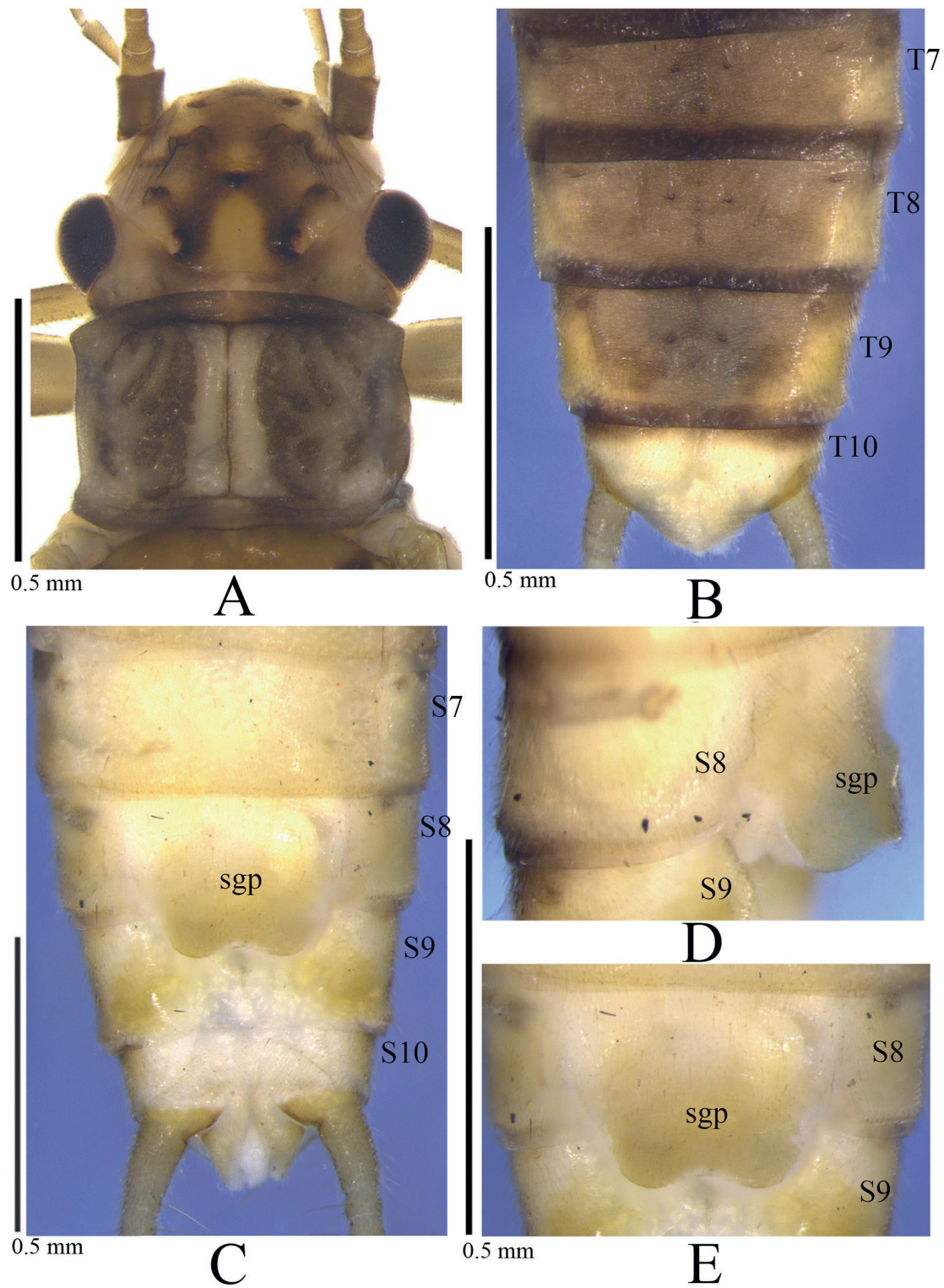


**Fig. 2.** *Tibetisoperla elongata* sp. nov., ♂, holotype (HIST). **A.** Terminalia, dorsal view. **B.** Terminalia, ventral view. **C.** Vesicle, ventral view. **D.** Vesicle, lateral view. **E.** Terminalia, lateral view. **F.** Tergum 10 and paraproct, dorsal view. **G.** Apex of tergum 10 and paraproct, lateral view (cercus removed). Abbreviations: see Material and methods.

The female of *T. elongata* is different to *T. wangluyui* in subgenital plate structure, the former is broadly semicircular while the latter is subquadrate. Additionally, *T. elongata* with a typically posterior notch which is indistinct of *T. sclerotica*. Terga 1–8 of female with black medial stripes and subgenital plate is broadly triangular in *T. sclerotica*.



**Fig. 3.** *Tibetisoperla elongata* sp. nov., ♂, holotype (HIST). **A.** Aedeagus, dorsal view. **B.** ♂, Aedeagus, ventral view. **C.** Aedeagus, lateral view. **D.** Basal half of aedeagus, detail of spinous area, dorsal view. **E.** Aedeagal apex, dorsal view. Abbreviations: see Material and methods.



