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Biodiversity and distribution of mayflies (Ephemeroptera) in the Russian Far East

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Twenty-five years of investigations on the distribution and taxonomy of the mayflies in the Russian Far East has resulted in the records of 170 species belonging to 39 genera and 16 families. Original findings of mayflies in tributaries of the Sea of Japan, the basin of Ussuri, and Amur Rivers are presented. Most of the recorded species inhabit East Palaearctic and Palearchearctic areas. A list of all species found in the Russian Far East is given.

Keywords: Ephemeroptera; mayfly; fauna; Russian Far East

Introduction

Detailed investigations of mayflies in the Russian Far East began in the 1940s. Previously, only about 10 species had been described by various authors, who encountered specimens through casual collecting. The majority of these descriptions focused on the Amur River basin, where by the mid-1900s eight species were known: *Anagenesia sibirica* McLachlan, 1872; *Ephemera amurensis* Navas, 1913 (modern name *E. orientalis* McLachlan, 1875); *Oniscigaster palaearcticus* Tshernova, 1930 (today *Siphlonurus palaearcticus*); *Eopolymitarcus nigridorsum* Tshernova, 1934 (today *Ephoron nigridorsum*); *Anagenesia paradoxa* Buldovsky, 1935; *Chankagenesia natans* Buldovsky, 1935; *Behningia ulmeri* Lestage, 1935 (now known as Far Eastern *Behningia tshernovae* Edmunds & Traver, 1959) and *Acanthametropus nikolskyi* Tshernova, 1948. One species —*Ephemera sachalinensis* Matsumura, 1911—has been described from Sakhalin Island, and in 1927 G. Ulmer found six species in the material of the Swedish expedition to the Kamchatka Peninsula (1920–1922). Four of those species were described as new: *Paraleptophlebia curvata*, *Ameletus camtschaticus*, *Cinygma malaisei* and *C. cavum* (modern names *Cinygmula malaisei* and *C. cava*). In 1952, O.A. Tshernova surveyed the Amur River basin and reported 65 mayfly species, among which 30 ones were new. There are a large number of publications on the systematics and taxonomy of mayflies (Bajkova 1962, 1965, 1967, 1970, 1972a, 1975, 1976, 1979, 1980; Levanidova 1968, 1972, 1982; Tshernova 1972, 1973, 1976, 1978, 1979, 1981; Tshernova and Bajkova 1960; Sinitshenkova 1973a, 1973b, 1977, 1981a,b, 1982; Kluge 1982, 1983a,b, 1985, 1987a). In 1986, the

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first key to the mayfly imagines of the Russian Far East was published (Tshernova et al. 1986), which included 139 species.

At the beginning of my research in the Russian Far East (in 1981), the investigation of mayflies had reached a stage of generalisation. Previous investigations had been allowed to publish annotated checklists of the mayflies of the Russian Far East (Tiunova 1984, 1986, 1989), and revisions of the Heptageniidae (Kluge 1987b, 1988, 1989) and Baetidae (Novikova 1987) had been carried out. During this time it became obvious that the Russian Far East had been investigated rather selectively. There were no data on mayflies of the basins of the upper part of the Ussuri River, Bolshaya Ussurca, Khor, Bikin, tributaries of the Amur River (Anui, Gur, Amgun, Bureya, Zeya and other), the rivers of Western Priokhotye, the Kuril Islands, and Sakhalin Island. Therefore, since 1987 the author has surveyed more than 250 streams across all territories of the southern part of the Russian Far East (Figure 1). This research resulted in a series of publications (Tiunova and Belov 1984; Tiunova and Levanidova 1989; Tiunova 1990, 1991a, 1991b, 1995a, 1995b, 1995c, 1997, 1999a, 1999b, 1999c, 2006a, 2006b, 2007a, 2007b, 2008a, 2008b; Ishiwata, Tiunova and Kuranishi 2000; Tiunova and Potikha 2003; Tiunova, Kluge and Ishiwata 2004; Tiunova and Tiunov 2007) devoted to the taxonomy and faunal description of mayflies. In 2004–2007 streams of the Amur River Basin were also surveyed within the program 'Complex researches in the Amur River Basin (2004–2008)' under the auspices of the Far Eastern Branch of the Russian Academy of Sciences.

Results and discussion

Our data have increased the known mayfly fauna in the Russian Far East to 170 species in 39 genera and 16 families. The distribution of mayfly species among the regions of the Russian Far East is given in Table 1. It is necessary to note that the streams of Chukotka and Kamchatka Peninsula are still insufficiently investigated. The greatest diversity of mayflies is recorded from the southern part of the Russian Far East, including the basins of the Ussuri River, Amur, and the Sea of Japan (Table 1).

Ussuri River Basin

The Ussuri River is one of the biggest tributaries of the Amur River, running for 897 km. In its basin, 117 species are found, which is about 69% of the entire mayfly fauna of the Far East of Russia. From a point of confluence with the Sungach River up to its mouth, the Ussuri River forms the boundary with China. We surveyed the basic tributaries of the Ussuri River, large rivers including Bolshaya Ussurka, Bikin, Khor, and a series of smaller streams (Kabarga, Malinovka, Shivki, Kiya, and others).

The first summarised data on the species composition of mayflies found along the rivers of the Ussuri River basin were introduced in I. Levanidova's (1982) monograph. The list includes 23 species of mayflies for the Ussuri River, 24 species for the Bolshaya Ussurka River and 43 species for the Khor River. The Bikin River had six known species (Levanidova 1964). Our data increase the faunal lists of mayflies so now there are recorded 82 species for the Ussuri River, 72 for the Bolshaya Ussurca River, 76 for the Bikin River, and 63 species for the Khor River (Tiunova, Teslenko and Arefina 1997; Tiunova 2003).

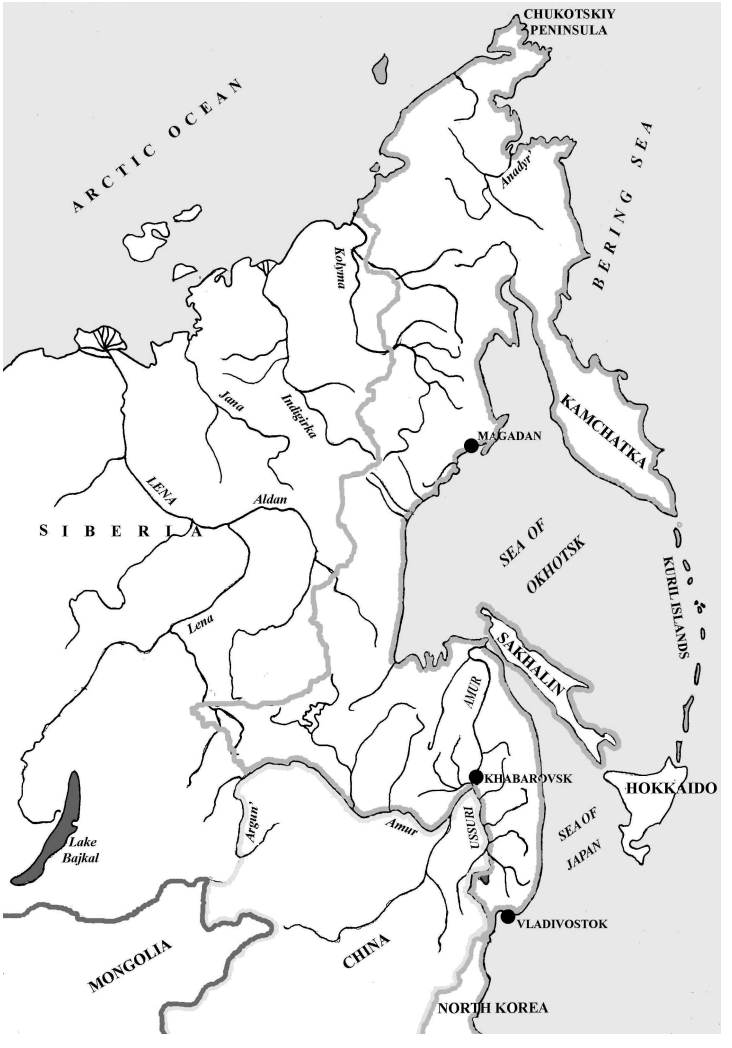

Figure 1. Study area in the Far East of Russia.

