

New synonymy and new data on the distribution of the mayflies from Korea and the Russian Far East (Ephemeroptera)

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Based on comprehensive examination of type specimens of Northeast Asian mayflies, the following new synonymy is established: *Ecdyonurus bajkovae* Kluge, 1986 = *E. sub-spinosus* (Braasch & Soldan, 1988), syn. n.; *Epeorus curvatus* Matsumura, 1931 = *E. anatolii* Sinitshenkova, 1981, syn. n.; *E. (Iron) aesculus* Imanishi, 1934 = *Iron koreanicus* Braasch & Soldan, 1988, syn. n.; *Ephemerella (Cincticostella) levanidovae* Tshernova, 1952 = *E. (C.) castanea* Allen, 1971, syn. n.; *E. (Ephemerella) dentata* Bajkova, 1967 = *E. (E.) keijoensis* Allen, 1971, syn. n.; *E. (E.) kozhovi* Bajkova, 1967 = *E. (E.) notofascia* Yoon & Bae, 1988, syn. n. Taxonomic discussions on some problematic species and new distributional data are provided.

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Introduction

About one hundred and fifty species of mayflies occur in the Far East of Russia which is close to two thirds of all known Northeast Asian mayflies (Tshernova et al., 1986; Bae, 1997). Tshernova, Bajkova, Sinitshenkova, Kluge, and Tiunova mainly contributed to the knowledge of mayfly fauna of the Far East of Russia. On the other hand, sixty-six species of mayflies have been reported from Korea since Imanishi (1940) (Bae et al., 1994; Bae, 1997). The North Korean mayfly fauna has been thoroughly investigated recently (Braasch & Soldan, 1988; Bae & Soldan, 1997; Bae & Andrikovics, 1997).

Although geographically adjacent, mayflies from Korea and the Far East of Russia have been scarcely treated together until 1980s because of the communication problems between those countries. For this study, we intensively examined type and

non-type material from Korea and the Far East of Russia. We deal herein with new synonymy, taxonomic discussions on some problematic species, and new distributional data.

Material

Mayflies from the Far East of Russia (FE Russia), North Korea (N Korea), and South Korea (S Korea) were examined. For detailed information on type material deposited at Zoological Institute in St.Petersburg (ZIN), see Kluge (1995). For numerous non-type specimens (many of them reared) deposited at St.Petersburg State University (SPbU), see various Kluge's previous papers. For type and non-type material deposited at Seoul Women's University (SWU), see Bae et al. (1994) and Bae's various previous papers.

Taxonomic account

Family BAETIDAE

Baetis (Baetis) fuscatus (Linnaeus, 1761)

Baetis n1a: Imanishi, 1940: 221 (larva; N Korea, Japan, Manchuria); Yoon & Bae, 1988a: 111 (S Korea).

Baetis fuscatus (L.): Müller-Liebenau, 1969: 128 (larva, imago; Europe); Kluge, 1980: 562 (Siberia); Tshernova et al., 1986: 133 (imago; FE Russia); Bae & Soldan, 1997 (N Korea).

Baetis (Baetis) fuscatus (L.): Novikova & Kluge, 1987: 8; Kluge, 1997: 194 (larva; Palearctic).

Material examined. Numerous larvae, imagines, and imagines reared from larvae (Europe, Siberia, FE Russia, N Korea, S Korea; SPbU, SWU).

Imanishi (1940) described larvae of this species as "*Baetis n1a*" from North Korea, Japan, and Manchuria. Since then, there have been many faunistic studies in Korea listing this species under the arbitrary name "*Baetis n1a*" which refers to any *fuscatus*-type baetid (see Yoon & Bae, 1988a). This is a transpalearctic species known from Europe to East Asia. The form distributed in Siberia and the Far East differs from that of Europe by orange colour of turban eyes of male imago (Kluge, 1980). It is a very common species in the Far East of Russia and in Korea occurring from upper to down stream areas, sometimes in polluted streams.

Baetis (Nigrobaetis) muticus (Linnaeus, 1758)

Baetis muticus (L.): Müller-Liebenau, 1969: 180 (larva, imago; Europe).

Baetis KUa: Yoon & Bae, 1988a: 111 (S Korea).

Baetis (Nigrobaetis) muticus (L.): Novikova & Kluge, 1987: 10; Novikova & Kluge, 1994: 635 (larva, imago; Europe, East Kazakhstan); Kluge, 1997: 190 (larva); Bae & Soldan, 1997 (N Korea).

Alainites muticus (L.): Waltz et al., 1994: 34 (Europe).

