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STUDIES ON KOREAN STONEFLIES (INSECTA: PLECOPTERA) WITH DESCRIPTIONS OF TWO NEW SPECIES

Bill P. Stark

Box 4045, Department of Biology, Mississippi College, Clinton, Mississippi, U.S.A. 39058
E-mail: stark@mc.edu

ABSTRACT

Two new species, *Kathroperla doma* sp.n. (Chloroperlidae) and *Perlodes kippenhani* sp.n. (Perlodidae), are recognized, the female and egg are described for *Kamimuria zwicki* Stark & Sivec, and new Korean records are given for *Kiotina decorata* (Zwick), *Neoperla ussurica* Sivec & Zhiltzova, *Oyamia nigribasis* Banks, *Yoraperla han* Stark & Nelson and *Y. uchidai* Stark & Nelson. The description of *K. doma* represents the first Asian record of genus *Kathroperla.* An updated checklist of 44 formally named plecopterans recorded from the Republic of Korea is presented.

Keywords: Plecoptera, stonefly, Republic of Korea, new species, new records

INTRODUCTION

The knowledge of Korean stoneflies continues to increase since the studies of Zwick (1973a, 1973b) in which 13 species were formally recognized and a few additional species represented by females were identified at the generic level. Kim et al. (1998) provide details for 31 species recorded in the Republic of Korea at that time; subsequently Ham (2008, 2009), Ham & Bae (2002), Jin & Bae (2005a, 2005b), Stark & Sivec (2008a, 2008b) and Zwick & Teslenko (2001), among others, have provided data on Korean Plecoptera. Ham (2008) reports 40 species are known for the Republic of Korea and 23 for the Democratic People's Republic of Korea. These lists will doubtlessly continue to grow as new collections are made and analyzed. The present study is based on a small collection of systellognathan stoneflies made by Pierre Tripotin with Malaise traps, or by Michael Kippenhan, Bozeman, Montana, at a few sites in the Republic of Korea. The Tripotin material was made available for study by the United States National Museum (USNM) and the Kippenhan material by B.C. Kondratieff, Colorado State University; specimens from both collections are deposited in the United States National Museum.