Original elements of the fauna of the Russian Far East collected for the first time in the Ussuri River basin are the following mayfly species: *Protobehningia asiatica*, *Potamanthus formosus*, *Ecdyonurus rubromaculatus*, *Ecdyonurus yoshidae*, *Heptagenia guranica*, *Metretopus tertius*, *Isonychia crassiuscula*, *Caenis pustula*, *Parameletus arcuatus*, *P. ensiformis*, *Acanthametropus nikolskyi*, and *Potamanthellus chinensis*. The last two species are included in the Red Data Book of Primorsky Krai (Tiunova 2005).

Amur River Basin

Another region equally rich in mayfly diversity is the Amur River basin up to the border with the Chitinskaya oblast. Here, 123 species, or 72% of the Russian Far East mayfly fauna, are found. The Amur River with its length of 4444 km is one of

Table 1. List of Ephemeroptera recorded in the Far East of Russia.

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Potamanthidae												
Potamanthus Pictet, 1843												
P. formosus Eaton, 1892	–	–	–	–	–	–	–	+	+	+	+	EAci
P. luteus oriens Bae & McCafferty, 1991	–	–	–	–	–	+	+	+	+	+	+	EP
Rhoenanthus Eaton, 1881												
R. coreanus Yoon & Bae, 1985	–	–	–	–	–	+	–	+	–	–	+	EAc
Ephemeridae												
Ephemera L., 1758												
E. japonica McLachlan, 1875	–	–	+	+	–	–	–	–	–	+	–	EAci
E. orientalis McLachlan, 1875	–	–	–	+	+	+	+	+	+	+	+	EP
E. sachalinensis Matsumura, 1911	–	–	–	+	–	+	–	+	+	–	+	EP
E. shengmi Hsu, 1937	–	–	–	–	–	+	+	+?	+	–	–	EAc
E. strigata Eaton, 1892	–	–	–	+	+	+	+	+	+	+	+	EAci
E. transbajkalica Tshernova, 1973	–	–	–	+	–	–	–	+?	+	–	–	EP
Polymitarcyidae												
Ephoron Williamson, 1802												
E. shigae (Takahasi, 1924)	–	–	–	–	–	+	+	+	+	+	+	EAci
E. nigridorsum (Tshernova, 1934)	–	–	–	–	–	+	–	–	+	–	–	TP
Palingeniidae												
Anagenesia Eaton, 1883												
A. paradoxa Buldovsky, 1935	–	–	–	–	–	–	–	–	+	–	–	EAc
Chankagenesia Buldovsky, 1935												
Ch. natans Buldovsky, 1935	–	–	–	–	–	–	+	–	+	–	–	EAc
Ch. sibirica McLachlan, 1872	–	–	–	–	–	–	–	–	+	–	–	EAc
Behningiidae												
Behningia Lestage, 1929												
B. tshernovae Edmunds & Traver, 1959	–	–	–	–	–	–	+	–	+	–	–	EAc
Protobehningia Tshernova & Bajkova, 1960												
P. asiatica Tshernova & Bajkova, 1960	–	–	–	–	–	–	–	+	–	–	–	EAc

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Heptageniidae												
Cinygma Eaton, 1885												
C. lyriformis (McDunnough, 1924)	+	+	+	+	+	+	−	−	+	+	−	AP
Cinygmula McDunnough, 1933												
C. brunnea Tiunova, 1990	−	−	−	−	−	+	−	−	+	−	+	EAc
C. cava Ulmer, 1927	−	+	+	+	+	+	−	+	+	+	−	EP
C. irina Tshernova & Belov, 1982	−	−	−	−	+	+	−	+	+	−	−	EAc
C. hirasana Imanishi, 1935	−	−	+	−	+	+	+	+	+	+	+	EAci
C. kurenzovi (Bajkova, 1965)	−	−	+	+	+	+	+	+	+	−	+	EP
C. levanidovi Tshernova & Belov, 1982	−	−	−	−	−	+	−	−	−	−	+	EAc
C. malaisei Ulmer, 1927	+	+	−	−	+	−	−	−	−	−	−	EP
C. putoranica Kluge, 1980	+?	+	+	+	+	−	−	−	−	+	−	EP
C. sapporensis (Matsumura, 1904)	−	−	+	+	+	+	+	+	+	+	+	EP
C. unicolorata Tshernova, 1979	+	+	−	−	+	−	−	−	+	−	−	EP
Cinygmula sp.	−	−	−	−	−	+	−	−	+	−	−	
Ecdyonurus Eaton, 1868												
E. abracadabrus Kluge, 1983	−	−	−	+	+	+	+	+	+	−	+	EP
E. aspersus Kluge, 1980	−	−	+	+	+	+?	+	+	+	−	−	EP
E. aurarius Kluge, 1983	−	−	−	−	−	+	+	+	+	−	−	EP
E. dracon Kluge, 1983	−	−	−	−	−	+	−	−	−	−	+	EAc
E. bajkovae Kluge, 1986	−	−	−	−	−	+	+	+	+	+	+	EAc
E. inversus Kluge, 1980	−	−	−	−	+	−	−	−	+	−	−	EP
E. fragilis Tiunova, 2006	−	−	−	−	−	+	+	+	+	−	−	EAc
E. joernensis Bengtsson, 1909	−	−	−	+	+	+	+	+	+	−	+	TP
E. kibunensis Imanishi, 1936	−	+?	−	−	+?	+?	−	−	−	+	+	EAci
E. levis (Navas, 1912)	−	−	−	−	−	+	+	+	+	−	+	EP
E. scalaris Kluge, 1983	−	−	−	−	−	+	+	+	+	+	+	EAc
E. simplicioides (McDunnough, 1924)	−	−	−	+	−	+	+	+	+	−	−	AP
E. rubromaculatus You, Wu, Gui & Hsu, 1981	−	−	−	−	−	+	−	+	−	−	−	EAc
E. yoshidae Takahashi, 1924	−	−	−	−	−	−	−	+	−	+	+	EAci
E. vicinus (Demoulin, 1964)	−	−	−	−	+	−	−	−	−	−	−	EP

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Epeorus Eaton, 1881												
E. anatolii Sinitshenkova, 1981	−	−	−	−	−	+	+	+	+	−	−	EP
E. ermolenkoi Tshernova, 1981	−	−	+	+	−	−	−	−	−	−	−	EAi
E. frolenkoi Sinitshenkova, 1981	−	−	−	+	−	−	−	−	−	−	−	EAi
E. gornostajevi Tshernova, 1981	−	−	−	−	−	+	−	−	−	−	−	EAc
E. latifolium Ueno, 1928	−	−	+	−	−	−	−	−	−	+	+	EAi
E. ninae Kluge, 1995	−	−	−	+	+	+	−	+	+	−	−	EP
E. pellucidus (Brodsky, 1930)	−	−	−	+	+	+	+	+	+	−	+	EP
E. rubeus Tiunova, 1991	−	−	−	−	−	+	−	+	−	−	−	EAc
E. (*Iron*) *aesculus* Imanishi, 1934	−	−	+	+	+	+	+	+	+	+	+	EAci
E. (*I.*) *alexandri* Kluge & Tiunova, 1989	−	−	−	−	−	+	+	+	+	−	−	EP
E. (*I.*) *maculatus* (Tshernova, 1949)	−	+	−	+	+	+	+	+	+	−	+	EP
E. (*I.*) *uenoi* (Matsumura, 1933)	−	−	+	−	−	−	−	−	−	+	−	EAi
Heptagenia Walsh, 1863												
H. chinense Ulmer, 1919	−	−	−	−	−	−	−	−	+	−	−	EAc
H. flava Rostock, 1878	−	−	−	+	+	+	+	+	+	+	−	TP
H. guranica Belov, 1981	−	−	−	−	−	−	−	+	+	−	+	EAc
H. orbiticola Kluge, 1987	−	−	−	−	+	−	−	−	+	−	−	TP
H. sulphurea (Müller, 1776)	−	+	−	+	+	+	+	+	+	−	+	TP
Rhithrogena Eaton, 1881												
R. bajkovae Sowa, 1973	−	−	−	+	+	+	+	+	+	−	−	EP
R. lepnevae Brodsky, 1930	−	−	+	+	+	+	+	+	+	−	+	EP
R. sibirica Brodsky, 1930	+	+	−	−	+	+	+	+	+	−	−	EP
Ametropodidae												
Ametropus Albarda, 1878												
A. fragilis Albarda, 1878	−	−	−	−	−	−	−	−	+	−	−	TP
Metretopodidae												
Metreplecton Kluge, 1996												
M. macronyx Kluge, 1996	−	−	−	−	+	−	−	+	+	−	−	EP