Material examined. Numerous larvae, imagines, and imagines reared from larvae from Europe, the Urals and Caucasus, one larva from Eastern Kazakhstan (SPbU). *Baetis* KUa: Yoon & Bae, 1988 (N Korea, S Korea; SWU).

This species has been known from Korea as "*Baetis* KUa" since Yoon & Bae (1988a). Based on examination of a good series of larval material from Europe and Asia, we determine this species as *Baetis (Nigrobaetis) muticus*. Formerly the easternmost point of recorded distribution of *B. (N.) muticus* was Eastern Kazakhstan (Novikova & Kluge, 1994).

Waltz et al. (1994) suggested a new classification for selected baetid groups, in which the genus *Alainites* Waltz & McCafferty, 1994 was established with the type species *Ephemerella mutica* Linnaeus, 1758 (wrongly spelled as "*Baetis muticus* L., 1758"). According to our investigation (Novikova & Kluge, 1994), the type species of *Alainites* is undoubtedly congeneric with the type species of *Takobia* Novikova & Kluge, 1987, and both can be placed in the subgenus (or genus) *Nigrobaetis* Kazlauskas in Novikova & Kluge, 1987 (see Kluge, 1997: 189).

Family HEPTAGENIIDAE

Ecdyonurus (Afghanurus) bajkovae Kluge, 1986

Paracinygmula zhiltzovae Bajkova, 1975: 56 (nom. praeecc.) (larva; FE Russia).

Ecdyonurus zhiltzovae (Bajkova): Kluge, 1983: 31 (imago; FE Russia).

Ecdyonurus KUa: Yoon & Bae, 1984: 14 (larva; S Korea) (associated with *E. bajkovae* Kluge by Bae et al., 1994).

Ecdyonurus bajkovae Kluge in Tshernova et al., 1986: 117 (nomen novum pro *Paracinygmula zhiltzovae* Bajkova) (imago; FE Russia); Kluge, 1988: 300; Kluge, 1995: 19 (type deposition).

Nixe subspinosa Braasch & Soldan, 1988: 25 (imago; N Korea), *syn. n.*

Ecdyonurus subspinosa (Braasch & Soldan): Bae et al., 1994: 40 (S Korea).

Ecdyonurus (Afghanurus) bajkovae Kluge: Kluge, 1997: 200 (larva; FE Russia).

Material examined. Holotype and paratypes (larvae) of *Paracinygmula zhiltzovae* Bajkova, 1975 = *Ecdyonurus bajkovae* Kluge, 1986 (FE Russia; ZIN). Larvae, imagines and imagines reared from larvae (FE Russia, N Korea, S Korea; SPbU, SWU).

This species was originally described from larvae from the Far East of Russia (Bajkova, 1975) and Korea (Yoon & Bae, 1984). The adults were reared from larvae from the Far East of Russia and described by Kluge (1983). Soldan, on the other hand, collected the adult of the same species from North Korea in 1986 and described it under the name *Nixe subspinosa* Braasch & Soldan, 1988. Soldan also collected larvae and reared adults of *N. subspinosa* from North Korea (see Bae & Soldan, 1997).

This species was placed in the genus *Paracinygmula*, *Ecdyonurus*, or *Nixe*. The type species of *Paracinygmula* Bajkova, 1975 and the type species of *Nixe* Flowers, 1980 are undoubtedly congeneric with the type species of *Afghanurus* Demoulin, 1964

(Kluge, 1988), and all of them can be placed in the genus *Ecdyonurus* Eaton, 1868 s. l.

***Ecdyonurus* (*Afghanurus*) *joernensis* Bengtsson, 1909**

Ecdyonurus joernensis Bengtsson, 1909: 19 (female imago; Europe).

Heptagenia mongolica Bajkova & Varychanova, 1978: 111 (larva; Mongolia).

Heptagenia dentata Braasch, 1979: 69 (imago; Mongolia).

Ecdyonurus mongolicus (Bajkova & Varychanova): Kluge, 1980: 573 (larva, imago; Siberia); Bajkova, 1984: 116 (Mongolia).

Ecdyonurus KUB: Yoon & Bae, 1984: 14 (larva; S Korea).

Ecdyonurus joernensis mongolicus (Bajkova & Varychanova): Tshernova et al., 1986: 177 (imago; FE Russia); Kluge, 1988: 300; Bae et al., 1994: 39 (N Korea).

Nixe mongolica (Bajkova & Varychanova): Braasch & Soldan, 1988: 25 (N Korea).

Ecdyonurus (*Afghanurus*) *joernensis* Bengtsson: Kluge, 1997: 200 (larva; Scandinavia, Russia, Mongolia).

Material examined. Numerous larvae, imagines and imagines reared from larvae (Europe, the Urals, Siberia, Mongolia, FE Russia, S Korea; SPbU, SWU).