**Fig. 4.** *Tibetisoperla elongata* sp. nov., ♀, paratype (HIST) **A.** Head and pronotum, dorsal view. **B.** Terminalia, dorsal view. **C.** Terminalia, ventral view. **D.** Subgenital plate, lateral view. **E.** Subgenital plate, ventral view. Abbreviations: see Material and methods.

*Tibetisoperla sclerotica* sp. nov.

[urn:lsid:zoobank.org:act:5F951431-4255-4A09-B0BB-A645800BB1B1](https://zoobank.org/urn:lsid:zoobank.org:act:5F951431-4255-4A09-B0BB-A645800BB1B1)

Figs 5–9

**Diagnosis**

General color dark brown. Vesicle reduced to a black transverse band. Ventrobasal sclerite of aedeagus black, generally subquadrate in outline with a triangular postcentral notch.

**Etymology**

The specific epithet refers to the sclerotized ventrobasal sclerite of everted aedeagus.

**Material examined**

**Holotype**

CHINA • ♂; Qinghai Province, Menyuan County, Meihua village; 37°16'6.99" N, 102°8'3.58" E; alt. 2979 m; 30 Jul. 2021; Wei-Hai Li leg.; HIST.

**Paratypes**

CHINA – Qinghai Province • 1 ♀; same locality as for holotype; 31 Jul. 2021; HIST • 2 ♀♀; Menyuan County, Xiami Town, Qihankaigou; 37°9'30.73" N, 102°1'52.09" E; alt. 2694 m; 3 Jul. 2021; Wei-Hai Li and Rong-Rong Shen leg.; HIST • 1 ♀; Menyuan County, Zhugu Village, Sigou; 37°7'54.39" N, 102°23'57.56" E; alt. 2570 m; 28 Jul. 2021; Bin Zhang leg.; HIST • 1 ♀; Menyuan County, Liuhuanggou; 37°47'45.24" N, 101°14'53.16" E; alt. 3407.8 m; 29 Jul. 2021; Zhuo-Yin Jiang leg.; HIST • 2 ♀♀; Qilian County, Zhamashenxigou, Dongchagou; 38°9'14.18" N, 100°1'22.40" E; alt. 3015 m; 9 Jul. 2021; Wei Zeng leg.; CAU.

**Description**

**Male**

ADULT HABITUS (Figs 5A, C–D). General color dark brown to black (Fig. 5A). Head mostly brown, with dark area around ocelli, tentorial callosities and M-line, the area sometimes extending to center of occiput. M-line dark brown. Triocellate, anterior ocellus slightly smaller. Antennae brown, scape darker, palpi brownish. Pronotum disc with dark brown rugosities and wide, brown, longitudinal stripe disjunct with thin black midline. Legs brown, femora darker. Wings hyaline, veins brown. Cerci brownish, apical segments darker.

ABDOMEN (Figs 5D, 6, 7A–B). Forewing length ca 7.1 mm, hindwing length ca 6.0 mm. Abdominal tergal pattern obscure due to entirely black coloration. Tergum 9 bearing two patches of black sensilla on posterior margin by triangular medial membranous area extended anterolaterally forming a T-shaped paler marking. Tergum 10 with thin, longitudinal, pale, medial line; distal half bilobate, with 4–5 apical setae. Vesicle located on posterior margin of sternum 8, reduced to black transverse band. Paraprocts with recurved spiny apical sclerite, covered by ca. 13–14 tiny spines.

AEDEAGUS (Fig. 8). Mostly membranous except for a dark ventrobasal sclerite, sclerite subquadrate with triangular postcentral notch; greatly enlarged posterior to ventrobasal sclerite. Aedeagus apical third upcurved and generally globular before narrowest nipple-like apex, brownish; mostly covered by fine spinules but lacking large spine.