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Metretopus Eaton, 1891												
M. borealis (Eaton, 1871)	+	+	−	−	+	−	−	−	+	−	+	CB
M. tertius Tiunova, 1995	−	−	−	+	−	−	−	+	+	−	−	EAci
Acanthametropodidae												
Acanthametropus Tshernova, 1948												
A. nikolskyi Tshernova, 1948	−	−	−	−	−	−	−	+	+	−	−	EP
Isonychiidae												
Isonychia Eaton, 1871												
I. concoloria Tiunova et al., 2004	−	−	−	−	−	−	−	−	+	−	−	EAc
I. crassiuscula Tiunova et al., 2004	−	−	−	−	−	−	−	+	−	−	−	EAc
I. ignota (Walker, 1853)	−	−	−	−	−	−	−	+	+	−	−	TP
I. ussurica ussurica Bajkova, 1970	−	−	−	−	−	+	+	+	+	−	+	EP
I. ussurica sibirica Tiunova et al., 2004	−	−	−	−	−	−	−	−	+	−	−	EP
I. vshivkovae Tiunova et al., 2004	−	−	−	−	−	+	−	−	−	−	−	EAc
I. sexpetala Tiunova et al., 2004	−	−	−	−	−	−	+	+	+	−	−	EAc
I. gr. *japonica*	−	−	−	+	−	+	+	+	−	−	−	
Ameletidae												
Ameletus Eaton, 1885												
A. camtschaticus Ulmer, 1927	+	+	−	−	+	−	−	+	+	−	−	EP
A. cedrensis Sinitshenkova, 1977	−	−	−	−	−	+	+	+	+	−	−	EAc
A. costalis (Matsumura, 1931)	−	−	+	+	−	+	−	+	−	+	+	EAci
A. inopinatus Eaton, 1871	−	−	−	−	+	−	−	−	−	−	−	TP
A. montanus Imanishi, 1930	+	+	+	+	+	+	+	+	+	+	+	EP
A. pilatus Sinitshenkova, 1981	−	−	−	−	−	+	−	−	+	−	−	EAc
A. labiatus Sinitshenkova, 1981	−	−	−	−	+	+	−	−	+	−	−	EAc
Siphlonuridae												
Siphlonurus Eaton, 1868												
S. alternatus Say, 1824	−	−	−	−	+	+	−	−	−	−	−	TP
S. immanis Kluge, 1985	−	−	−	−	+	+	+	+	+	−	+	EP

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
S. chankae Tshernova, 1952	−	−	−	−	−	−	+	+?	+	−	+	EP
S. lacustris (Eaton, 1870)	+	+	+	−	+	+	+	+	+	−	−	TP
S. zhelochovtsevi Tshernova, 1952	−	−	−	−	+	+	+	+	+	+	−	EP
S. palaearcticus (Tshernova, 1949)	−	−	−	+	−	+	+	+	+	−	+	EP
Parameletus Bengtsson, 1908												
P. arcuatus Tiunova, 2008	−	−	−	−	−	−	−	+	−	−	−	EAc
P. ensiformis Tiunova, 2008	−	−	−	−	−	−	−	+	−	−	−	EAc
P. chelifer Bengtsson, 1908	+	+	−	−	+	−	−	+	+	−	−	CB
P. minor (Bengtsson, 1909)	−	+	−	−	+	−	−	+	+	−	−	TP
Baetidae												
Baetis Leach, 1815												
B. (*Nigrobaetis*) *acinaciger* Kluge, 1983	−	−	−	+	−	+	−	+	−	−	+	EAc
B. (*N.*) *bacillus* Kluge, 1983	−	−	+	−	+	+	+	+	+	−	+	EP
B. (*Labiobaetis*) *atrebatinus* Eaton, 1870	−	−	−	−	−	+	−	+	+	−	+	TP
B. (*L.*) *tricolor* Tshernova, 1928	−	−	−	−	−	−	+	+	+	−	−	TP
B. (*Baetis*) *bicaudatus* Dodds, 1923	+	+	+	+	+	+	−	+	+	+	−	AP
B. (*B.*) *feles* Kluge, 1980	−	−	+	−	+	−	−	−	−	−	−	EAc
B. (*B.*) *fuscatus* L., 1761	−	−	+	+	+	+	+	+	+	+	+	TP
B. (*B.*) *macani* Kimmins, 1957	−	+	+	−	−	−	−	−	+	−	−	CB
B. (*B.*) *pseudothermicus* Kluge, 1983	−	+	+	+	+	+	+	+	+	−	+	EP
B. (*B.*) *silvaticus* Kluge, 1983	−	−	−	+	−	+	+	+	−	−	+	EAc
B. (*B.*) *thermicus* Ueno, 1928	−	−	+	+	−	−	−	−	−	+	+	EAi
B. (*B.*) *ussuricus* Kluge, 1983	−	−	−	−	+	+	+	+	−	−	−	EP
B. (*B.*) *ursinus ursinus* Kazlauskas, 1963	−	−	−	+	+	+	−	+	+	−	+	EP
B. (*B.*) *vernus* Curtis, 1834	+	+	+	+	+	+	+	+	+	−	−	TP
B. (*Acentrella*) *gnom* (Kluge, 1983)	−	−	−	−	−	+	+	+	+	+	+	EP
B. (*A.*) *fenestratus* (Kazlauskas, 1963)	+	−	+	−	+	+	−	+	+	−	−	EP
B. (*A.*) *sibiricus* (Kazlauskas, 1963)	+	+	+	+	+	+	+	+	+	+	+	EP
B. (*Baetiella*) *tuberculatus* (Kazlauskas, 1963)	−	−	−	+	−	+	−	+	+	−	+	EP

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Cloeon Leach, 1815												
C. (*Cloeon*) *dipterum* L., 1761	−	−	−	+	−	+	+	+	+	+	+	TP
C. (*Centroptilum*) *kazlauskasi* (Kluge, 1983)	−	−	−	+	−	+	−	+	−	−	−	EAci
Cloeon (*Centroptilum*) sp.1	−	−	−	−	−	+	−	+	+	−	−	EAc
C. (*Procloeon*) *albisternum* (Novikova, 1986)	−	−	−	−	−	−	−	+	+	−	−	EAc
C. (*P.*) *bifidum* Bengtsson, 1912	−	−	−	−	−	−	−	−	+	−	−	TP
C. (*P.*) *maritimum* (Kluge, 1983)	−	−	−	−	−	+	−	+	−	−	+	EAc
C. (*P.*) *pennulatum* (Eaton, 1870)	−	−	−	+	−	+	+	+	+	−	+	TP
C. (*P.*) *pulchrum*? (Eaton, 1885)	−	−	−	−	−	−	−	+	−	−	−	TP
C. (*Similicloeon*) *simile* Eaton, 1870	−	+	+	+	−	−	−	+	+	−	−	TP
Baetopus Keffermüller, 1960												
B. (*B.*) *wartensis* Keffermüller, 1960	−	−	−	+	−	−	−	−	−	−	−	TP
B. (*Raptobaetopus*) *tenellus* (Albarda, 1878)	−	−	−	−	−	−	−	+	+	−	−	TP
Oligoneuriidae												
Oligoneuriella Ulmer, 1924												
O. pallida (Hagen, 1855)	−	−	−	−	−	−	−	+	+	−	−	TP
Leptophlebiidae												
Choroterpes Eaton, 1881												
Ch. (*Euthraulus*) *altioculus* Kluge, 1984	−	−	−	−	−	−	−	+	−	+	+	EP
Choroterpes sp.	−	−	−	−	+	+	+	+	+	−	−	
Leptophlebia Westwood, 1840												
L. (*Neoleptophlebia*) *chocolata* (Imanishi, 1937)	−	−	+	+	+	+	+	+	+	+	+	EP
L. (*P.*) *curvata* Ulmer, 1927	−	−	−	+	−	−	−	−	−	−	−	EAc
L. (*N.*) *vladivostokica* (Kluge, 1982)	−	−	−	−	−	+	−	−	−	−	−	EAc
L. (*Paraleptophlebia*) *strandii* Eaton, 1901	−	+	−	+	+	+	−	+	+	−	−	TP
Ephemerellidae												
Amurella Kluge, 1997												
A. gracilis Tshernova, 1952	−	−	−	−	−	−	−	−	+	−	−	EAc