RESULTS AND DISCUSSION

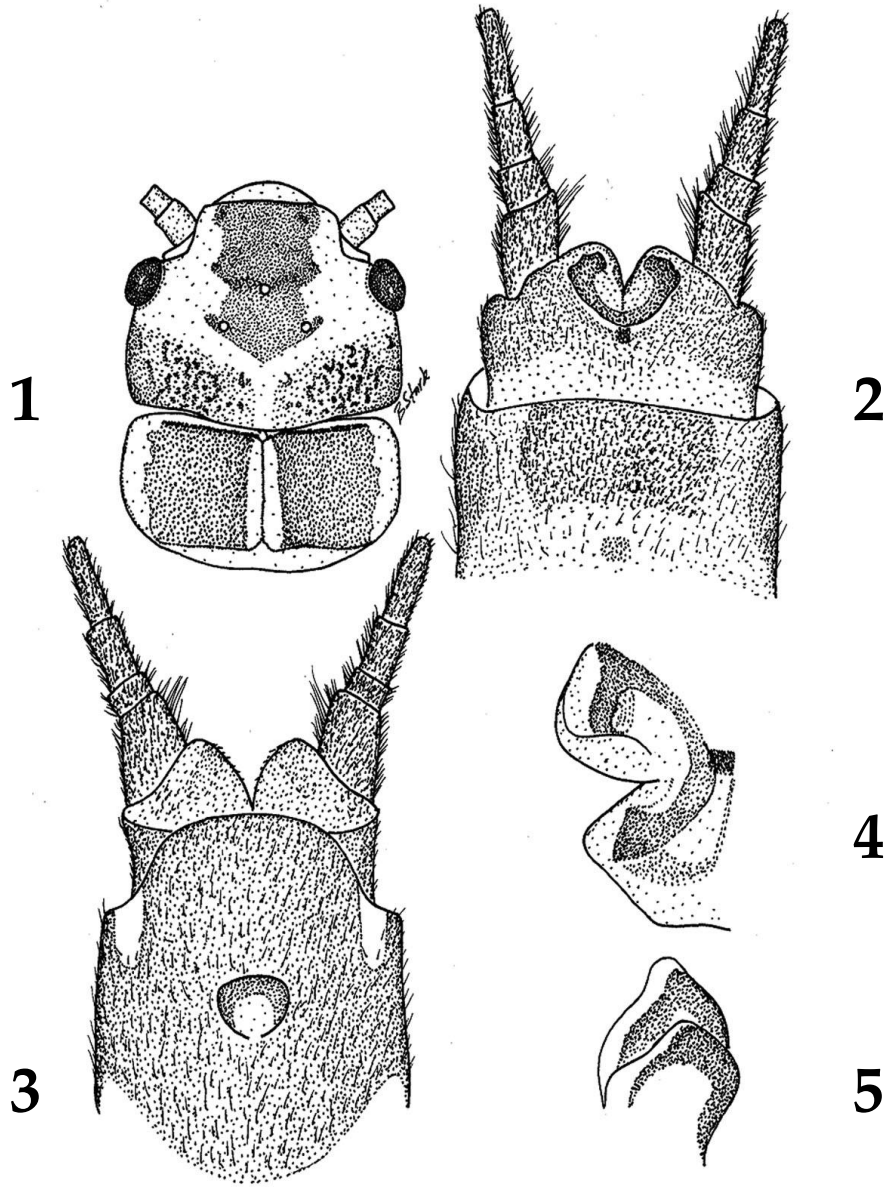
Chloroperlidae

Kathroperla doma sp. n.

(Figs. 1-10)

Material examined. Holotype ♂, Republic of Korea, Chungbuk, Sangchon-Myeon, Dungeon-li near Doma Pass, 750 m, 2-26 May 2006, P. Tripotin coll. 2, Malaise trap in forest on small stream (USNM). Paratype: Republic of Korea, Gangwondo, Odaesan, near Dong-daesan, 800 m, 37° 44.31′ N, 128° 35.71′ E, 3-21 June 2006, P. Tripotin, coll. 4, Malaise trap in old Korean fir forest, 1♀ (USNM).

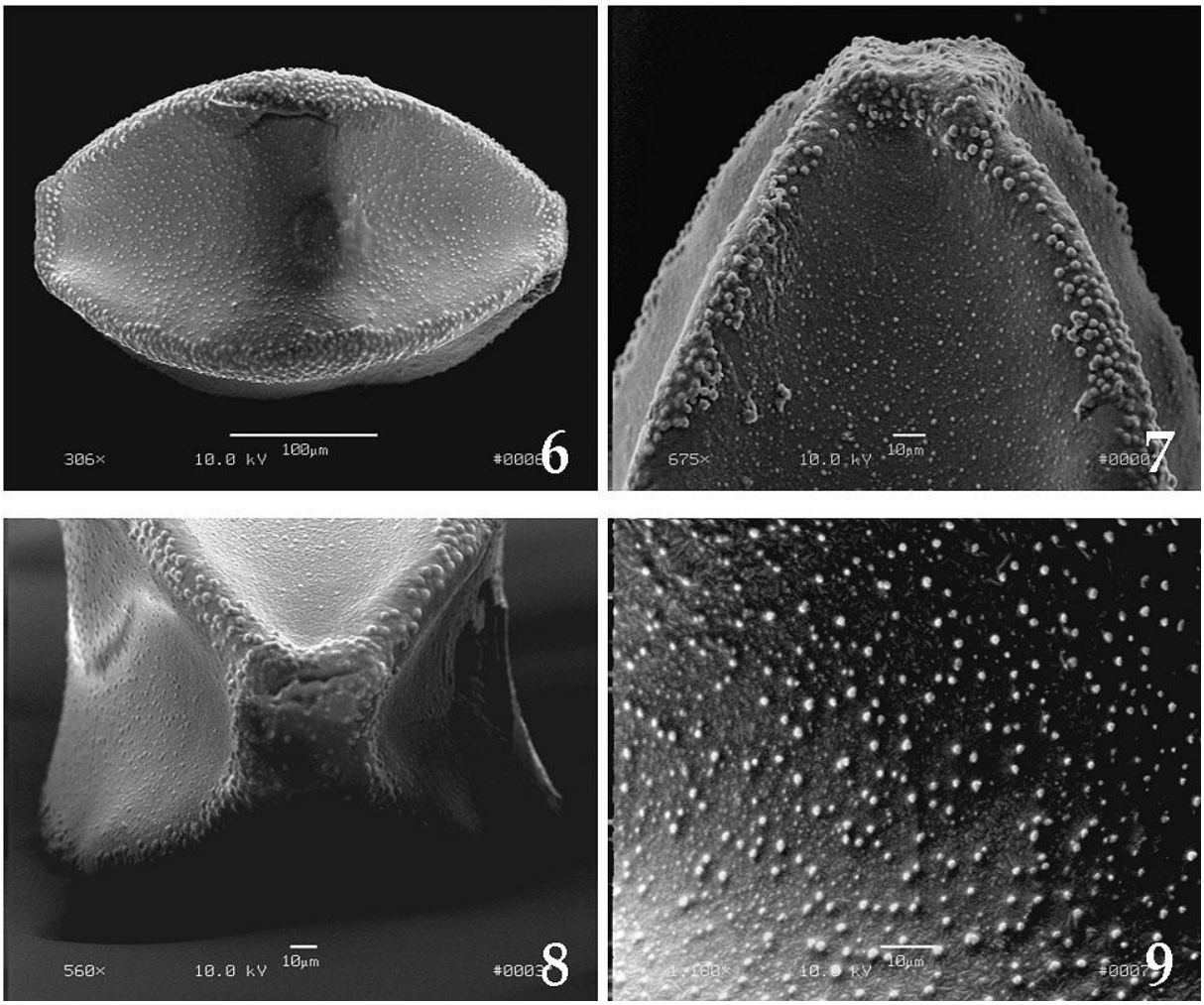
Adult habitus. General color brown with pale areas on body. Head with dark brown median patch covering ocelli and extending to anterior frons (Fig. 1); occiput paler but with numerous irregularly-shaped, scattered maculations. Pronotum brown but with pale median and lateral margins.Thoracic sterna with extensive dark brown areas. Wings pale with dark veins, legs pale brown, cerci dark brown.