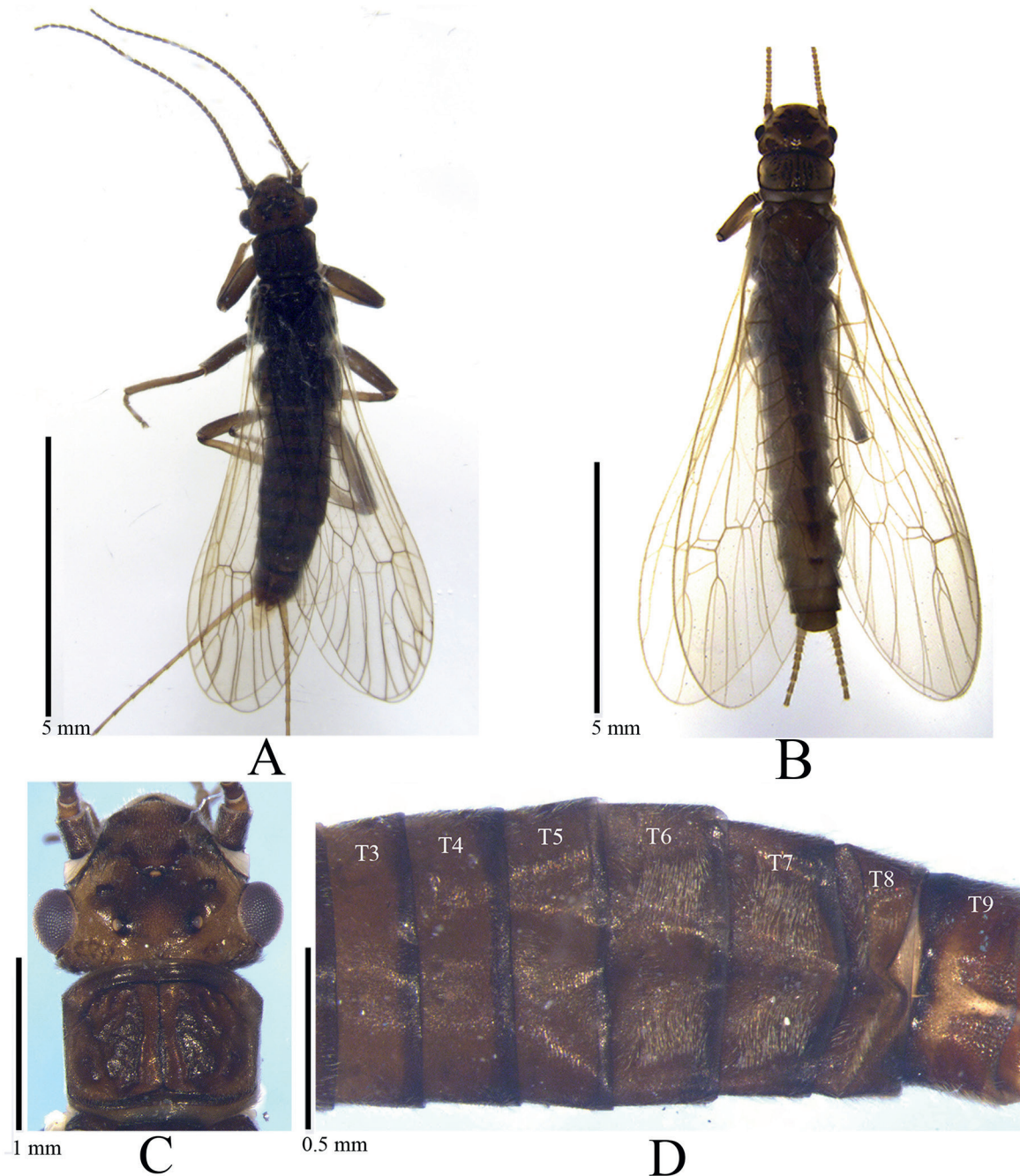
**Female**

ADULT HABITUS (Figs 5B, 9A). Forewing length 7.8–9.8 mm, hindwing length 5.8–8.0 mm (N=7). Body coloration generally similar to male.