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Drunella Needham, 1905												
D. aculea Allen, 1971	−	−	−	+	+	+	+	+	+	−	+	EAc
D. basalis (Imanishi, 1937)	−	−	+	−	−	−	−	−	−	+	−	EAi
D. cryptomeria (Imanishi, 1937)	−	−	+	+	+	+	+	+	+	+	+	EP
D. lepnevae Tshernova, 1949	−	−	−	+	+	+	+	+	+	−	+	EP
D. sachalinensis (Matsumura, 1931)	−	−	+	−	−	−	−	−	−	+	−	EAi
D. solida Bajkova, 1980	−	−	−	−	−	+	+	+	+	−	+	EAc
D. triacantha Tshernova, 1949	+	+	+	+	+	+	+	+	+	+	+	EP
D. trispina (Uéno,1928)	−	−	+	−	−	−	−	−	−	+	−	EAi
Ephacerella Paclt, 1994												
E. longicaudata (Uéno, 1928)	−	−	−	−	−	+	−	−	−	+	+	EAci
Ephemerella Walsh, 1862												
E. aurivillii Bengtsson, 1908	−	+	+	+	+	+	+	+	+	+	+	TP
E. dentata Bajkova, 1967	−	+	−	−	+	+	+	+	+	+	+	EP
E. kozhovi Bajkova, 1967	−	+	+	+	+	+	+	+	+	−	+	EP
E. mucronata (Bengtsson, 1909)	−	+	−	+	+	+	−	+	+	−	−	CB
Cincticostella Allen, 1971												
C. levanidovae Tshernova, 1952	−	−	−	+	−	+	+	+	−	+	+	EAci
C. tshernovae Bajkova, 1962	−	−	−	−	−	+	+	+	−	+	+	EAc
C. okumai (Gose, 1980)	−	−	+	−	−	−	−	−	−	+	−	EAi
C. nigra (Uéno, 1928)	−	−	+	+	−	−	−	−	−	+	−	EAi
Serratella Edmunds, 1959												
S. ignita (Poda, 1761)	+	−	+	+	+	+	+	+	+	−	+	TP
S. setigera (Bajkova, 1967)	−	−	+	+	+	+	+	+	+	+	+	EP
S. thymalli (Tshernova, 1952)	+	+	−	−	+	+	+	+	+	−	−	EP
S. zapekinae Bajkova, 1967	−	−	−	−	+	+	+	+	+	−	+	EP
Torleya Lestage, 1917												
T. mikhaili Tiunova, 1995	−	−	−	−	−	+	+	+	+	−	−	EAc
T. padunica Kazlauskas, 1963	−	−	−	−	+	+	+	+	+	−	−	EP

(*continued*)

Table 1. (*Continued*).

Species	Chukotka	Kamchatka	Kuril Islands	Sakhalin Island	Sea of Okhotsk Basin	Sea of Japan Basin	Khanka Lake Basin	Ussuri River Basin	Amur River Basin	Japan	Korea	Distribution
Uracanthella Belov, 1979												
U. lenoki (Tshernova, 1952)	–	–	–	+	–	+	+	+	+	–	–	EP
U. punctisetae (Matsumura, 1931)	–	–	–	+	+	+	+	+	+	+	+	EP
Neoephemeridae												
Potamanthellus Lestage, 1930												
P. chinensis (Hsu, 1935)	–	–	–	–	–	+	+	+	–	–	+	EAc
Caenidae												
Brachycercus Curtis, 1834												
B. corniger Kluge, 1991	–	–	–	–	–	–	–	+	+	–	–	EP
B. harisella Curtis, 1834	–	–	–	–	–	–	–	–	+	–	–	TP
B. minutus Tshernova, 1952	–	–	–	–	–	–	–	–	+	–	–	TP
B. tubulatus Tshernova, 1952	–	–	–	–	–	–	–	+	+	–	+	EAc
Caenis Stephens, 1835												
C. amurensis Kluge, 1987	–	–	–	–	–	–	+	+	+	–	–	EAc
C. cornuta (Tshernova, 1952)	–	–	–	–	–	–	+	–	+	–	–	EAc
C. horaria (L., 1758)	–	–	–	–	+	–	+	–	+	+	–	TP
C. lactea (Burmeister, 1839)	–	–	–	–	–	–	–	–	+	–	–	TP
C. maculata (Tshernova, 1952)	–	–	–	–	–	+	+	+	+	–	–	EAc
C. miliaria (Tshernova, 1952)	–	–	–	–	–	+	+	+	+	–	–	EP
C. macronyx Kluge, 1987	–	–	–	–	–	–	–	–	+	–	–	EAc
C. pseudorivulorum Keffermüller, 1960	–	–	–	–	–	–	–	+	+	–	–	TP
C. pustula Tiunova, 1999	–	–	–	–	–	–	+	+	+	–	–	EAc
C. rivulorum Eaton, 1884	–	–	–	+	–	+	+	+	+	–	–	TP

Notes: Records marked by '?' were determined from young larvae. Distribution: A – Amphipacific, C – Circum-Boreal, TP – Transpalaearctic, EP – East-Palaearctic, EAc – East-Asian continental, EAi – East-Asian island, EAci – East-Asian continental-island.

the most significant rivers of Russia. Regarding the water discharge volume, the Amur River is only surpassed by the Yenisei, Ob' and Lena rivers. Our investigation followed the largest tributaries of the Amur River, the Anui, Gur, Yai, Amgun', Bureya, Zeya, Arkhara, Bolshoi Ol'doi, Amasar, Bira, and Bidzhan, and included streams of the Evreiskaya Avtonomnaya Oblast' and Amurskaya Oblast' along a line from the cities of Khabarovsk to Chita.

Prior to 1940, the mayfly fauna of the Amur River remained to be almost uninvestigated, with only eight species known for all river basins. The mayflies collected in 1945–1949 by members of the Amur Ichthyological Expedition came from approximately 50 various streams of the Amur River basin and adjacent territories, and reflect the abundance and diversity of species. In the material of O.A. Tshernova (1952), 65 species of mayflies were noted for the region. Thus, for the Amur River 30 species are reported from its basic channel. Investigations of the mayflies of the Amur River basin were conducted in 1949–1964 by employees of the Amur Branch of Pacific Institute of Fish Industry and Oceanography. Data from these surveys increased the species list up to 101 species, among which 19 were determined only to genus level (Bajkova 1965). Fourteen species were found in the Lower Amur for the first time. Further research along the Amur River resulted in a series of articles describing some new species (Bajkova 1970, 1972a, 1972b, 1974, 1977; Belov 1981; Kluge 1987a, 1987b). These works are summed up in an annotated checklist of mayflies of the Russian Far East (Tiunova, 1984, 1986, 1989) that includes 86 species. As a result, the original list of records has been modified by more than 50%: on the one hand it was significantly reduced due to the removal of species that had been incorrectly determined, and on the other hand the list increased as newly encountered species were added.

Among 123 mayfly species inhabiting the Amur River basin, 54 species are found in its basic channel. The following species were only collected in the basic Amur River bed: *Behningia tshernovae*, *Ametropus eatoni*, *Ephemera shengmi*, *Isonychia ignota*, *I. concoloria*, *Caenis lactea*, *C. macronyx*, *Brachycercus harrisella*, *B. minutus*, *Anagenesia paradoxa*, and *A. sibirica*.

Sea of Japan basin

The streams draining into the basin of the Sea of Japan are highly variable, both in length and in hydrological parameters. This area includes streams of the northern and eastern parts of the Sikhote-Alin mountain system and the southeastern spurs of the Black Mountains. We investigated large rivers such as the Tumnin, Razdolnaya, Malinovka, Milogradovka, Samarga, Botchi, Avvakumovka, Serebryanka, and about 30 streams of a moderately cold-water type, each with a length of about 50 km. The majority of these streams are important as so-called salmon rivers, where salmon not only spawn, but where salmon fry feed and grow until migration to the ocean. Previously, the level of mayfly investigations in this part of the Russian Far East was rather nonuniform, and only four species were recorded for the streams of central and east Sikhote-Alin until 1981. The rivers of north Sikhote-Alin had not been investigated at all. The mayfly fauna of the southern part of the area, namely the Black Mountain region, had been rather well investigated. Research on the fauna of that region was initiated by I.M. Levanidova in the 1970s (Levanidova, Levanidov and Makarchenko 1977; Levanidova 1982; Vshivkova et al. 1992). Since the early 1980s, mayflies of the rivers of the Sea of Japan basin have been systematically

studied (Kluge 1983a, 1986b; Tiunova 1988, 1993, 2006a; Potikha 1985, 1987, 1990, 2002; Kluge and Tiunova 1989; Tiunova et al. 2003; Tiunova and Potikha 2005).

