

Bibliographic Review, Systematic Status, and Biogeographic Notes on Korean and Far East Russian Stoneflies (Insecta: Plecoptera) with Their New Korean Records

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Comprehensive bibliographic sources of Plecoptera systematics in Korea and Far East Russia were provided. Systematic status and distributional features of stoneflies in those areas were also discussed. Based on comprehensive type and non-type material examinations in those areas, new synonymies of *Sweltsa colorata* Zhiltzova and Levanidova, 1978 [= *Sweltsa nikkoensis* (Okamoto), 1912] and *Capnia* KUa (Yoon and Aw, 1986) [= *Paracapnia recta* Zhiltzova, 1984] were established; and the following species were newly recorded from Korea: *Taenionema japonicum* (Okamoto), *Paraleuctra cercia* (Okamoto), *Leuctra fusca* (Linnaeus), *Eucapnopsis stigmatica* Okamoto, *Paracapnia recta* Zhiltzova, *Nemoura jezoensis* (Okamoto), *Stavsolus japonicus* (Okamoto), *Isoperla flavescens* Zhiltzova and Potikha, *Alloperla joosti* Zwick, *A. rostellata* (Klapalek), *Sweltsa nikkoensis* (Okamoto), and *S. lepnevae* Zhiltzova.

The Plecoptera is a relatively small order of insects with about 2500 world species. Approximately 200 species of them have been reported from Northeast Asia, including Japan (Kawai, 1967, 1976), Far East Russia (FE Russia) (Zhiltzova and Zapekina-Dulkeit, 1986), and Korea (Yoon and Aw, 1988; Ra et al, 1991a, 1994). Although geographically adjacent, the stonefly faunas of Northeast Asian countries, in particular those of Korea and FE Russia, have not been thoroughly treated because of the difficulties in materials and information exchange as it is known for other aquatic insect groups (Bae, 1997).

The purpose of this study is to review Plecoptera systematics of Korea and FE Russia from a historical perspective and to understand their distributional features in the areas. New distributional records of stoneflies from Korea are also provided.

Materials and Methods

Primary type materials (holotype and lectotype) of 52 species, secondary type materials (paratype and paralectotype) of 48 species, and non-type materials of over 40 additional species of stoneflies from FE Russia and Korea, which were deposited at the

Zoological Institute in St. Petersburg (Zhiltzova, 1995), Chonnam National University, and Seoul Women's University, were comparatively examined for this study. FE Russian type and non-type materials at the Zoological Institute were examined by JSK during his research visit to St. Petersburg in 1997. Additional reference materials from Japan, deposited at Nara Women's University, were also checked by YJB in 1997.

Bibliographic review

Since Okamoto (1921) described *Perla* (*Oyamia*) *coreana* Okamoto [= *Oyamia nigribasis* Banks, 1920] from Korea for the first time, Korean stoneflies have been studied by Wu (1935), Kasai (1938), Ueno (1941), Komatsu (1971), Zwick (1973a, 1973b), Yoon and Aw (1985, 1986, 1988), Ra et al (1991a, 1991b, 1994), and Stark and Nelson (1994). Recent systematic studies of Korean stoneflies were more concerned about the larvae, and larval keys to the known species and genera were prepared (Yoon and Aw, 1988).

The stonefly fauna of FE Russia has been mainly investigated by Zhiltzova and her colleagues since the 1970s, covering almost all the plecopteran taxa (Zhiltzova and Levanidova, 1970, 1978, 1984; Zhiltzova and Zwick, 1971; Zwick et al, 1971; Zhiltzova, 1972, 1974, 1975, 1976a, 1976b, 1977a, 1977b, 1978, 1979a, 1979b, 1979c, 1979d, 1980a, 1980b, 1980c, 1981a, 1981b, 1981c, 1982a, 1982b, 1984a, 1984b, 1988a,

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Table 1. Number of genera and species of the Plecoptera known in Korea and Far East Russia