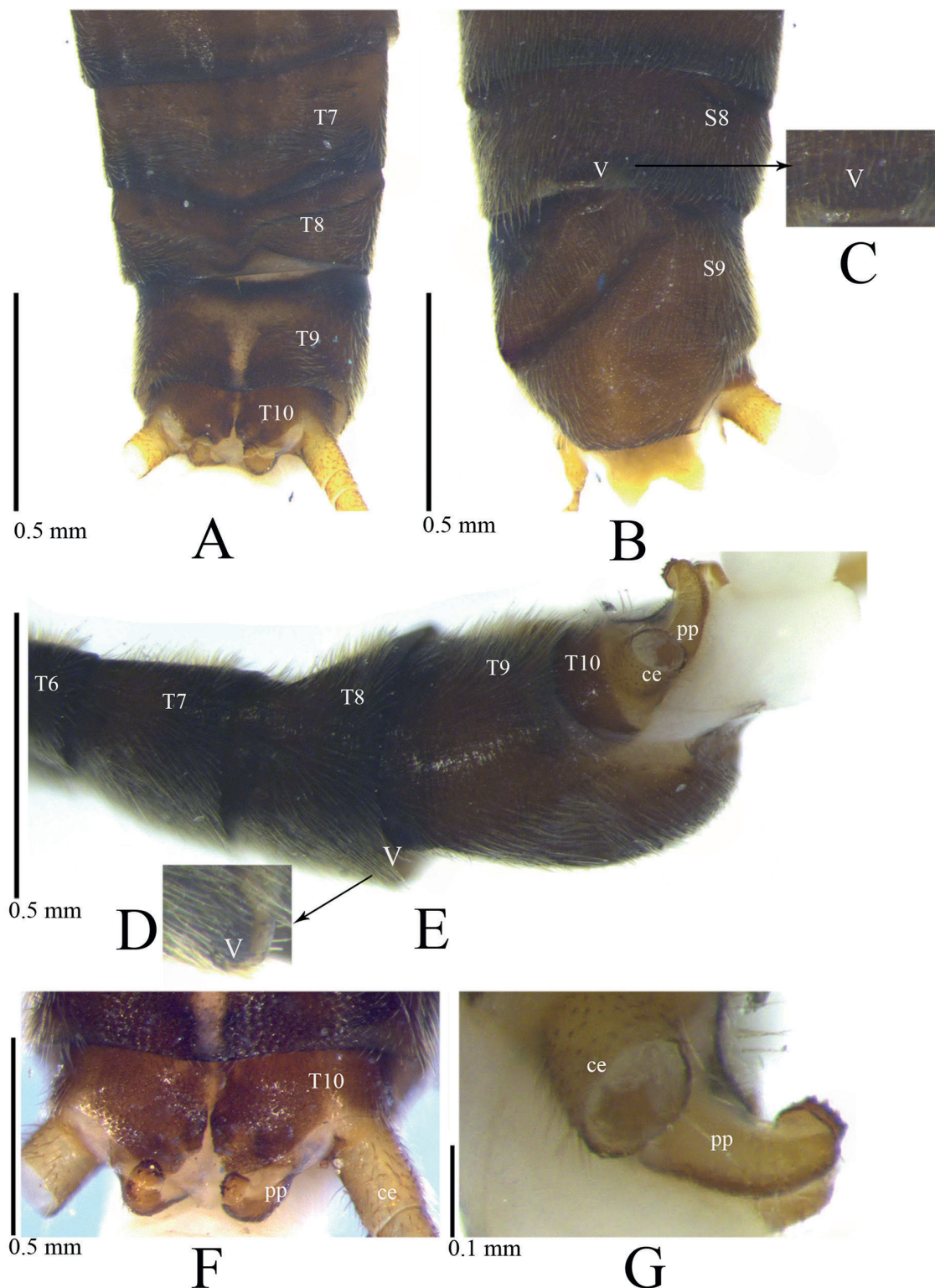


ABDOMEN (Fig. 9B–D). Abdominal segments lighter and terga 1–8 with black medial tergal stripes in young individuals. Tergum 10 unmodified. Sternum 8 with sclerotized lateral portion and posterior subgenital plate, anteromedial portion membranous. Subgenital plate broadly triangular with dense long hairs, covering anterior third of sternum 9, with a posteromedial notch; lateral margins partially separated and heavily sclerotized. Sternum 9 with a pair of slope paramedial strips.

EGG. Unknown.



**Fig. 5.** *Tibetisoperla sclerotica* sp. nov. **A.** ♂, holotype (HIST) habitus, dorsal view. **B.** ♀, paratype (HIST), habitus, dorsal view. **C.** ♂, holotype (HIST), head and pronotum, dorsal view. **D.** ♂, holotype (HIST), terga 3–9, dorsal view. Abbreviations: see Material and methods.



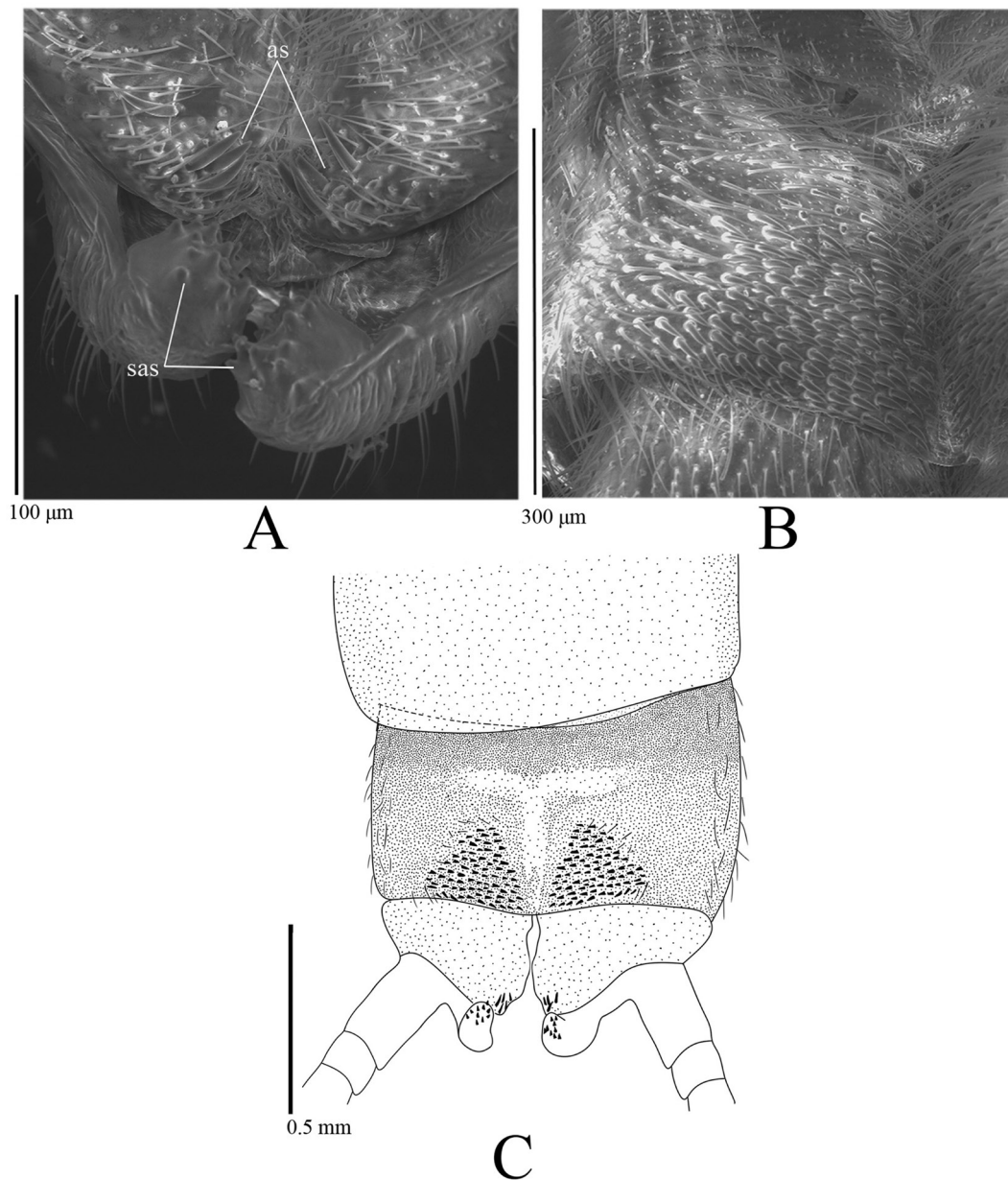
**Fig. 6.** *Tibetisoperla sclerotica* sp. nov., ♂, holotype (HIST). **A.** Terminalia, dorsal view. **B.** Terminalia, ventral view. **C.** Vesicle, ventral view. **D.** Vesicle, lateral view. **E.** Terminalia, lateral view. **F.** Tergum 10 and paraproct, dorsal view. **G.** Apex of tergum 10 and paraproct, lateral view (cercus removed). Abbreviations: see Material and methods.