Figs. 1-5. *Kathroperla doma* structures. 1. Head and pronotum. 2. Male terminalia, dorsal. 3. Male terminalia, ventral. 4. Epiproct, oblique dorsal aspect. 5. Epiproct, oblique lateral aspect.

Male. Forewing length 15 mm. Cerci 4-segmented. Abdominal tergum 9 bearing a slightly darker, median brown patch covered with short, thick setae (Fig. 2). Epiproct with a butterfly-like shape (Figs. 2, 4-5); anterior sclerite very dark, lateral margins elevated and median field depressed in a deep V; posterodorsal margin of tergum 10 darker and with a short median, very dark stem connecting to median area of epiproct sclerite; epiproct surrounded on posterolateral margins by membranous lobes of paraprocts. Vesicle of sternum 9 almost circular in outline and bearing very fine setae on ventral surface; margins darker around dorsum (Fig. 3). Aedeagus not everted.

Female. Forewing length 16 mm. Cerci 4-segmented. Subgenital plate reaches beyond mid point of



Figs. 6-9. *Kathroperla doma* egg. 6. Entire egg, lateral aspect. 7. Collar end, lateral aspect. 8. Collar end, apical aspect. 9. Detail of chorionic surface.

sternum 9; posterior margin bifurcate with divergent lobes (Fig. 6); internal dark bar extends from base of notch for most of plate length.

Egg. Based on eggs dissected from ovarioles. Four sided. Length ca. 350 µm; width at midlength ca. 216 µm and tapered to both ends (Fig. 6); apical width ca. 50 µm. Poles blunt, similar, almost square and with four longitudinal ribs extending between corners of poles (Figs. 7-8). Surfaces between ribs concave and covered with small irregularly sized blunt projections (Fig. 9).

Larva. Unknown.

Etymology. The species name, used as a noun in apposition, is based on Doma Pass, where the holotype specimen was collected.

Diagnosis. *Kathroperla doma* while generally consistent with the *Kathroperla* ground plan, has a derived cercal structure, female subgenital plate structure and egg structure that separate it from both Nearctic species. Males are similar to *K. takhoma* in vesicle shape but lack the patches of sensilla basiconica found on tergum 10 in that species. The new species is also distinguished from the Nearctic species on the basis of the 4-segmented cerci (Figs. 2-3); both Nearctic species have 12-13 cercal segments. The female subgenital plate is more similar in length

and basal outline to *K. perdita* but differs in having divergent apical lobes and in the presence of a mesal internal sclerite (Fig. 10). Eggs of the Nearctic species are circular in cross section and have coarsely tuberculate chorionic surfaces whereas the egg of *K. doma* is more or less 4 sided and has a finely tuberculate chorion.

