

## MAYFLIES OF THE LAKE HOVSGOL REGION, MONGOLIA

S. Enkhtaivan<sup>1</sup> and T. Soldán<sup>2</sup>

<sup>1</sup> *Mongolian Academy of Sciences, Geoecology Institute,  
Baruun Selbe 13, Ulaanbataar, Tov 211238 Mongolia*

<sup>2</sup> *Department of Insect Ecology, Institute of Entomology, Czech Academy of Sciences,  
Ceske Budejovice CZ-37005, Czech Republic*

### Abstract

Collections in 1995–1997 and in 2002–2003 from Lake Hovsgol and the surrounding region, especially the eastern tributaries, yielded 56 species, 28 of these representing new Mongolian national records. Unidentified larvae of *Isonychia* sp. and *Ephoron* sp. bring the known mayfly fauna of Lake Hovsgol to at least 58 species. The resulting data may have value for monitoring environmental changes resulting from global warming, permafrost melt and grazing. The study also provides a better understanding of the taxa that may be important for using macroinvertebrates to monitor surface water quality in the region.

Key words: mayfly; tributary streams; Lake Hovsgol; Mongolia

### Introduction

Reviews of the published literature and collections during the past several years by the authors and colleagues have demonstrated that at least 79 species of mayflies, or Ephemeroptera, are presently known from Mongolia. Mayflies from Mongolia have been studied from the 1940s with scattered records or new species descriptions in several papers (e.g., D. Braash 1977, 1979, 1980, 1982; V. Landa and T. Soldán 1983; and others). Mostly these studies were based on materials from the Mongolian-Germany biological expedition collected by M. Stubbe and K. Gunther in 1962, 1964 and 1977; the Hungarian-Mongolian expedition collected by Z. Kaszab in 1964, 1965, 1966 and 1968; and the Soviet-Mongolian joint expedition of the Irkutsk and Mongolian State Universities, which started its activities in 1970.

In 1995, The Academy of Natural Sciences began collaborations with the National University of Mongolia and the Mongolian Academy of Sciences in joint biodiversity research expeditions in the Hovsgol Nuur (lake) watershed, Mongolia. As a result, the first Long-Term Ecological Research Site in Mongolia was established in 2002 at Lake Hovsgol.

This study (“the Hovsgol Project”) was possible due to funding provided by the Mongolian Academy of Sciences, which received a five-year grant from the Global Environment Facility and implemented by the World Bank for a study entitled, “Dynamics of Biodiversity Loss and Permafrost Melt in Lake Hovsgol.”

Lake Hovsgol is a graben of the Baikal Rift System and is the largest lake in Mongolia in terms of the amount of fresh water (383.3 m<sup>3</sup>) and the second by the area (2760 km<sup>2</sup>). Its maximum depth is 262 m, making it the fourth deepest lake in Central Asia. It is the world's fourteenth largest source of fresh water with a virtually undisturbed watershed and a diverse and interesting biota. The outflow of Lake Hovsgol, the River Eg, is a tributary of the Selenge River, the largest source of water entering Baikal (50%); thus, these great lakes are connected (e.g., Kozhova et al. 1989, Baatar, Samiya and Goulden 1997). The climate of the region is distinctly continental: The maximum air temperature is +35°C, the minimum is –45°C and annual precipitation is 300–430 mm a year (Atlas of the Lake Hovsgol 1989). The Lake is located on the southern edge of the Siberian taiga, historically with permafrost, such that it is a region of great interest for monitoring climate change. Over the last three decades, average air temperature has increased by 1.8°C in this region and permafrost has been melting conspicuously.

Six valleys along the eastern shore of the lake were selected for study beginning in 2002. They included the heavily grazed northeastern valleys of Turag (N 51°18', E 100°48') and Shagnuul south of the town of Hanh; mideastern Noyon and Sevsuul with moderate grazing; and southeastern Dalbay and Borsog (N 50°58', E 100°45') valleys with little or no grazing pressure. In this region, streams usually melt in late May and freeze in mid November.

In this paper, we include species that were collected in 1995–1997 and 2002–2003 with their sample site locality and other information. Also, we are able to report on some other species which were found in the Hovsgol region prior to our study. At least 24 taxa are reported here from Mongolia for the first time.

### **Material and Methods**

The materials from 1995–1997 were collected by J. Morse, J. Gelhaus, B. Hayford, A. Prather, E. Hunter, B. Namkhaidorj and C. Goulden and identified by T. Soldán in 2001. Mayfly larvae and adults were collected by me during May through September, 2002–2003, as part of the summer field work of the Hovsgol-GEF Project. Larvae were collected by use of the Rapid Bioassessment Protocol from upper, middle and lower sites in each of the six study streams each June, July and August in 2002–2003. Adults were collected primarily with sweep nets and with Malaise traps continuously set in the forest edge and on the riverbank of each study valley.

A few specimens were reared in the field. Ice is not available in the Mongolian countryside. Nevertheless, I was successful in rearing mature larvae and subimagos to adulthood by packing rearing-vials in mosses in a cooler.

Light trapping proved unsatisfactory probably due to the extended daylight period in summer, cold crepuscular temperatures and/or inactivity or lack of attraction of the insects.