**Distribution**

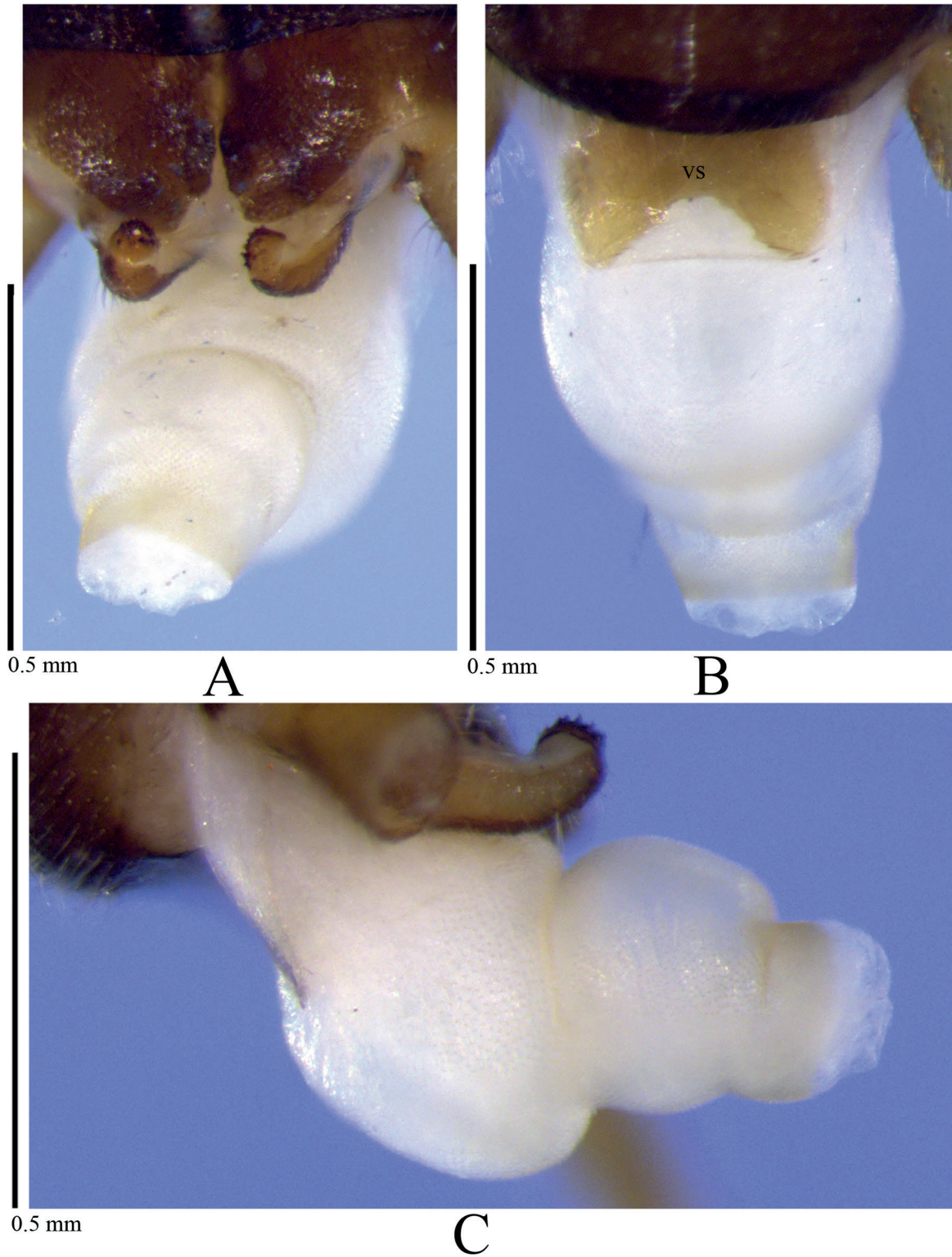
China: Qinghai Province. Presently only known from Menyuan County.