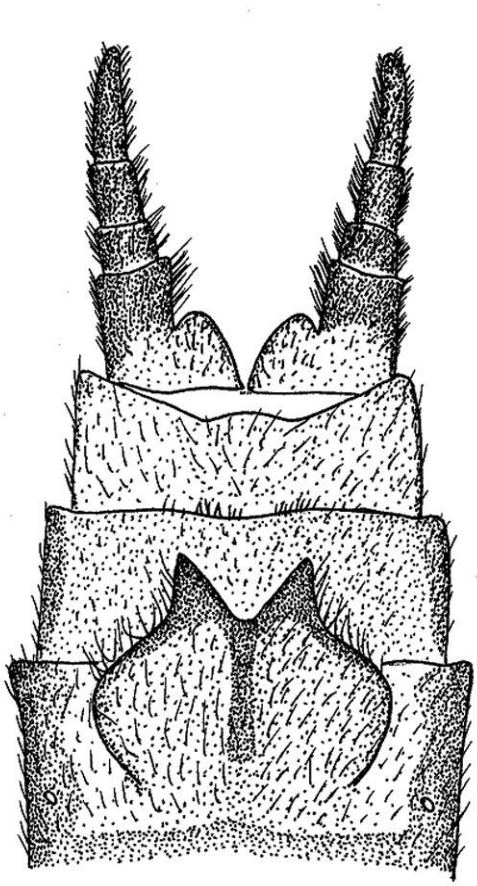


Fig. 10. *Kathroperla doma* female terminalia, ventral.

Comments. The genus *Kathroperla,* originally proposed from a single female specimen of *K. perdita* Banks collected in British Columbia (Banks 1920), remained monotypic until Stark & Surdick (1987) described *K. takhoma* from California and Washington. The group was thought to be a Nearctic endemic, but like *Utaperla* Ricker, another paraperline genus reported earlier from the Russian Far East (Zhiltzova 1982; Zhiltzova & Levanidova 1970; Zwick 2006), *Kathroperla* is now also known from the eastern Palearctic region.

Peltoperlidae

Yoraperla han Stark & Nelson

Yoraperla han Stark & Nelson, 1994:254. Holotype ♂ (Uchida collection). Sesok-pyongjon, Chiri-san, Kyongsang-nam-do, [Republic of] Korea

Material examined. Republic of Korea: Chungbuk, Songchon-Myeon, Dungeon-li, near Doma Pass, 750 m, 2-26 May 2006, P. Tripotin, Malaise trap in forest on small stream, 6♂, 10♀ (USNM).

Comments. This species has apparently not been reported since the original description based on 9 male and 20 female specimens from a single locality (Stark & Nelson 1994). These specimens agree in most details with the original description, but a few scattered setal-spines and a covering of fine, short microtrichia occur on the lateral aedeagal lobes of the new specimens, in contrast to the type series in which the lateral lobes are said to be "…well developed but without armature".

Yoraperla uchidai Stark & Nelson

Yoraperla uchidai Stark & Nelson, 1994:257. Holotype ♂ (Uchida collection), Odae-chon, Odae-san, 700 m, Kang-uron-do, [Republic of] Korea

Material examined. Republic of Korea: Gangwando, Odaesan, near Dong-daesan, 800 m, 37° 44.35′ N, 128° 35.71′ E, 3-21 June 2006, P. Tripotin, Malaise trap in old Korean fir forest, 8♀ (USNM).

Comments. This is apparently the first report of *Y. uchidai* since the original description based on a male and female from two sites on Odaesan. Unfortunately, no additional male specimens are available for comparison with the holotype.

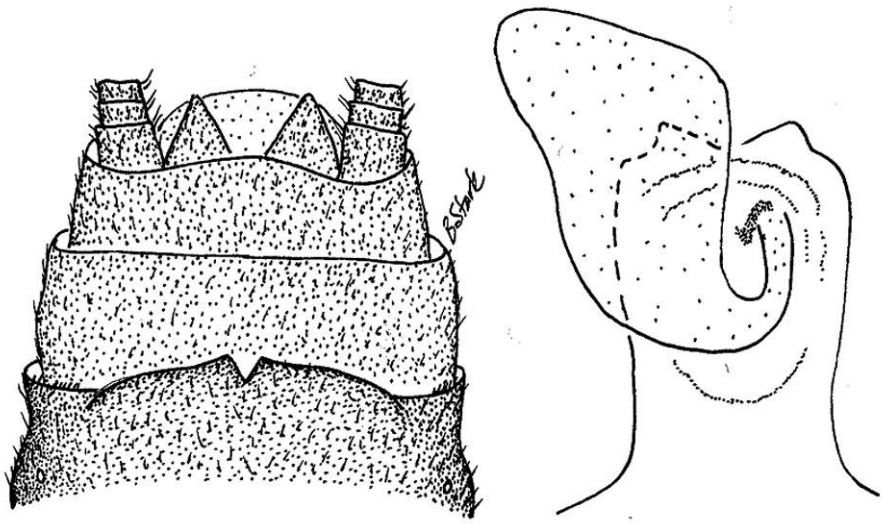
Perlidae

Kamimuria zwicki Stark & Sivec
(Figs. 11-18)