Family	Korea		Far East Russia	
	No. of genera	No. of species	No. of genera	No. of species
Scopuridae	1	1	0	0
Taeniopterygidae	1	1	4	4
Nemouridae	3	6	4	26
Leuctridae	3	3	4	11
Capniidae	2	2	7	29
Pteronarcyidae	1	1	1	2
Peltoperlidae	1	2	0	0
Perlodidae	5	5	9	22
Perlidae	5	6	9	10
Chloroperlidae	2	4	7	23
Total	24	31	45	127

1988b, 1989, 1995; Levanidova and Zhiltzova, 1976, 1979; Zhiltzova and Zapekina-Dulkeit, 1977, 1986; Zhiltzova and Potikha, 1983, 1992; Potikha and Zhiltzova, 1986, 1996; Zhiltzova and Teslenko, 1989; Teslenko and Zhiltzova, 1989, 1992, 1997; Zhiltzova et al, 1975, 1995; Sivec and Zhiltzova, 1996). Klapalek (1908, 1916), Navas (1912, 1930), Samal (1939), Zapekina-Dulkeit (1955, 1959, 1960, 1970), Kawai (1966, 1969), and Levanidova (1970a, 1970b) were also treated in the FE Russian fauna. These taxonomic studies on FE Russian stoneflies have been based mainly on adults. The comprehensive adult (Zhiltzova and Zapekina-Dulkeit, 1986) as well as larval keys (Zhiltzova and Teslenko, 1997) were prepared.

Systematic status and biogeographic notes

Among the 127 species of stoneflies under 45 genera and 8 families from FE Russia, only one-fourth of them were known in the larval stage (see Zhiltzova and Zapekina-Dulkeit, 1986; Zhiltzova and Teslenko, 1997). The majority of FE Russian stoneflies are small-sized groups, for example Nemouridae (26 spp.), Capniidae (29 spp.), and Chloroperlidae (23 spp.), as well as the common stonefly family Perlodidae (22 spp.) (Table 1).

In contrast, a relatively small number of stoneflies, 31 species under 24 genera and 10 families, including new records herein, have been recorded from Korea (Table 1). This is not only because Korea is geographically limited, but because the Korean fauna has been investigated mainly at larval stage, resulting in many undetermined species (Yoon and Aw, 1988). The number of species of Korean stoneflies would probably double if the 17 species of undetermined larvae were associated to adults and the small-sized groups such as Nemouridae, Leuctridae, Capniidae, and Chloroperlidae were thoroughly investigated.

Based on the presently known distributional ranges of the plecopteran taxa in Korea and FE Russia, some distributional features could be interpreted. While small-sized stoneflies such as the families Capniidae, Nemouridae, and Chloroperlidae abundantly occur in FE Russia, they do not constitute such dominant taxa