The mayfly fauna of streams of the Sea of Japan basin now includes 102 species (Table 1). Among the interesting finds in this area are records of *Ephoron nigridorsum*, *Ephemera shengmi*, *Ecdyonurus fragilis*, *E. rubromaculatus*, *Cinygmula levanidovi*, *Oligoneuriella pallida*, *Leptophlebia vladivostokica*, *Isonychia vshivkovae*, *Ephacerella longicaudata* and *Rhoenanthus coreanus*. The last two species are listed in the Red Data Book of Primorsky Krai.

Lake Khanka

The water bodies of Lake Khanka are also highly variable, including foothill sections of streams with moderately cold water and flat sections with moderately warm to warm watercourses. Lake Khanka is the largest freshwater reservoir in the Russian Far East. It is 95 km long and covers a surface area of 4070 km^2, with prevailing depths of 1–3 m, reaching a maximum depth of 10.6 m. Our systematic investigations of the rivers of the Lake Khanka basin began in 1996. Previously we had conducted one-trip collections from several streams in the area. We studied the Komissarovka, Ilistaya, Nesterovka, Poperechnaya, Malinovka, Kiselevka, and Mel'gunovka rivers, as well as Lake Khanka. These investigations resulted in a list of the mayflies of Lake Khanka basin totalling 79 species (Table 1).

On one hand, the mayfly fauna of Lake Khanka is rather poor, but it is also highly unique. Only 11 species are found: *Ephoron shigae*, *Ephemera shengmi*, *Heptagenia flava*, *Siphlonurus chankae*, *Cloeon dipterum*, *Caenis amurensis*, *C. cornuta*, *C. maculata*, *C. miliaria*, *Chankagenesia natans*, and *Behningia tshernovae*. The latter two species are both unique finds for this region. In the Russian Far East, *Behningia tshernovae* was long considered to be endemic for the lower part of the Amur River (Tiunova 1997). It is a rare species, a Far Eastern endemic included in the Red Data Book of Primorsky Krai. Other rare species found in the Lake Khanka basin are *Potamanthellus chinensis*, *Ecdyonurus fragilis*, *Isonychia sexpetala*, *Torleya mikhaili*, *Caenis amurensis*, *C. pustula*, and *C. cornuta*.

Okhotsk Sea Basin

Our studies of coastal rivers along the Okhotsk Sea were carried out in 1998–2000. The material was collected in the rivers Marikan, Okhota, Bulginka, Kuhtui, Ul'ya, Aldoma, Chelasin, Maya, Uika, Lantar', Til, Uda, Iski and others. The author also studied mayfly material collected in Taui River Basin (Arefina et al. 2003). Prior to 1998 the mayflies of this region were basically not investigated. Thanks to our collecting the mayfly list increased to 67 species. The most interesting find is *Siphlonurus alternatus*. Its known distributional limit in the Eastern Palaearctic was previously Yakutia and Transbaikalia (Tshernova, Kluge, Sinitshenkova and Belov 1986; Tiunova 2007b). Prior to our discoveries, the known distributions of *Cinygmula kurenzovi*, *C. hirasana*, *C. irina* and *Rhithrogena bajkovae* had their limits in the north by the rivers of the Amur River Basin. *Parameletus minor*, earlier known in the Russian Far East only from Kamchatka Peninsula, was also found (Tshernova et al. 1986; Kluge 1997; Tiunova 2007b, 2008a). *Ecdyonurus vicinus* was also collected in this region, though previously it was described from Afghanistan and reported by Kluge (1980) from Kazakhstan and Siberia.

Sakhalin Island

The likewise species-rich region of Sakhalin Island includes watercourses and reservoirs in which 61 species have now been found (Tiunova 2007a). Before this publication, there were no general reports on the mayflies of Sakhalin Island available. Most publications were confined to taxonomic and faunistic research on particular species or specific islands (Tshernova 1952; Levanidova 1968; Bajkova 1976; Sinichenkova and Tshernova 1976; Sinichenkova 1981b; Tshernova et al. 1986). Thus, based on data on literature, 29 species of mayflies were known from Sakhalin Island.

From 1979 to 2004, researchers from the Institute of Biology and Soil Science of the Far Eastern Branch of Russian Academy of Sciences (IBSS FEB RAS), the author, and participants of the International Sakhalin Project (ISIP) carried out a joint investigation of the streams and rivers of Sakhalin Island from Kriljon Cape in the south up to Schmidt Peninsula in the north. Based on this material, 34 mayfly species were added to the list. Among the most interesting findings are *Baetis acinaciger*, *B. silvaticus* and *Cloeon (Centroptilum) kazlauskasi*, which we had noted only in Primorskiy Kray and, for the last species, in Khabarovskiy Krai. The five species, *Ephemera japonica*, *Epeorus ermolenkoi*, *E. frolenkoi*, *Baetis thermicus* and *Cincticostella nigra* are insular species, occurring in the South of the Russian Far East.

Kuril Islands

The mayfly fauna of the Kuril Islands now totals 39 species, among which eight are typical island species (Tiunova 2003, 2007b). Systematic investigations of the streams of Kunashir Island were carried out from 1970–1980 by the author and other members of the Laboratory of Freshwater Hydrobiology IBSS FEB RAS. Material was collected on the islands of Kunashir, Shikotan and Iturup. Tiunova (1995c) presents these results, listing 24 species for Kunashir Island, 13 of which were previously identified as island species (Sinichenkova and Tshernova 1976; Sinichenkova 1981b; Tshernova and Belov 1982; Tshernova et al. 1986). Subsequently, material collected by members of the International Kuril Expedition (IKIP, 1995–1999) were given to the author to identify mayfly species from the Kunashir Islands of Shikotan, Zelenyi, Iturup, Urup, Onekotan, Macanrushi, Paramushir and Shumshu. As a result, the list of mayflies was increased by 15 species. Interesting finds from the islands include *Baetis (Nigrobaetis) bacillus*, *B. macani* and *Cloeon (S.) simile*. Species such as *Epeorus latifolium*, *E. (Iron) uenoi*, *Drunella basalis*, *D. sachalinensis*, *D. trispina* and *Cincticostella okumai* were found to inhabit only the watercourses of Kuriles Islands.

Kamchatka Peninsula and Chukotka

The streams of the Kamchatka peninsula (28 species) and Chukotka (17 species) have the smallest number of mayfly species. The first data on mayflies of Kamchatka peninsula were presented in G. Ulmer's work (Ulmer 1927) where four species were described based on imagines, and the occurrence of *Ephemerella aurivillii*, previously considered as a European species, was noted in the fauna of the peninsula. Kurenkov (1967) recorded 19 species and Levanidova (1972) listed 22 species for this region.

In 2000, using material from the Kamchatka expedition (1996–1997), together with Japanese colleagues, we added two more species to the list: *Baetis pseudothermicus* and *B. bicaudatus* (Ishiwata et al. 2000). It also fell to us to determine mayfly specimens collected by participants of the Institute of Biological Problems of the North (Magadan), the Institute of Sea Biology (Vladivostok) and the Russian Federal Research Institute of Fisheries and Oceanography (Moscow). The results of those studies allowed us to compile a list of mayflies including 28 species, which is close to the theoretically possible 30–33 species. The family Caenidae is not included, though in our material young larvae of the genus *Caenis* are present, but these could not be identified to species level.

Despite of the low diversity of mayfly species along the streams of Chukotka (17 species), this area is of significant interest for faunistic research as it is a part of the ancient Bering land bridge, the location of migration routes between Asia and North America. The first report on mayflies of Chukotka peninsula was published by Levanidova in 1976. Based on material collected by Levanidova and other members of the laboratory of Freshwater Hydrobiology (1972–1974), the species list included 12 species. Later, in I. Levanidova's monograph (1982) there were 15 species reported for Chukotka peninsula, three of which are also not identified to species level. The mayfly list given in our work is based on the material of I. Levanidova and those collected during many years of research by I. Zasypkina (Institute of Biological Problems of the North) (Zasypkina, Rybuchin, Makarchenko and Makarchenko 1996).