This is a transpalearctic species occurring from Europe to East Asia. On its systematic position see discussion above, under *Ecdyonurus* (*Afghanurus*) *bajkova*; the usage of the generic name *Heptagenia* for this species was undoubtedly wrong.

***Epeorus curvatulus* Matsumura, 1931**

Epeorus curvatulus Matsumura, 1931: 1477 (Japan); Imanishi, 1934: 392 (imago, larva; Japan); Imanishi, 1940: 250 (larva; N Korea, S Korea, Manchuria); Braasch & Soldan, 1988: 27 (N Korea); Kluge, 1997: 205 (larva).

Epeorus (*Belovius*) *curvatulus* Matsumura: Tshernova, 1981: 326 (imago; Japan).

Epeorus (s. str.) *anatolii* Sinitshenkova, 1981: 814 (larva; FE Russia), syn. n.; Kluge, 1995: 19 (type deposition).

Epeorus rautiani Sinitshenkova, 1982: 52 (larva, imago; Siberia) (synonymized with *E. anatolii* by Tiunova, 1987: 7); Tshernova et al., 1986: 117 (imago; Siberia); Kluge, 1995: 27 (type deposition);

Material examined. Larvae and imagines (S Korea, FE Russia; SWU, SPbU). Holotypus (larva) of *E. anatolii* Sinitshenkova, 1981 (FE Russia; ZIN). Paratypes (larvae, imagines and imagines reared from larvae) of *E. rautiani* Sinitshenkova, 1982 (Siberia; ZIN);

In the original description of the subgenus *Belovius* Tshernova, 1981, this taxon was

characterized by imaginal features only; a number of unrelated species of which important larval characters were unknown were placed there, *E. curvatulus* among them. Sinitshenkova (1981) gave a diagnosis of the subgenus *Belovius* based on larval characters: each of tergalliae of the pairs II-VII has a wide proximal lobe separated from remainder of tergallia by posterior costa. With this diagnosis, *Belovius* became a natural taxon. According to this diagnosis, *E. curvatulus* must be placed not in *Belovius*, as each tergallia of *E. curvatulus* has the posterior costa on its posterior margin. Based on this character, Sinitshenkova described *E. anatolii* as belonging not to *Belovius*, but to the subgenus *Epeorus* s. str.

***Epeorus* (*Iron*) *aesculus* Imanishi, 1934**

Epeorus aesculus Imanishi, 1934: 384 (imago, larva partim; Japan); Imanishi, 1940: 250 (larva; N Korea).

Iron aesculus (Imanishi): Sinitshenkova, 1978: 50 (larva, imago; FE Russia); Tshernova et al., 1986: 120 (imago; FE Russia).

Epeorus (*Iron*) *aesculus* Imanishi: Kluge & Tiunova, 1989: 8 (larva, imago; FE Russia); Kluge, 1997: 206 (larva; FE Russia).

Iron koreanicus Braasch & Soldan, 1988: 25 (larva; N Korea), syn. n.

Material examined. Larvae, imagines and imagines reared from larvae (FE Russia, N Korea, S Korea; SPbU, SWU).

Originally *E. aesculus* was described from imagines and two forms of larvae tentatively attributed to this species (Imanishi, 1934). Sinitshenkova (1978) redescribed imagines and true larvae of *E. aesculus*, and distinguished it from *Iron maculatus* Tshernova, 1949. Kluge & Tiunova (1989) gave an additional description of this species. Soldan (pers. comm.) recently agreed that *Iron koreanicus* is conspecific with Kluge & Tiunova's (1989) concept of *E. (I.) aesculus*.

Family EPHEMERELLIDAE

***Ephemerella* (*Cincticostella*) *levanidovae* Tshernova, 1952**

Ephemerella levanidovae Tshernova, 1952: 274 (larva, FE Russia).

Ephemerella orientalis Tshernova, 1952: 279 (imago; FE Russia) (synonymy established by Tshernova et al., 1986: 138).