Table 2. Occurrence of the plecopteran genera in Korea and Far East Russia

Taxa	Korea	Far East Russia
Scopuridae		
<i>Scopura</i>	○	
Taeniopterygidae		
<i>Taeniopteryx</i>		○
<i>Taenionema</i>	○	○
<i>Strophopteryx</i>		○
<i>Mesyatsia</i>		○
Nemouridae		
<i>Amphinemura</i>	○	○
<i>Nemoura</i>	○	○
<i>Protonemura</i>	○	○
<i>Podmosta</i>		○
Leuctridae		
<i>Leuctra</i>	○	○
<i>Paraleuctra</i>	○	○
<i>Perlomyia</i>		○
<i>Rhopalopsale</i>	○	○
Capniidae		
<i>Capnia</i>		○
<i>Capniella</i>		○
<i>Eucapnopsis</i>	○	○
<i>Isocapnia</i>		○
<i>Mesocapnia</i>		○
<i>Paracapnia</i>	○	○
<i>Takagripopteryx</i>		○
Pteronarcyidae		
<i>Pteronarcys</i>	○	○
Peltoperlidae		
<i>Yoraperla</i>	○	
Perlodidae		
<i>Arcynopteryx</i>	○	○
<i>Perlodes</i>	○	○
<i>Megarcys</i>	○	○
<i>Pictetiella</i>		○
<i>Levanidovia</i>		○
<i>Skwala</i>		○
<i>Stavsolus</i>		○
<i>Isoperla</i>	○	○
<i>Diura</i>		○
<i>Kaszabia</i>	○	○
Perlidae		
<i>Oyamia</i>	○	○
<i>Paragnetina</i>	○	○
<i>Kamimuria</i>	○	○
<i>Neoperla</i>	○	○
<i>Agnentina</i>		○
<i>Acroneuria</i>		○
<i>Claassenia</i>		○
<i>Gibosia</i>		○
<i>Kiotina</i>	○	○
Chloroperlidae		
<i>Paraperla</i>		○
<i>Utaperla</i>		○
<i>Alloperla</i>	○	○
<i>Haploperla</i>	○	○
<i>Suwallia</i>		○
<i>Sweltsa</i>	○	○
<i>Triznaka</i>		○

in the Korean stonefly fauna (Table 1) probably because of the limited investigation range as mentioned above.

Among 48 presently known plecopteran genera from Korea and FE Russia, there are 23 genera common in both areas (Table 2). The following eight species of stoneflies, *Scopura laminata*, *Nemoura tau*, *Pteronarcys macra*, *Yoraperla han*, *Y. uchidai*, *Perlodes stigmatica*, *Kamimuria coreensis*, and *Kiotina decorata* have been recorded to be relatively limited in Korea but have not been found in FE Russia.

One of the most remarkable distributional features in the stonefly fauna in the Northeast Asian region is the distribution of the Scopuridae and Peltoperlidae families. In case of the genus *Scopura* (Scopuridae), its distri-

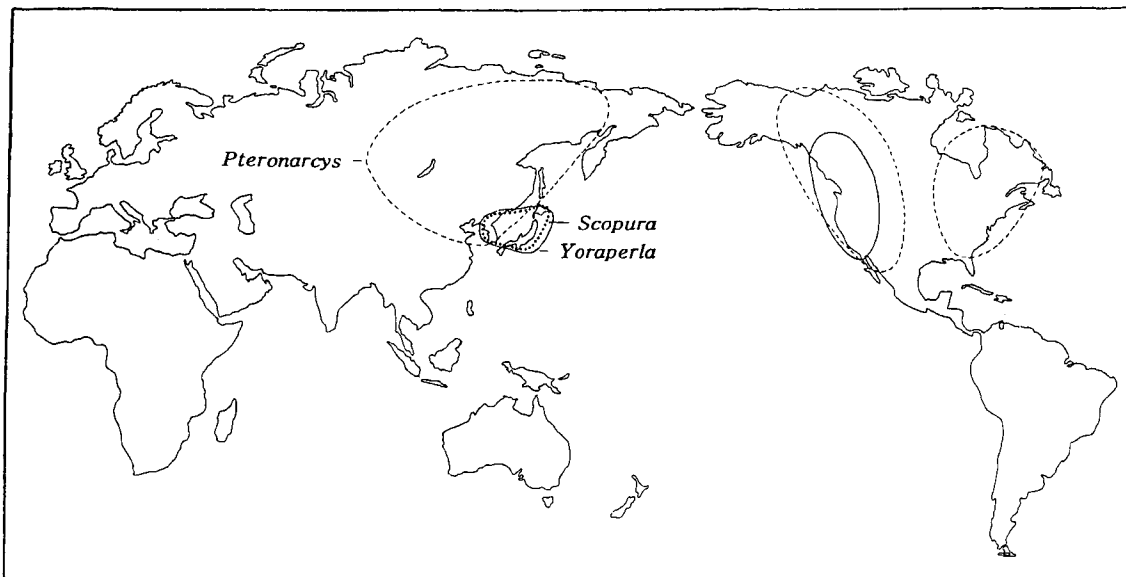


Fig. 1. Distribution of *Scopura* (Scopuridae, dotted line), *Yoraperla* (Peltoperlidae, continuous line), and *Pteronarcys* (Pteronarcyidae, broken line).