Kamimuria zwicki Stark & Sivec, 2008a:1. Holotype ♂ (Illinois Natural History Survey), Jirisan, Mamyang-gun, Songjeon-li, Mansu-sa, [Republic of] Korea

Material examined. Republic of Korea: Jirisan, Hamyang-gun, Songjeon-li, Macheon-Myeon, 700 m, 35° 20.93′ N, 127° 38.50′ E, 27 July-16 August 2004, P. Tripotin, Malaise trap on small stream, 4♂, 2♀ (USNM).

Female. Forewing length 26 mm. Subgenital plate short and triangular, projecting over base of sternum 9 and bearing a small triangular notch (Fig. 11). Vagina membranous except for a small sclerite at spermatheca base (Fig.12); outline somewhat rectangular but with anterolateral margins slightly projecting. Spermathecal stalk forming a half-coil; spermatheca an elongate, balloon-like structure.



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Figs. 11-12. *Kamimuria zwicki* female structures. 11. Terminalia, ventral. 12. Vagina and spermatheca, ventral.

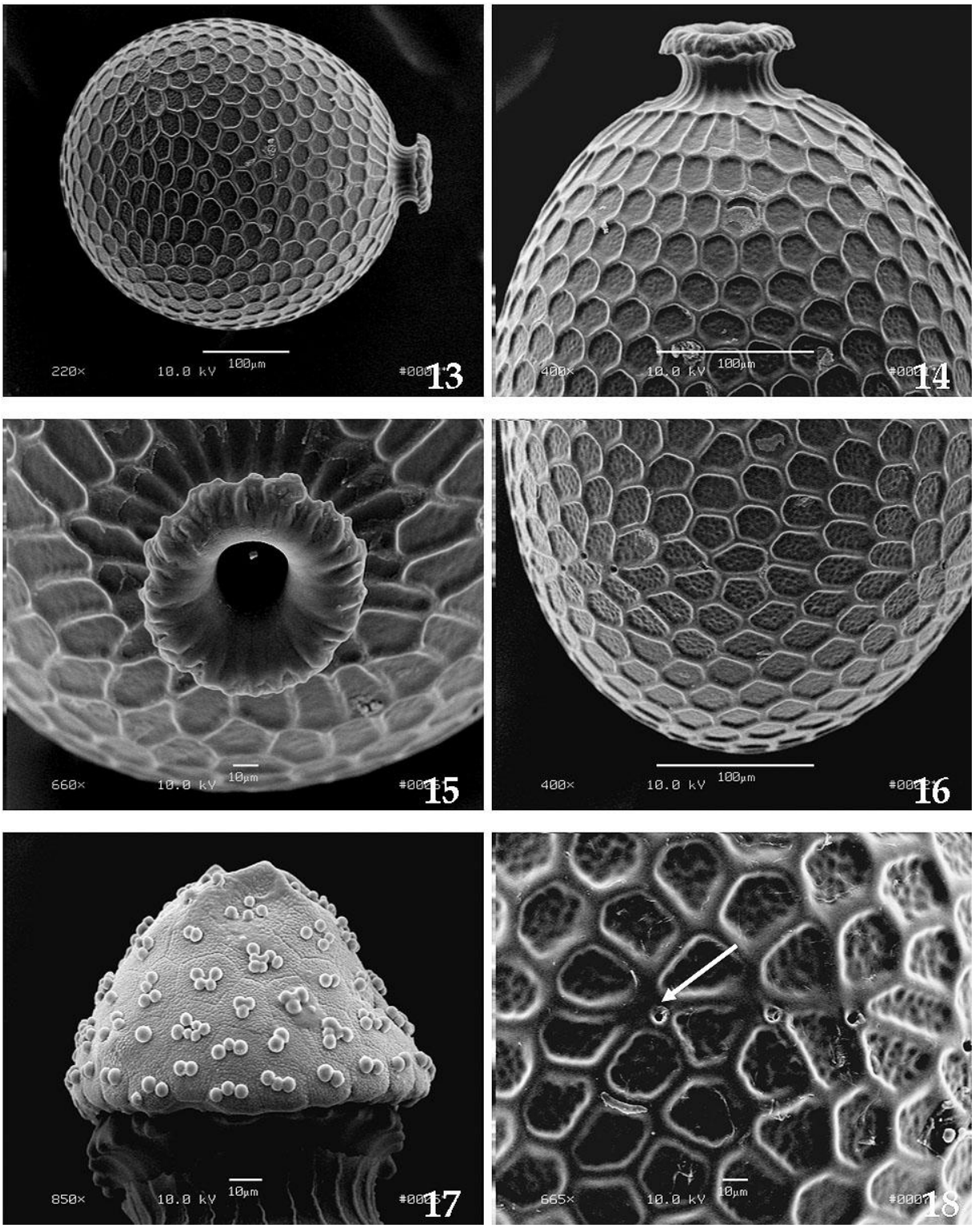
Egg. Outline of body oval, length (including collar) ca. 420 µm, width ca. 347 µm (Fig. 13). Collar stalked with flanged and incised rim, collar length ca. 38 µm, collar diameter across rim ca. 77 µm (Figs. 14-15); anchor mushroom shaped and covered with small globular structures imbedded in follicle cell impressions (Fig. 17). Chorionic surface covered throughout with hexagonal follicle cell impressions (Figs. 13, 16); walls of follicle cell impressions smooth and raised above pitted floors (Figs. 14-16). Micropyles form an irregular subequatorial row; each orifice surrounded by rosette of follicle cell impressions (Fig. 18).