**Remarks**

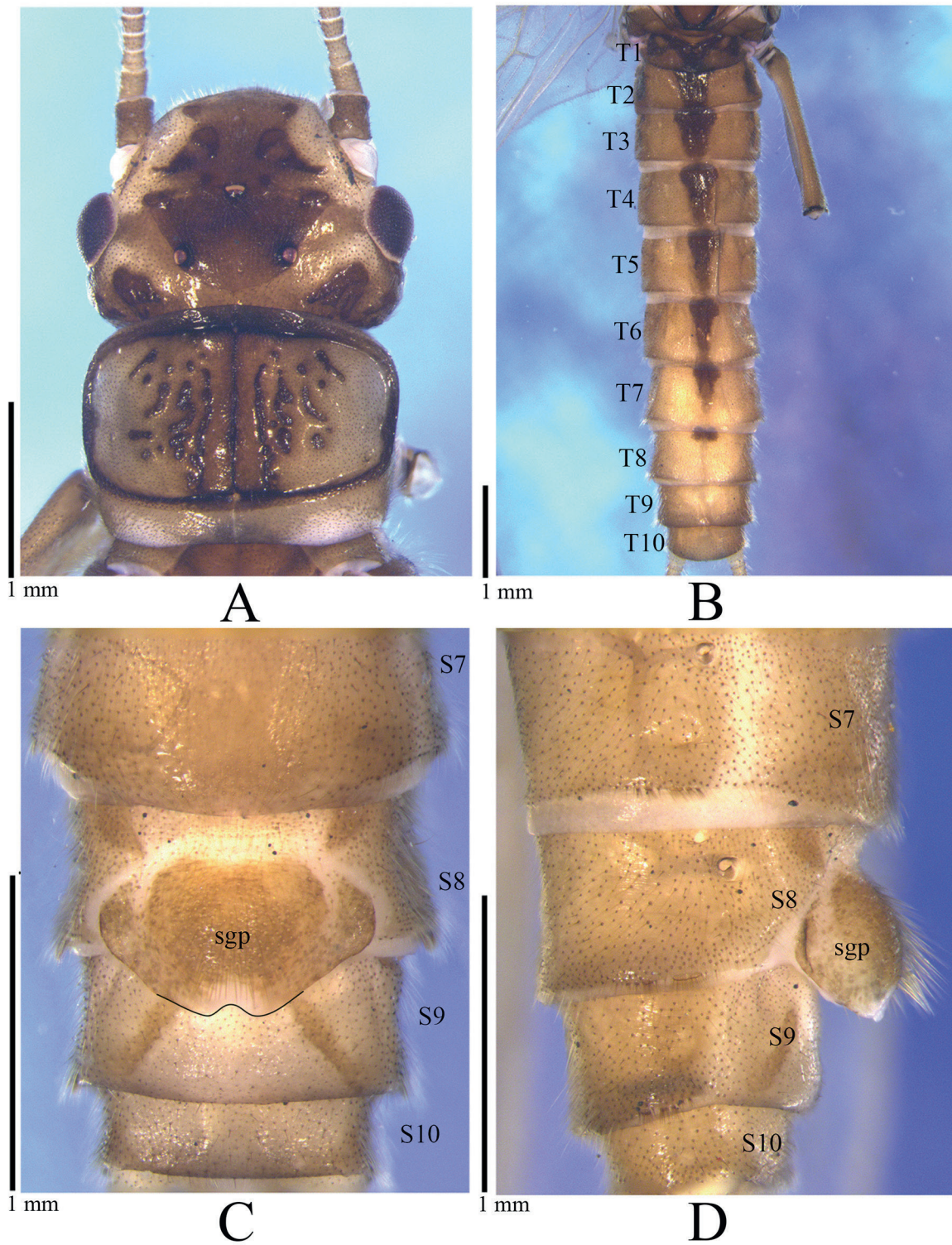
The new species closely resembles *T. wangluyui* Huo & Du, 2021 in dark body coloration and reduced vesicle on sternum 8, but it is easily separated from that species by the large ventrobasal sclerite of aedeagus which is entirely membranous in *T. wangluyui*.