but is very limited only in Korea and Japan (Uchida and Maruyama, 1987) (Fig. 1). The genus *Yoraperla* (Peltoperlidae) also occurs only in Korea, Japan, and western North America (Stark and Nelson, 1994) (Fig. 1). Since the phylogenetic relationships within the families have not been thoroughly studied, it is difficult to postulate their historical biogeography at this moment. It is, however, most plausible that those distributions are mainly caused by the vicariance events because the families, in particular, the wingless stonefly family Scopuridae, are considered to be poor dispersers.

The genus *Pteronarcys* (Pteronarcyidae) is distributed in a relatively wide range in East Asia, mainly occurring in East Siberia, Amur basin, Okhotsk coast, Primorye, Sakhalin, Korea, and northeastern China, as well as in eastern and western North America (Nelson, 1988) (Fig. 1). Nelson (1988) supposed that the clade of Asian *Pteronarcys*, including *P. reticulata* and *P. sachalina*, originated from the North American lineage. Additional species of *Pteronarcys*, *P. macra*, was described from South Korea (Ra et al., 1991a). This species was recently collected from the Primorye region in FE Russia by YJB (unpublished data).

As in many other animal and plant groups, aquatic insects in Northeast Asia represent unique faunistic characteristics (Levanidova and Zhiltzova, 1979; Bae, 1997). This Northeast palaeartic distribution, in a narrow sense, includes the areas of the South of the Amur river basin in FE Russia and the Korean peninsula, along the Sikhote mountains and Paektusan-Zhangbeisan area, as well as the Japanese islands which is represented by the stonefly species *Amphinemura coreana*, *A. verrucosa*, *A. steinmanni*, *Rhopalopsola mahunkai*, *Stavsolus japonicus*, *Paragnetina flavotincta*, *Oyamia nigribasis*, and *Sweltsa nikkoensis*. Some

species, for example *Taenionema japonica*, *Paraleuctra cercia*, *Megarcys ochracea*, and *Alloperla rostellata*, however, show a wider range of Northeast palaeartic distribution extending up to the Kamchatka peninsula. Some transpalaeartic species, for example *Leuctra fusca*, which is widespread in Europe and Siberia, are also present in Northeast Asia.

New Korean records

The following 12 species are newly recorded from Korea. Not providing descriptions, a list of the newly recorded species, related synonymies, and examined materials are herein presented.

Family Taeniopterygidae

Taenionema japonicum (Okamoto)

Rhabdiopteryx japonica Okamoto, 1922: 12.

Taeniopteryx (Rhabdiopteryx) japonica: Ueno, 1929: 139.

Nuria frigida Navas, 1930: 7.

Taenionema frigida: Zwick, Levanidova, and Zhiltzova, 1971: 850.

Doddsia japonica: Zwick, 1973c: 152.

Taenionema japonicum: Ricker and Ross, 1975: 152.

Materials examined: 1M, 1F and 14L, Chollanam-do, Tamyang-gun, Pyongpungsan, 15 V 1987; 1M, 1F and 4L, Chollabuk-do, Namwon-gun, Chirisan, Paemsagol valley, 20 X 1986.

Family Leuctridae

Paraleuctra cercia (Okamoto)

Leuctra cercia Okamoto, 1922: 37; Kohno, 1957: 5.

Paraleuctra cercia: Kawai, 1967: 36.

Materials examined: 10M and 12F, Chollabuk-do, Muju-

gun, Mujuguchondong valley, 28 IV 1991.

Leuctra fusca (Linnaeus)

Phryganea fusca Linnaeus, 1758: 549.