Comments. The egg of this species is generally similar to that of *K. lyubaretzi* Teslenko (Teslenko 2006) but the chorionic surface of that species is coarsely and regularly pitted throughout and the follicle cell impression walls are not elevated. In addition, the anchor of *K. lyubaretzi* is flattened and the female subgenital plate has no notch. Stark & Sivec (2008a) commented on the similarity of internal male genitalia for these probable sister species.

Kiotina decorata (Zwick)

Schistoperla decorata Zwick, 1973a:166. Holotype ♂ (Hungarian Natural History Museum), Kaesong, Bagyon Mts., Kengi Province, [Republic of] Korea
Kiotina decorata: Uchida, 1990:135
Kiotina decorata: Stark & Sivec, 2008b:166

Material examined. Republic of Korea: Ulsan Metro City, Sangbuk-Myeon, Gajisan Provincial Park, Soeknamsa, 24 May 2006, M. Kippenhan, 2♀ (USNM). Chungnam, Keumsan, Gunbuk-Myeon, Sanan, 20 April-8 May 2005, P. Tripotin, Malaise trap on small stream, 1♂ (USNM).



Figs. 13-18. *Kamimuria zwicki* egg. 13. Entire egg, lateral aspect. 14. Collar end, lateral aspect. 15. Collar end, apical aspect. 16. Anterior end, lateral aspect. 17. Anchor. 18. Micropyle (arrow).

Comments. Ra et al. (1991) redescribed the adults and provided new records and the first description of the egg of this species; Stark & Sivec (2008b) gave additional Korean records.

Neoperla ussurica Sivec & Zhiltzova

Neoperla ussurica Sivec & Zhiltzova, 1996:14. Holotype ♂ (Zoological Institute, St. Petersburg), Ussuri River, 6 km from Stepanovka, Primorskiy Kray, Russia

Material examined. Republic of Korea: Kangwondo, Chuncheon Nam, Myson, Magog-li, 70 m, 37° 43.786'N, 127° 34.689' E. 24 May-12 June 2004, P. Tripotin, Malaise trap in larch planted forest with dense shrub layer, 1♂ (USNM).
Comments. This specimen is in close agreement with those illustrated in the original description, and represents a small range extension from the earlier reported distribution in the Russian Far East (Sivec & Zhiltzova 1996).

Oyamia nigribasis Banks

Oyamia nigribasis Banks, 1920:316. Holotype ♂ (USNM), Yalu River, 150-200 miles from mouth [Korea/Manchuria border]