Ephemerella (*Cincticostella*) *levanidovae* Tshernova: Allen, 1971: 516 (larva, FE Russia); Tshernova et

- al., 1986: 138 (imago; FE Russia); Kluge, 1995: 41 (type deposition).
- Ephemerella (Cincticostella) castanea* Allen, 1971: 514 (larva; S Korea), *syn. n.*
- Cincticostella levanidovae* (Tshernova): Tiunova, 1987: 9 (FE Russia).
- Cincticostella castanea* (Allen): Yoon & Bae, 1988b: 29 (larva, imago; S Korea).
- Material examined.* Lectotype and paralectotypes (larvae) of *Ephemerella levanidovae* Tshernova, 1952 (FE Russia; ZIN). Larvae, imagines, and imagines reared from larvae (FE Russia, S Korea; SPbU, SWU).
- We recognize this synonymy based on a good series of reared material of *E. (C.) levanidovae* and *E. (C.) castanea* from the type localities in the Far East of Russia and in Korea respectively. This species commonly occurs in clean mountain streams.
- Ephemerella (Drunella) solida* Bajkova, 1980**
- Ephemerella trispina* na: Imanishi, 1940: 193 (larva; N Korea).
- Ephemerella solida* Bajkova, 1980: 796 (larva; FE Russia).
- Ephemerella (Drunella) solida* (Bajkova): Tshernova et al., 1986: 140 (imago; FE Russia); Kluge, 1997: 210 (larva; FE Russia).
- Drunella solida* (Bajkova): Tiunova, 1978: 7 (FE Russia); 1988: 5 (imago; FE Russia).
- Material examined.* Larvae, imagines, and imagines reared from larvae (FE Russia, N Korea, S Korea; SPbU, SWU).
- Previously the species described by Imanishi (1940) under arbitrary name "*Ephemerella trispina* na" was incorrectly associated with *Ephemerella triacantha* by Tshernova (1952). *E. (D.) solida* is distinguished from *E. (D.) triacantha* by the presence of stout setae on fore femora, lack of a longitudinal ridge on fore femora, and distinct colour pattern on thorax and abdomen. Previously, this species has been frequently misidentified as *E. (D.) triacantha* in faunistic studies in Korea.
- Ephemerella (Drunella) triacantha* Tshernova, 1949**
- Ephemerella trispina* na: Imanishi, 1940: 194 (larva; N Korea).
- Ephemerella triacantha* Tshernova, 1949: 151 (larva; Altai).
- Ephemerella tenax* Tshernova, 1952: 273 (larva; FE Russia) (synonymy established by Kluge, 1995: 43).
- Ephemerella (Drunella) triacantha* (Tshernova): Edmunds, 1959: 546; Tshernova et al., 1986: 139 (imago; FE Russia); Kluge, 1997: 210 (larva; FE Russia).
- Ephemerella (Drunella) trispina* Ueno: Yoon & Kim, 1981: 37 (S Korea).
- Drunella triacantha* (Tshernova): Yoon & Bae, 1988a: 166 (larva, imago; S Korea).
- Material examined.* Larvae, imagines, and imagines reared from larvae (FE Russia, N Korea, S Korea; PSU, SWU). Lectotype and paralectotype (larvae) of *E. tenax* Tshernova, 1952 (FE Russia; ZIN).
- See discussion under *E. (D.) solida*, above.
- Ephemerella (Ephemerella) dentata* Bajkova, 1967**
- Ephemerella dentata* Bajkova, 1967: 331 (larva; FE Russia); Kluge, 1995: 40 (type deposition).
- Ephemerella (Ephemerella) keijoensis* Allen, 1971: 526 (larva; S Korea), *syn. n.*
- Ephemerella (Ephemerella) dentata* Bajkova: Kluge, 1997: 212 (larva; FE Russia).
- Material examined.* Holotype (larva) of *E. dentata* Bajkova, 1967 (FE Russia; ZIN). Larvae (FE Russia; SPbU) and imagines reared from larvae (S Korea; SWU).
- Based on the examination of type material of *E. dentata* and a good series of reared material of *E. (E.) keijoensis* from the type locality (Seoul, Korea), we established the above synonymy.
- Ephemerella (Ephemerella) kozhovi* Bajkova, 1967**
- Ephemerella nba*: Imanishi, 1940: 202 (larva; N Korea) (associated with *E. notofuscia* by Yoon & Bae, 1988b).
- Ephemerella kozhovi* Bajkova, 1967: 327 (larva, imago; FE Russia); Kluge, 1995: 40.
- Ephemerella (Ephemerella) kozhovi* Bajkova: Tshernova et al., 1986: 138 (imago; FE Russia); Kluge, 1997: 212 (larva; FE Russia).
- Ephemerella notofuscia* Yoon & Bae, 1988b: 34 (larva; S Korea), *syn. n.*
- Material examined.* Holotype and paratypes (imagines and larvae) of *E. kozhovi* Bajkova, 1967 (FE Russia; ZIN). Holotype and paratypes (larvae) of *E. notofuscia* Yoon & Bae, 1988 (S Korea; SWU). Larvae, imagines and imagines reared from larvae (FE Russia, S Korea; SPbU, SWU).
- We establish the above synonymy by comparison of the type specimens of both species.
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