Leuctra fusca: Zhiltzova and Zapekina-Dulkeit, 1986: 231.

Materials examined: 4M and 8F, Kwangju, Mudungsan, Sanjang valley, 5 XI 1990.

Family Capniidae

Eucapnopsis stigmatica Okamoto

Eucapnopsis stigmatica Okamoto, 1922: 9; Kawai, 1967: 78.

Capnella bulba Ueno, 1929: 147.

Materials examined: 3M and 5F, Chollabuk-do, Namwon-gun, Chirisan, Pamsagol valley, 3 III 1990, 8 III 1987; 5M and 6F, Chollabuk-do, Puan-gun, Sangso-myon, Naesosa, 13 III 1991.

Remarks: *E. stigmatica* is superficially similar to *E. brevicauda* Claassen.

Paracapnia recta Zhiltzova

Paracapnia recta Zhiltzova, 1984a: 78.

Capnia KUa: Yoon and Aw, 1986: 13. NEW SYNONYM.

Materials examined: 27M and 57F, Kwangju, Mudungsan, Sanjang valley, 17 IV 1995; 38M and 27F, same locality, 3 III 1995; 1F, same locality, 21 IV 1989; 12F, Chollabuk-do, Puan-gun, Sangso-myon, Naesosa, 23 III 1991; 1L, Chollanam-do, Tamyang-gun, Pyongpung-san, 29 I 1995.

Remarks: In Korea, the larva of this species has been known as *Capnia* KUa (Yoon and Aw, 1986, 1988). Based on the penis-like structure in the abdomen, which is found both in the mature larva and adult as well as based on close field observations, we associated the larval and adult stages of this species.

Family Nemouridae

Nemoura jezoensis (Okamoto)

Protonemura jezoensis Okamoto, 1922: 32.

Nemoura jezoensis: Claassen, 1940: 57; Shimizu, 1994: 219.

Protonemura jezoensis: Illies, 1966: 232.

Nemoura gracilis Zhiltzova, 1982a: 39; Zhiltzova and Zapekina-Dulkeit, 1986: 216.

Materials examined: 2M, Kangwon-do, Soraksan, Oknyotang, 16 VI 1994.

Remarks: Shimizu (1994) redescribed this species from Japan, and synonymized *N. gracilis* Zhiltzova from FE Russia with this species.

Family Perlodidae

Stavsolus japonicus (Okamoto)

Isogenus (Dictyogenus) japonicus Okamoto, 1912: 111; Claassen, 1940: 107.

Isogenus (Stavsolus) japonicus: Ricker, 1952: 125; Kawai, 1967: 105.

Materials examined: 3M, Kwangju, Mudungsan, Sanjang valley, 28 V 1992; 2F, same locality, 12 V 1994; 9F, same locality, 12 V 1994; 2M and 3F, same locality, 21 V 1994; 1F, Chollanam-do, Changhung-gun, Yuchi Porimsa, 24 IV 1990; 1F, Chollabuk-do, Namwon, Paemsagol valley, 17 IV 1987; 1F, Kyongsangnam-do, Hadong-gun, Chirisan Ssanggyesa, 15 V 1993; 3M and 21F, Kangwon-do, Hongchon-gun, Odaesan, Woljongsa valley, 16 VI 1994; 3F, Chollanam-do, Hwasun-gun, Nam-myon, Sapyong, 27 V 1993; 1M and 5F, Kangwon-do, Soraksan, Oknyotang, 15 VI 1994; 1M, Kangwon-do, Soraksan, Osaek, 16 VI 1994; 1M and 1F, Kangwon-do, Myongju-gun, Odaesan, Sogumgang, 17 VI 1994; 4M and 8F, Chungchungbuk-do, Tanyang-gun, Woraksan, Songgye valley, 27 IV 1993; 20L, Kyongsangbuk-do, Ponghwa-gun, Sokpo-myon, Taehyon-ri, 28 III 1993.