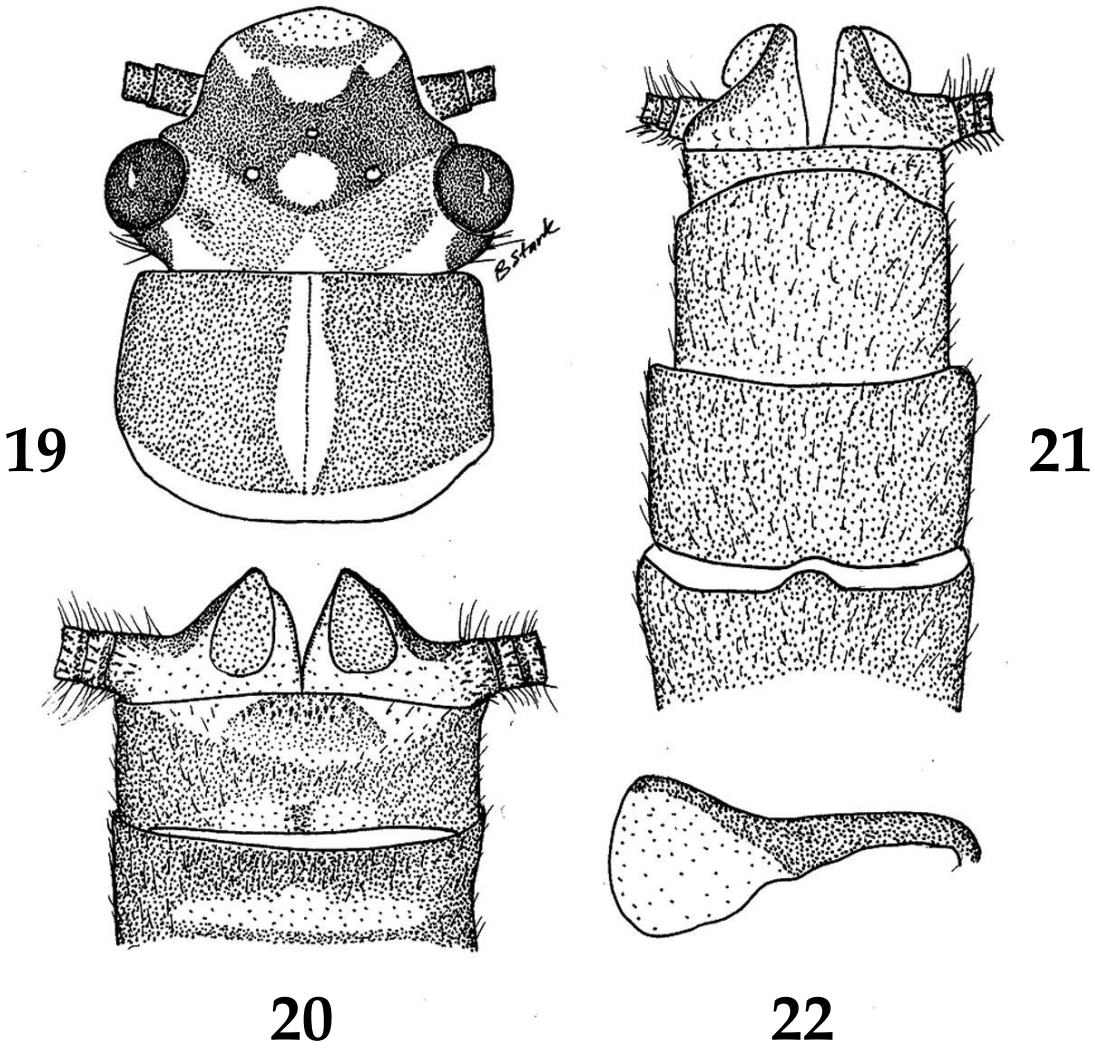
Material examined. Republic of Korea: Ulsan Metro City, Sangbuk-Myeon, Gajisan Province Park, Soeknamsa, 24 May 2006, M. Kippenhan, 2♀ (USNM).
Comments. Zwick (1973b) reported this species from a small series of specimens collected in Hjangsan, Mjohjang-san, Korea, by personnel of the Institute of Zoology, Polish Academy of Sciences in 1965. Ra et al. (1991) gave additional Korean records, redescribed the adults and provided scanning electron micrographs of the eggs of this species (as *Oyamia coreana* Okamoto), and Isobe & Uchida (2009) recently reviewed the genus, including new data for *O. nigribasis* and the Japanese species.

Perlodidae

Perlodes kippenhani sp. n.
(Figs. 19-22)