**Fig. 7.** *Tibetisoperla sclerotica* sp. nov., ♂, holotype (HIST). **A.** Tergum 10 and paraproct, dorsal view. **B.** Tergum 9, left portion, dorsal view. **C.** Terminalia, dorsal view. Abbreviations: see Material and methods.



**Fig. 8.** *Tibetisoperla sclerotica* sp. nov., ♂, holotype (HIST). **A.** Aedeagus, dorsal view. **B.** Aedeagus, ventral view. **C.** Aedeagus, lateral view. Abbreviations: see Material and methods.

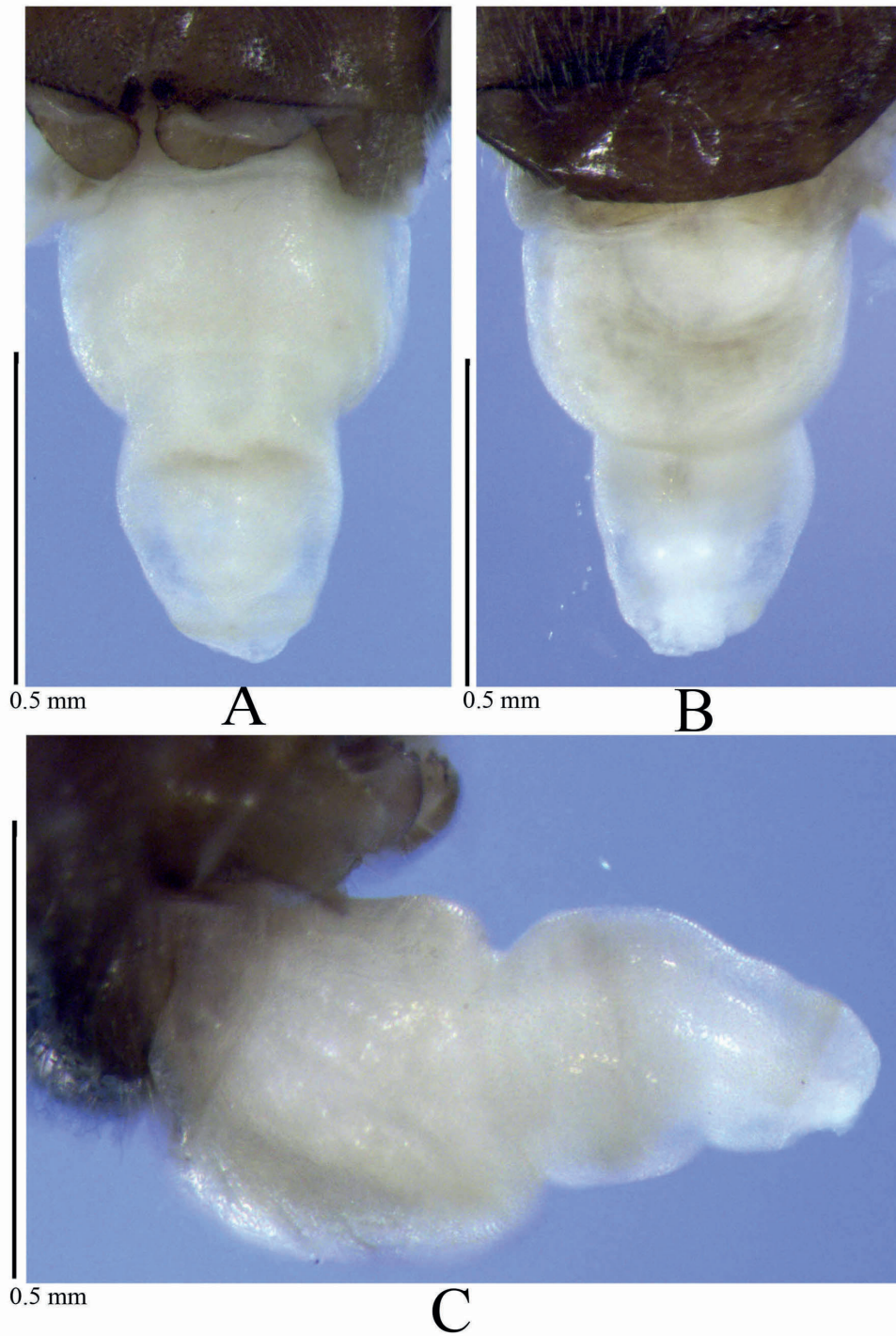


**Fig. 9.** *Tibetisoperla sclerotica* sp. nov., ♀, paratype (HIST). **A.** Head and pronotum, dorsal view. **B.** Abdomen, dorsal view. **C.** Subgenital plate, ventral view. **D.** Subgenital plate, lateral view. Abbreviations: see material and methods.

*Tibetisoperla wangluyui* Huo & Du, 2021

Fig 10

*Tibetisoperla wangluyui* Huo & Du, 2021: 343, figs 1–10 (original description).