Remarks: *Stavsolus* is a monotypic genus, which occurs in Japan, FE Russia, and Korea. Zwick (1973a, 1973b) reported undetermined female adults of this genus from North Korea.

Isoperla flavescens Zhiltzova and Potikha

Isoperla sp.: Zhiltzova and Potikha, 1983: 22

Isoperla flavescens Potakha and Zhiltzova, 1986: 50

Materials examined: 2M, 1F and 4L, Kyongsangbuk-do, Chilgok-gun, Palgongsan, Kasansansong, 3 V 1992.

Family Chloroperlidae

Alloperla joosti Zwick

Alloperla joosti Zwick, 1971: 37; Zhiltzova and Zapekina-Dulkeit, 1986: 198.

Materials examined: 1M and 6F, Kyonggi-do, Kapyong-gun, Hwaaksan, 13 VI 1994.; 4F, Kyonggi-do, Kapyong-gun, Myongjisan, 13 VI 1994; 5M and 23F, Kangwon-do, Soraksan, Misiryong, 15 VI 1994; 9F, Kangwon-do, Hongchon-gun, Odaesan, Woljongsa valley, 16 VI 1994.

Alloperla rostellata (Klapalek)

Isopteryx rostellata Klapalek, 1923: 29

Alloperla rostellata: Zwick et al., 1971: 857; Zwick, 1973a: 165; Zhiltzova, 1977a: 23; Zhiltzova and Potikha, 1983: 23; Potikha and Zhiltzova, 1986: 54.

Materials examined: 4F, Kangwon-do, Hongchon-gun, Odaesan, Wolchongsa valley, 16 VI 1994; 2F, Kangwon-do, Kosong-gun, Soraksan, Misiryong, 15 VI 1994.

Remarks: This species has been redescribed by Zwick et al (1971) and was recorded from North Korea by Zwick (1973a).

Sweltsa nikkoensis (Okamoto)

Chloroperla nikkoensis Okamoto, 1912: 147; Claassen, 1940: 189.

Sweltsa nikkoensis: Zwick, 1973c: 297.

Sweltsa colorata Zhiltzova and Levanidova, 1978: 20. NEW SYNONYM.

Materials examined: 1M, 151F and 2L, Chollanam-do, Tamyang-gun, Chuwalsan, 6 V 1995; 1M, 83F and 16L, Kwangju, Mudungsan, Sanjang valley, 12 V 1994; 12F and 15L, Kangwon-do, Hongchon-gun, Odaesan, Woljongsa valley, 16 VI 1994; 1F and 14L, Kangwon-do, Wonju, Chiaksan, 17 VI 1994; 5F and 19L, Kyonggi-do, Kapyong-gun, Myongjisan, 13 VI 1994; 5M, 46F and 17L, Kangwon-do, Soraksan, Misiryong, 15 VI 1994; 1M, 3F and 22L, Kyongsangnam-do, Hadong-gun, Chirisan, Ssanggyesa, 25 VI 1995; 3M, 6F and 14L, Kwangju, Mudungsan, Sanjang valley, 15 V 1993; 20M and 26F, Cheju-do, Soguipo, Tonnaeko, 26 V 1996.

Remarks: Based on the examination of the type materials of *Sweltsa colorata*, we established the above synonymy. This species is widespread in Korea and Japan, inhabiting small mountain streams.

Sweltsa lepnevae Zhiltzova

Sweltsa lepnevae Zhiltzova, 1977a: 24.

Materials examined: 1M and 2F, Kangwon-do, Pyongchang-gun, Paeksoksan, 17 VI 1994; 1F, Kangwon-do, Soraksan, Misiryong, 15 VI 1994; 25F, Kangwon-do, Hongchon-gun, Odaesan, Woljongsa valley, 16 VI 1994; 21F, Kangwon-do, Wonju, Chiaksan, 17 VI 1994; 2F, Kangwon-do, Myongju-gun, Odaesan, Sogumgang, 17 VI 1994.

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