Material examined. Holotype ♂, Republic of Korea, Gangwondo, Pyeongchang-gun, Odaesan National Park trail to Sangwonsa, 13 May 2006, M. Kippenhan (USNM).
Adult habitus. General color black with limited areas of yellow pigment. Head dark but with circular interocellar yellow spot and pale M-line forward of median ocellus (Fig. 19); additional pale areas on occiput. Pronotum black with yellow median stripe, thoracic venter mostly black. Femora black, tibiae dark at base but slightly paler for most of length. Wing membrane transparent to pale brown, veins dark brown. Wings with several crossveins between R vein and Costa beyond cord. Gills apparently absent or, if present, collapsed under submentum. Basal two abdominal segments divided by pleural membrane.
Male. Forewing length 13 mm. Abdominal terga without lobes, but terga 9-10 dark with areas of pale pigment (Fig. 20); tergum 10 with pale posteromedian area armed with a small patch of short, anteriorly directed, thickened setae; tergum 8 and 9 with wide patches of sensilla basiconica near posterior margins. Paraprocts with slender, dark sclerite along caudolateral margins and much of anterior area occupied by an expansive, eversible membranonous lobe, which extends forward from apex toward posterior margin of tergum 10 (Figs. 20-22). Abdominal sternum 7 with a small median lobe projecting dorsad into intersegmental membrane (Fig. 22).
Female. Unknown.
Larva. Unknown.
Etymology. The patronym honors Michael Kippenhan, collector of the holotype specimen.
Diagnosis. *Perlodes* is poorly known in Asia, and only one species, *P. stigmata* Ra, Kim, Kang & Ham, has been reported from Korea (Ra et al. 1994). The new species differs from *P. stigmata* in several respects including having the pronotal disks almost entirely black, in lacking submental gills, in having two rather than three basal abdominal segments divided by pleural membrane, and in details of the male paraprocts. Ra et al. (1994) show the paraprocts of *P. stigmata* as triangular structures projecting posteriorly and crossing near midlength. In *P.*

kippenhani these structures extend upward and terminate on the anteroapical margin with a large membranous bag, or eversible paraproct lobe (EPL of Zwick 1997) similar to those found in at least some other members of *Perlodes* and *Filchneria* (Zwick 1997). No lobe is present on sternum 7 in *Perlodes microcephalus* (Pictet) or *P. disbar* (Rambur) (Zwick pers. comm.) and in *P. kippenhani* this structure projects dorsad and could be easily overlooked. The new species is also similar to one being described by V.A. Teslenko from the Russian Far East (Teslenko pers. comm.) but in her species the posterior margin of tergum 10 extends upward more strongly than in the Korean species and the sclerotized portion of the paraprocts in the Russian species appears to be more extensive than in *P. kippenhani*.



Figs. 19-22. *Perlodes kippenhani* structures. 19. Head and pronotum. 20. Male terminalia, dorsal. 21. Male terminalia, ventral. 22. Paraproct, lateral.

Checklist of Formally Named Plecoptera Known from the Republic of Korea

Capniidae
- *Eucapnopsis stigmatica* Okamoto
- *Paracapnia recta* Zhiltzova

Leuctridae
- *Leuctra fusca* (Linnaeus)
- *Megaleuctra saebat* Ham & Lee
- *Paraleuctra cercia* (Okamoto)
- *Perlomyia mahunkai* (Zwick)

Nemouridae
- *Amphinemura baei* Ham & Lee
- *A. rai* Ham & Lee
- *A. steinmanni* Zwick
- *Nemoura espera* Ham & Lee
- *N. gemma* Ham & Lee
- *N. jezoensis* (Okamoto)
- *N. phasianusa* Ham
- *N. tau* Zwick
- *Protonemura villosa* Ham & Lee

Scopuridae
- *Scopura gaya* Jin & Bae
- *S. jiri* Jin & Bae
- *S. laminata* Uchida
- *S. scorea* Jin & Bae

Taeniopterygidae
- *Taenionema japonicum* (Okamoto)

Chloroperlidae
- *Alloperla joosti* Zwick
- *A. mediata* (Navas)
- *A. rostellata* (Klapálek)
- *Sweltsa illiesi* Zhiltzova & Levanidova
- *S. lepnevae* Zhiltzova
- *S. nikkoensis* (Okamoto)
- *Kathroperla doma* sp.n.

Peltoperlidae
- *Yoraperla han* Stark & Nelson
- *Y. uchidai* Stark & Nelson

Perlidae
- *Claassenia manchuriana* (Banks)
- *Kamimuria coreana* Ra, Kim, Kang & Ham
- *K. zwicki* Stark & Sivec
- *Kiotina decorata* (Zwick)
- *Neoperla quadrata* Wu & Claassen
- *N. ussurica* Sivec & Zhiltzova
- *Oyamia nigribasis* Banks
- *Paragnetina flavotincta* (McLachlan)

Perlodidae
- *Isoperla flavescens* Zhiltzova & Potikha
- *I. lunigera* (Klapálek)
- *I. sowerbyi* Wu & Claassen
- *Perlodes kippenhani* sp.n.
- *P. stigmata* Ra, Kim, Kang & Ham
- *Stavsolus japonicus* (Okamoto)

Pteronarcyidae
- *Pteronarcys sachalina* Klapálek

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