A prominent feature of the Chukotka mayfly fauna is the prevailing presence of common species. All mayflies have a wide distribution, and the fauna does not contain endemic forms. This is different to the mayfly fauna known for the Primorskii Krai and the Amur River Basin. This difference is probably connected with an insufficient level of investigation, as even on Kamchatka, with its poor freshwater fauna, 28 species are now registered, which is 60% more than on Chukotka.

Biogeographical composition

As for biogeography, the mayfly fauna of the Russian Far East includes mainly East Asian and East Palaearctic species, which account about 78% of the species composition (Table 2). Mayflies with East-Asian and East Palaearctic types of distribution are most common in the basins of the Ussuri and Amur rivers, as well as in the Sea of Japan.

Among the regions investigated, species with East-Asian distribution are most richly represented in streams of the Sea of Japan (38%) and the Kuril Islands (36%). It is no wonder that the maximum numbers of endemic insular mayfly species are found on the Kuril Islands. Species with East-Palaearctic distribution prevail in streams of the Chukotka Peninsula (59%) and the Sea of Okhotsk (59%). Mayflies with Trans-Palaearctic distribution are most abundant on Kamchatka Peninsula (25%) and Sakhalin Island (22%). Species with extensive distributions—the Amphipacific and Circumboreal types—comprise the greatest percentage on Chukotka (24%).

It is necessary to note the large similarities between the mayfly fauna of the Russian Far East and the faunas of Korea and Japan. According to data from Bae and Yoon (1997) and others (Bae, Kluge, Yu and Chun 1998; Bae and Liu 1999; Hwang and Bae 2001), there are 81 species reported in Korean rivers, among which 67 species also inhabit the southern rivers of the Russian Far East. According to

Table 2. Biogeographical composition the mayfly fauna of the Far East of Russia.

Distribution	Chukotka	Kamchatka	Sea of Okhotsk basin	Sakhalin Island	Kuril Islands	Amur River basin	Ussuri River basin	Sea of Japan basin	Khanka Lake basin	Far East of Russia
East-Asian	-	4 (1)	12 (8)	25 (15)	36 (14)	28 (36)	34 (40)	36 (36)	30 (23)	43 (72)
East-Palaearctic	59 (10)	54 (15)	57 (38)	47 (28)	38 (15)	44 (53)	44 (51)	54 (45)	49 (37)	35 (58)
Palaearctic	-	18 (5)	16 (11)	13 (8)	8 (3)	10 (12)	9 (10)	9 (9)	9 (7)	9 (15)
Trans-Palaearctic	18 (3)	11 (3)	9 (6)	10 (6)	13 (5)	12 (15)	10 (12)	6 (6)	9 (7)	10 (17)
Circum-Boreal	23 (4)	14 (4)	6 (4)	5 (3)	5 (2)	4 (5)	3 (3)	3 (3)	3 (2)	3 (5)
Number of species	17	28	67	60	39	121	116	99	76	167

Notes: Upper lines – %; bottom lines – number of species in respective region.

Ishiwata (2001), there are 140 species found in Japan, among which 44 species are also present in the rivers of the Russian Far East (Table 1).

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References

Arefina, T.I., Ivanov, P. Yu., Kocharina, S.L., Lafer, G. Sh., Makarchenko, M.A., Teslenko, V.A., Tiunova, T.M., and Khamenkova, E.V. (2003), 'Fauna of aquatic insects of Taui River basin (Magadan Territory)', in *Vladimir Ya. Levanidov's Biennial Memorial Meeting*, ed. E. Makarchenko, Vladivostok: Dalnauka, pp. 45–60.

Bae, Y.J., and Liu, G.C. (1999), 'Mayflies (Ephemeroptera) from Changbaishan area in Northeast Asia', *Entomological Research Bulletin*, 25, 1–6.

Bae, Y.J., and Yoon, I.B. (1997), 'A revised catalogue of the Ephemeroptera of Korea', *Entomological Research Bulletin*, 23, 43–53.

Bae, Y.J., Kluge, N. Yu., and Chun, D.J. (1998), 'New synonymy and new data on the distribution of the mayflies from Korea and the Russian Far East (Ephemeroptera)', *Zoosystematica Rossica*, 7, 89–94.

Bajkova, O.Ya (1962), 'New species of the genus *Ephemerella* Walsh (Ephemeroptera, Ephemerellidae) from mountain tributaries of the Amur basin', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 48, 202–205.

Bajkova, O.Ya (1965), 'Fauna of mayflies of the Far East', *Voprosi geografii Dal'nego Vostoka*, 7, 301–330.

Bajkova, O.Ya (1967), 'New species of *Ephemerella* Walsh. (Ephemeroptera, Ephemerellidae) from the Far East and East Siberia', *Entomologicheskoe Obozrenie*, 46, 327–337.

Bajkova, O.Ya (1970), 'New and little-known species of mayflies (Ephemeroptera) from the basin of the Amur River', *Entomologicheskoe Obozrenie*, 49, 146–155.

Bajkova, O.Ya (1972a), 'On the mayflies of the Amur basin. I. Imagines (Ephemeroptera: Ephemerellidae)', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 77, 178–206.

Bajkova, O.Ya (1972b), 'On the mayflies of the Amur basin. II. Imagines (*Rhithrogena*, Heptageniidae)', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 77, 207–232.

Bajkova, O.Ya (1974), 'The study of mayflies (Ephemeroptera) from the basin of the Amur River', *Entomologicheskoe Obozrenie*, 53, 815–829.

Bajkova, O.Ya (1975), 'New genus of Ephemeroptera from the Primorye', *Izvestia Sibirskogo Otdelenia Akademii Nauk SSSR*, 5, 54–57.

Bajkova, O.Ya (1976), 'Ephemeroptera of the genus *Ameletus* Eaton of Amur basin', *Entomologicheskoe Obozrenie*, 55, 528–588.

Bajkova, O.Ya (1979), 'On the mayflies (Ephemeroptera) of Amur Basin', *Entomologicheskoe Obozrenie*, 58, 308–317.

Bajkova, O.Ya (1980), 'New species mayfly (Ephemeroptera, Ephemerellidae) from the Primorye', *Entomologicheskoe Obozrenie*, 59, 796–799.

Belov, V.V. (1981), 'New species of the mayfly genus *Heptagenia* Walsh (Ephemeroptera, Heptageniidae) from the Sought of the Khabarovsk region', *Entomologicheskoe Obozrenie*, 60, 601–603.

Ishiwata, S.I. (2001), 'A Checklist of Japanese Ephemeroptera', in *The 21st Century and Aquatic Entomology in East Asia, Proceedings of the 1st Symposium AESEA*, pp. 55–84.

Ishiwata, S.I., Tiunova, T.M., and Kuranishi, R.B. (2000), 'The mayflies (Insecta: Ephemeroptera) collected from the Kamchatka peninsula and the north Kuril Islands in 1996–1997', *Nature History Research*, 7, 67–75.

Hwang, J.M., and Bae, Y.J. (2001), 'Taxonomic review of the Siphlonuridae (Ephemeroptera) in Korea', in *The 21st Century and Aquatic Entomology in East Asia, Proceedings of the 1st Symposium AESEA*, pp. 45–53.

Kluge, N.Yu (1980), 'To the knowledge of mayflies (Ephemeroptera) of Taimyr national district', *Entomologicheskoe Obozrenie*, 59, 561–579.

Kluge, N.Yu (1982), 'New and little known mayflies of the Far East USSR. Families Leptophlebiidae and Siphlonuridae (Ephemeroptera)', *Vestnik LGU*, 9, 112–116.

Kluge, N.Yu (1983a), 'New and little known mayflies of the family Baetidae (Ephemeroptera) from the Primorye', *Entomologicheskoe Obozrenie*, 61, 65–79.

Kluge, N.Yu (1983b), 'New and little known mayflies of the Far East USSR. Genus *Ecdyonurus* (Ephemeroptera, Heptageniidae)', in *Ecology and Systematic Freshwater Organisms Far East*, ed. I. Levanidova, Vladivostok: FESC AS USSR, pp. 27–36.

Kluge, N.Yu (1985), 'On the taxonomy of Far East species group *aestivalis*, genus *Siphlonurus* Etn. (Ephemeroptera, Siphlonuridae)', *Vestnik LGU*, 10, 12–20.