**Fig. 10.** *Tibetisoperla wangluyui* Huo & Du, 2021, ♂ (HIST). **A.** Everted aedeagus, dorsal view. **B.** Everted aedeagus, ventral view. **C.** Everted aedeagus, lateral view.

### Material examined

CHINA • 2 ♂♂; Qinghai Province, Tianjun County, Buha River; 37°34'8.51" N, 98°39'24.07" E; alt. 3535 m; 13–14 Jul. 2021; Wei-Hai Li leg.; HIST.

### Distribution

China: Tibet and Qinghai provinces. Two males represent the first record for Qinghai Province.

### Remarks

This dark brown species is characterized by reduced vesicle with semicircular posterior margin and membranous aedeagus lacking sclerite. Two males examined here represent the first record for Qinghai Province.

### Discussion

The Isoperlinae *Tibetisoperla* present remarkable morphological differences from other genera of this subfamily (Huo & Du 2021). Together with the finding of these two additional species, bilobate posterior half of tergum 10 with large apical setae and a spiny apical sclerite of paraproct appear consistent with the type species, and should be considered the generic characters. Whether the aedeagus is with or without a sclerite, or sternum 8 has a developed or reduced vesicle, proved to be variable in this genus. The genus was originally known from Tibet and soon found in Qinghai Province of China in this study. The present discovery may allude to a higher diversity of *Tibetisoperla* on a wider geographical scale.

### Acknowledgements

We thank Mr Jixiang Wang for his helping in collecting specimens. We are very grateful to Dr Dávid Murányi for his assistance in the earlier draft of this paper. The research was supported by the National Natural Science Foundation of China (No. 31970402) and the commissioned project of the Qilian Mountain National Park administration of Qinghai Province, P. R. China (QHTX-2021-006).

### References

- Banks N. 1906. On the perlid genus *Chloroperla*. *Entomological News* 17: 174–175.
- Burmeister H.C.C. 1839. Plecoptera. *Handbuch der Entomologie, Berlin* 2 (2): 863–881.
- Cao Z.S., Wang Y. & Li W.H. 2020. A new species of *Isoperla* (Plecoptera: Perlodidae) from China. *Zootaxa* 4858 (2): 251–260. <https://doi.org/10.11646/zootaxa.4858.2.6>
- DeWalt R.E., Maehr M.D., Hopkins H., Neu-Becker U. & Stueber G. 2021. Plecoptera Species File Online. Vers. 5.0/5.0. Available from <http://Plecoptera.SpeciesFile.org> [accessed 20 Nov. 2021].
- Frison T.H. 1942. Studies of North American Plecoptera, with special reference to the fauna of Illinois. *Bulletin of the Illinois Natural History Survey* 22: 235–355. <https://doi.org/10.21900/j.inhs.v22.245>
- Huo Q.B. & Du Y.Z. 2021. A new genus of Isoperline (Plecoptera: Perlodidae) from Tibet, China. *Zootaxa* 4996 (2): 343–352. <https://doi.org/10.11646/zootaxa.4996.2.8>
- Latreille P.A. 1802. *Histoire naturelle, générale et particulière des crustacés et des insectes: ouvrage faisant suite aux oeuvres de Leclerc de Buffon, et partie du cours complet d'histoire naturelle rédigé par C. S. Sonnini, membre de plusieurs Sociétés savantes. Tome 3.* F. Dufart, Paris.
- Linnaeus C. 1758. *Systema naturae per regna tria natur, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.* Laurentii Salvii, Holmi. <https://doi.org/10.5962/bhl.title.559>

Murányi D. 2011. Balkanian species of the genus *Isoperla* Banks, 1906 (Plecoptera: Perlodidae). *Zootaxa* 3049: 1–46. <https://doi.org/10.1643/CE-08-219>

Szczytko S.W. & Kondratieff B.C. 2015. A Review of the Eastern Nearctic Isoperlinae (Plecoptera: Perlodidae) with the description of twenty-two new species. *Monographs of Illiesia* 1: 1–289.

Teslenko V.A. & Zhiltzova L.A. 2009. *Key to the Stoneflies (Insecta, Plecoptera) of Russia and Adjacent Countries. Imagines and Nymphs*. Russian Academy of Sciences, Far Eastern Branch, Dalnauka, Vladivostok.

Yang D. & Li W.H. 2018. *Species Catalogue of China. Vol. 2. Animals, Insecta (III), Plecoptera*. Science Press, Beijing.

*Manuscript received: 30 January 2022*

*Manuscript accepted: 16 May 2022*

*Published on: 15 June 2022*

*Topic editor: Tony Robillard*

*Section editor: Helen M. Barber-James*

*Desk editor: Eva-Maria Levermann*

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d'histoire naturelle, Paris, France; Meise Botanic Garden, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark; Naturalis Biodiversity Center, Leiden, the Netherlands; Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; Real Jardín Botánico de Madrid CSIC, Spain; Zoological Research Museum Alexander Koenig, Bonn, Germany; National Museum, Prague, Czech Republic.