Kluge, N.Yu (1987a), 'Two new species of mayflies of the genus *Caenis* (Ephemeroptera, Caenidae) from the lower Amur', *Vestnik LGU*, 3, 91–94.

Kluge, N.Yu (1987b), 'Mayflies of the genus *Heptagenia* Walsh (Ephemeroptera, Heptageniidae) of the fauna of the USSR', *Entomologicheskoe Obozrenie*, 66, 302–330.

Kluge, N.Yu (1988), 'Revision of genera of the family Heptageniidae (Ephemeroptera). I. Diagnoses of tribes, genera and subgenera of the subfamily Heptageniinae', *Entomologicheskoe Obozrenie*, 67, 291–313.

Kluge, N.Yu (1989), 'Mayflies of the genus *Heptagenia* Walsh (Ephemeroptera, Heptageniidae) of the fauna USSR. 2. Supplements and description of a new species from the Pamir', *Vestnik LGU*, 3, 3–13.

Kluge, N.Yu (1997), 'Oder mayflies (Ephemeroptera)', in *Key to Freshwater Invertebrates of Russia and Adjacent Lands*, ed. S. Tsalolikhin, St. Petersburg: Nauka, 3, 176–220, 304–329.

Kluge, N.Yu, and Tiunova, T.M. (1989), 'Palearctic mayflies of the group *longimanus* of the subgenus *Iron* (Ephemeroptera, Heptageniidae)', *Vestnik Zoologii*, 4, 7–14.

Kurenkov, I.I. (1967), 'The list of water invertebrates of intrinsic reservoirs of Kamchatka', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 57, 202–224.

Levanidova, I.M. (1964), 'To zoogeography of a hydrofauna of southern areas of the Far East', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 55, 175–195.

Levanidova, I.M. (1968), 'Benthos of tributaries of Amur (ecologo-faunistic review)', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 64, 191–289.

Levanidova, I.M. (1972), 'Mayflies of the Kamchatka Peninsula', *Izvestiya Tikhookeanskogo Nauchno Issledovatelskogo Instituta Rybnogo Khozyistva i Oceanography*, 82, 93–115.

Levanidova, I.M. (1976), 'Ephemeroptera and Trichoptera of the Chukchi Peninsula', in *Freshwater Fauna of the Chukchi Peninsula*, ed. I. Levanidov, Vladivostok: FESC AS USSR, pp. 38–56.

Levanidova, I.M. (1982), *Amphibiotic insects of mountain region of the Far East of the USSR*, Leningrad: Nauka.

Levanidova, I.M., Levanidov, V.Ya, and Makarchenko, E.A. (1977), 'Fauna of the bottom invertebrates "Kedrovaya Pad" reserve', in *Freshwater Fauna "Kedrovaya Pad" Reserve*, ed. V. Levanidov, Vladivostok: FESC AS USSR, pp. 3–43.

Novikova, E.A. (1987), 'Mayflies family Baetidae (Ephemeroptera) of fauna of the USSR', unpublished Ph.D. dissertation, Zoological Institute Academy Science, USSR.

Potikha, E.V. (1985), 'Preliminary results of studying of mayflies - Ephemeroptera Sikhote-Alinskyi reserve', in *Sikhote-Alinskyi Biospheric Area: Ecological Investigations*, eds. B. Petropavlovskii and A. Astaf'ev, Vladivostok: FESC AS USSR, pp. 86–99.

Potikha, E.V. (1987), 'The zoobenthos of the river Zabolochennaya of the Sikhote-Alinskyi biospheric reserve (Primorskiy Krai)', in *Bottom Invertebrates of the Rivers of the Far East and Eastern Siberia*, ed. E. Makarchenko, Vladivostok: DVO AS USSR, pp. 440–441.

Potikha, E.V. (1990), 'Composition and seasonal dynamics of the benthos in the Sukhoi stream', in *Ecological Studies in the Sikhote-Alin reserve (Peculiarities of the Oak Forest Ecosystems)*, ed. A.I. Myslenkov, Moscow: Glavokhota, pp. 72–82.

Sinitshenkova, N.D. (1973a), 'To the knowledge of the genus *Rhithrogena* Eaton (Ephemeroptera, Heptageniidae)', *Vestnik MGU, Ser Biology*, 3, 16–22.
Sinitshenkova, N.D. (1973b), 'Larvae of mayflies of palaearctic species of the genus *Rhithrogena* Eaton (Ephemeroptera, Heptageniidae)', *Vestnik MGU, Ser Biology*, 5, 9–17.
Sinitshenkova, N.D. (1977), 'Mayflies of the genus *Ameletus* Eaton from Primorye, of Fauna of the bottom invertebrates ''Kedrovaya Pad'' reserve', in *Freshwater Fauna ''Kedrovaya Pad'' Reserve*, ed. V. Levanidov, Vladivostok: FESC AS USSR, pp. 44–49.
Sinitshenkova, N.D. (1981a), 'New species of mayflies of genus *Ameletus* Eaton (Ephemeroptera, Siphlonuridae) with Sikhote-Alin', in *Invertebrate Animals in Ecosystems of the Salmon Rivers of the Far East*, ed. V. Levanidov, Vladivostok: FESC AS USSR, pp. 73–78.
Sinitshenkova, N.D. (1981b), 'To the knowledge of mayfly larvae of the genus *Epeorus* Eaton (Ephemeroptera, Heptageniidae)', *Entomologicheskoe Obozrenie*, 60, 813–823.
Sinitshenkova, N.D. (1982), 'New species of mayflies of the genera *Iron* and *Rhithrogena* in the fauna of the Far East and Transbaikal (Ephemeroptera, Heptageniidae)', *Bull MOIP*, 87, 53–67.
Sinitshenkova, N.D., and Tshernova, O.A. (1976), 'The new data on the Asiatic species of the genus *Ameletus* Eaton (Ephemeroptera, Siphlonuridae)', *Vestnik MGU, Ser Biology*, 5, 11–19.
Tiunova, T.M. (1984), 'List of mayfly (Ephemeroptera, Ephemerellidae) Far East of USSR', in *Biology of Freshwater of the Far East*, ed. E. Makarchenko, Vladivostok: FESC AS USSR, pp. 46–50.
Tiunova, T. (1986), 'Mayflies (Ephemeroptera) of the Far East of USSR', in *Bottom Organisms of Freshwater of the Far East*, ed. E. Makarchenko, Vladivostok: FESC AS USSR, pp. 14–34.
Tiunova, T. (1988), 'New data about mayflies' family Ephemerellidae (Ephemeroptera) of fauna of the Far East', in *Fauna, Systematic and Biology of Freshwater Invertebrates*, ed. E. Makarchenko, Vladivostok: FESC AS USSR, pp. 3–6.
Tiunova, T. (1989), 'Mayflies (Ephemeroptera) family Heptageniidae and Caenidae of the Far East of USSR', *Catalog of Caddisfly (Trichoptera), Mayfly (Ephemeroptera) Megaleptera of the Far East of USSR and Adjacent Lands, Part III*, pp. 52–68. Vladivostok: DVO AS USSR.
Tiunova, T. (1990), 'Description of a new species of mayflies of the genus *Cinygmula* McD. (Ephemeroptera: Heptageniidae) and larva of *Rhoenanthus rohdendorfi* Tshern (Potamanthidae) from Primorye territory', *Entomologicheskoe Obozrenie*, 69, 814–819.
Tiunova, T. (1991a), 'A new mayfly species (Ephemeroptera: Heptageniidae) from Primorye region (Far East USSR)', *Vestnik Zoology*, (4), 13–17.
Tiunova, T. (1991b), 'Description of imago *Potamanthellus rarus* (Ephemeroptera, Neoephemeridae) from Primorye', *Zoological Journal*, 70, 136–138.
Tiunova, T. (1993), *Mayfly of the Kedrovaya River and their ecologo-physiological characteristics*, Vladivostok: Dalnauka.
Tiunova, T. (1995a), 'A list of the Ephemeroptera of the Ussuri River Basin (Far East of Russia)', in *Report of the Studies on the Structure and Function of River Ecosystems of the Far East*, Japan, pp. 45–50.
Tiunova, T. (1995b), 'A new species of *Torleya* Lestage, 1917 (Ephemeroptera: Ephemerellidae) from the Far East of Russia', *Aquatic Insects*, 17, 51–56.
Tiunova, T. (1995c), 'The mayflies (Insecta: Ephemeroptera) of the Kunashir (Kuril Islands)', *Far Eastern Entomologist*, 9, 1–8.
Tiunova, T. (1997), 'First record of mayfly genus *Behningia* Lestage, 1929 (Ephemeroptera, Behningiidae) from Primorye', *Far Eastern Entomologist*, 47, 20.
Tiunova, T. (1999a), 'The first record of *Potamanthus formosus* Eaton, 1892 (Ephemeroptera: Potamanthidae) to the Russian fauna, with its redescription', *Far Eastern Entomologist*, 72, 1–7.
Tiunova, T. (1999b), 'A new species of *Metretopus* Eaton, 1901 (Ephemeroptera: Metretopodidae) from the Far East of Russia', *Aquatic Insects*, 21, 273–279.
Tiunova, T. (1999c), 'New Far Eastern Caenidae (Insecta: Ephemeroptera), with remarks, description of imagines and a new species', *Vestnik Zoologii*, 33, 11–21.

Tiunova, T. (2003), 'Mayflies (Ephemeroptera) the south of the Far East (a fauna, biology, functional ecology)', unpublished Dr. Sci. dissertation, Institute of Biology and Soil Sciences, Russian Academy of Sciences, Vladivostok, Russia.

Tiunova, T. (2005), '*Rhoenanthus coreanus*, *Behningia tshernovae*, *Acanthametropus nikolskyi*, *Anagenesia* (Chankagenesia) *natans*, *Potamanthellus chinensis*, *Ephemerella* (Ephacerella) *longicaudata*', in *Red Data Book Primorsky Krai, Animals. Rare and endangered species of animals*, ed. V. Kostenko, Vladivostok: AVK ''Apel'sin'', pp. 121–128.

Tiunova, T. (2006a), 'Mayfly (Ephemeroptera) of the East-Manchurian Mountains', in *Flora and Fauna of Kedrovaya Pad Nature Reserve*, ed. E. Makarchenko, Vladivostok: Dalnauka, pp. 50–62.

Tiunova, T. (2006b), 'A new species of the genus *Ecdyonurus* Eaton, 1868 (Ephemeroptera, Heptageniidae) from the Far East of Russia', *Euroasian Entomological Journal*, 5, 285–289.

Tiunova, T. (2007a), 'A contribution to the mayfly fauna (Insecta: Ephemeroptera) of Sakhalin Island', *Euroasian Entomological Journal*, 6, 379–386.

Tiunova, T. (2007b), 'Current knowledge of the mayfly fauna (Ephemeroptera) in the Far East of Russia and adjacent territories', *Euroasian Entomological Journal*, 6, 181–192 + III.

Tiunova, T. (2008a), 'Two new species of *Parameletus* Bengtsson, 1908 (Ephemeroptera, Siphlonuridae), and notes on other species from the Far East of Russia', *Zootaxa*, 1725, 17–26.

Tiunova, T. (2008b), 'Mayflies (Insecta, Ephemeroptera) basin of the Zeya River (Amurskyi region)', in *Freshwater Ecosystems of the Amur River Basin*, ed. E. Makarchenko, Vladivostok: Dalnauka, pp. 31–44.

Tiunova, T.M., and Belov, V.V. (1984), 'To the taxonomy of mayflies (Ephemeroptera, Ephemerellidae) from the southern Far East of USSR', in *Biology of freshwater of the Far East*, ed. I. Levanidova, Vladivostok: FESC AS USSR, pp. 74–77.

Tiunova, T.M., Kluge, N.Yu, and Ishiwata, S.I. (2004), 'Revision of the East Palaearctic genus *Isonychia* (Ephemeroptera: Isonychiidae)', *Canadian Entomologist*, 136, 1–41.

Tiunova, T.M., and Levanidova, I.M. (1989), 'Description a new mayfly species (Ephemeroptera) from the Soviet Far East', *Aquatic Insects*, 11, 241–245.

Tiunova, T.M., and Potikha, E.V. (2005), 'Mayfly (Insecta: Ephemeroptera) of the Eastern Sikhote-Alin', in *Vladimir Ya. Levanidov's Biennial Memorial Meeting*, ed. E. Makarchenko, Vladivostok: Dalnauka, pp. 328–333.

Tiunova, T.M., Teslenko, V.A., and Arefina, T.I. (1997), 'Amphibiotic insects of the Bikin River Basin', in *Ecosystems of the Bikin River Basin*, ed. S. Zolotukhin, Vladivostok: Dalnauka, pp. 105–116.

Tiunova, T.M., Teslenko, V.A., Arefina, T.I., Makarchenko, M.A., and Zorina, O.V. (2003), 'Fauna of aquatic insects of Barabashevka River basin (Southern Primorye)', in *Vladimir Ya. Levanidov's Biennial Memorial Meeting*, ed. E. Makarchenko, Vladivostok: Dalnauka, pp. 61–69.

Tiunova, T.M., and Tiunov, M.P. (2007), 'Fauna water invertebrates Bureya River Basin. Oder mayflies (Ephemeroptera)', in *Hydro-ecological monitoring in Bureyskaya Hydro-Electric Power Station Zone Influences*, ed. T. Tiunova, Khabarovsk: Institute Water and Ecological Problems FEB RAS, pp. 136–145.

Tshernova, O.A. (1952), 'Mayflies (Ephemeroptera) of the Amur River Basin and adjacent waters and their role in the nutrition of Amur fishes', in *Trudy Amurskoi Ichtiological Ekspeditsii 19450–1949*, ed. G. Nikolskiy, Moscow: MOIP, pp. 229–360.

Tshernova, O.A. (1972), 'Some new species of mayflies from Asia (Ephemeroptera, Heptageniidae, Ephemerellidae)', *Entomologicheskoe Obozrenie*, 51, 604–614.

Tshernova, O.A. (1973), 'On Palearctic species of mayflies of the genus *Ephemera* L. (Ephemeroptera, Ephemeridae)', *Entomologicheskoe Obozrenie*, 52, 324–339.

Tshernova, O.A. (1976), 'Larval identification table of the genera of the mayfly Heptageniidae (Ephemeroptera) of Holarctic and Oriental regions', *Entomologicheskoe Obozrenie*, 55, 332–346.

Tshernova, O.A. (1978), 'A new species of the genus *Cinygmula* McD. (Ephemeroptera, Heptageniidae) from the Ussuri Basin and Primorye region', *Nauchnie Dokladi Vishay Shkoly, Biol Nauki*, 7, 74–76.

Tshernova, O.A. (1979), 'A new species of mayflies (Ephemeroptera, Heptageniidae) from Northeastern USSR', *Trudy VEO*, 61, 9–11.
Tshernova, O.A. (1981), 'On the systematic of adult mayflies of the genus *Epeorus* Eaton, 1881 (Ephemeroptera, Heptageniidae)', *Entomologicheskoe Obozrenie*, 60, 323–336.
Tshernova, O.A., and Bajkova, O.Ya (1960), 'On a new genus of mayflies (Ephemeroptera, Behningiidae)', *Entomologicheskoe Obozrenie*, 39, 410–416.
Tshernova, O.A., and Belov, V.V. (1982), 'On the systematics of imago of palaearctic mayflies of the genus *Cinygmula* McDunnough, 1933 (Ephemeroptera, Heptageniidae)', *Entomologicheskoe Obozrenie*, 61, 278–296.
Tshernova, O.A., Kluge, N.Yu, Sinitshenkova, N.D., and Belov, V.V. (1986), 'Order Ephemeroptera', in *Identification of Insects of Far East USSR*, ed. P. Ler, Leningrad: Nauka, pp. 99–142.
Ulmer, G. (1927), 'Entomologische Ergebnisse der Schwedischen Kamtschtka-Expedition 1920–1922. II. Trichopteren und Ephemeropteren', *Archiv für Zoologie*, 19, 1–17.
Vshivkova, T.S., Kocharina, S.L., Makarchenko, E.A., Makarchenko, M.A., Teslenko, V.A., and Tiunova, T.M. (1992), 'Fauna of water invertebrates of the Kedrovaya Pad reserve and adjacent lands', in *Contemporary State of Flora and Fauna of the Kedrovaya Pad Reserve*, ed. E. Makarchenko, Vladivostok: DVO RAS SSSR, pp. 48–88.
Zasypkina, I.A., Rybuchin, A.C., Makarchenko, E.A., and Makarchenko, M.A. (1996), *The review of amphibiotic insects of Northeast of Asia*, Magadan: SBNZ DVO RAS.