Specimens were preserved in 75% ethanol and studied with a Wild® M5 dissecting microscope.

### Sample Collected Localities

1. G710: Hovsgol Aimag, Hovsgol Nuur area, W side  $\pm$ 48 km N of Khatgal, 50.41.14.N, 100.14.46.E; elev.  $\pm$ 1650 m; ice-free pool; 10 June 1996;
2. G713: Hovsgol Aimag, Hovsgol Nuur area, S side Alag Tsar River (near lake); 22 km ENE of Khatgal, 50.30.31.N, 100.24.12.E; elev.1615 m; 11–12 June 1996;
3. G714: Hovsgol Aimag, Hovsgol Nuur area, S side Alag Tsar River (near lake); 29 km ENE of Khatgal, 50.26.26.N, 100.23.30.E; elev.1693 m; 12 June 1996; in isolated small pool;
4. G715: Hovsgol Aimag, Hovsgol Nuur area, S side steppe pools along Alag Tsar River (near lake); 22 km ENE of Khatgal, 50.30.42.N, 100.23.44.E; elev.1615 m; 12 June 1996;
5. G716: Hovsgol Aimag, Hovsgol Nuur area, E side; Borsogiin gol (river), at bridge; 50.55.32.N, 100.46.19.E; elev.1640 m; 19 June 1996; Malaise trap;
6. G718: Hovsgol Aimag, Hovsgol Nuur area, E side; Borsogiyn gumnag am (stream); 50.57.19.N, 100.45.15.E; elev.1646 m; 14 June 1996; Malaise trap;
7. G719: Hovsgol Aimag, Hovsgol Nuur area, E side; S of Dalbayn Khyr; 50.59.22.N, 100.43.01.E; elev.1695 m; 14 June 1996; Malaise trap;
8. G721: Hovsgol Aimag, Hovsgol Nuur area, N side; Jargalant gol (stream), 25km NW of Khankh; 51.38.59.N, 100.31.48.E; isolated snowmelt pool; elev.1724 m; 15–16 June 1996; Malaise trap;
9. G722: Hovsgol Aimag, Hovsgol Nuur area, N side; Ikh Khoroo gol (river), 37 km NW of Khankh; benthic from river; 51.34.26.N, 100.28.48.E; elev.1721 m; 16 June 1996;
10. G724: Hovsgol Aimag, Hovsgol Nuur area, E side; Sevsuuliyn gol (river), 58 km S of Khankh; 51.09.42.N, 100.45.21.E; elev.1626 m; isolated pools along the river, 17 June 1996;
11. G725a: Hovsgol Aimag, Hovsgol Nuur area, E side; Noyon gol (stream), 51 km S of Khankh; 51.12.44.N, 100.46.06.E; elev.1669 m; from cobble in river; 18 June 1996;
12. G725b: Hovsgol Aimag, Hovsgol Nuur area, E side; Noyon gol (stream), 51 km S of Khankh; 51.12.44.N, 100.46.06.E; elev.1669 m; small pool along river; 18 June 1996;
13. G731: Hovsgol Aimag, steppe, 1 km N Moron (lat/long) of Moron 49.38.N, 100.10.E; elev.1290m; 21 June 1996;
14. G733a: Hovsgol Aimag, Selenge River, 14 km W of Ikh Uul (Bayan-Uhaa, lat/long.) of Bayan Uhaa; 48.33.N, 98.40.E; elev.1040 m; 21–22 June 1996;

15. G733b: Hovsgol Aimag, Selenge River, 14 km W of Ikh Uul (Ih-Uul, Yihe Uula Suma or Selenge; lat/long. Selenge); 49.26.N, 101.28.E; elev.1040 m; 21 June 1996;
16. G746: Hovsgol Aimag, Hovsgol Nuur area, Alag Tsar River (near lake); 22 km ENE of Khatgal, 50.4813194N, 100.4001850E; elev.1675 m; 13 July 1997;
17. G747: Hovsgol Aimag, Hovsgol Nuur area, E side, 50.5961823N, 100.4829633E; elev.1620 m; Heg Tsar cove; 14 July 1997;
18. G750: Hovsgol Aimag, Hovsgol Nuur area, E side, S of Dalbayn Khyr; Borsogo Cove; 50.9948283N, 100.7123029E; elev.1655 m; 15 July 1997;
19. G751: Hovsgol Aimag, Hovsgol Nuur area, E side, Borsogiyn gol (river main); 50.9253591N, 100.7552880E; elev.1710 m; 15 July 1997;
20. G752: Hovsgol Aimag, Hovsgol Nuur area, E side, Borsogiyn gol (tributary stream); 50.9351385N, 100.7595098E; elev.1700 m; 15 July 1997;
21. G753: Hovsgol Aimag, Hovsgol Nuur area, E side, Borsogiyn gol (tributary stream); 50.9542412N, 100.7538289E; elev.1640 m; 16 July 1997;
22. G756: Hovsgol Aimag, Hovsgol Nuur area, E side, Noyon gol (river); 51.2100917N, 100.7784033E; elev.1620 m; 17 July 1997;
23. G757: Hovsgol Aimag, Hovsgol Nuur area, E side, Turagyn gol (river); 51.2873608N, 100.8270800E; elev.1640 m; 17 July 1997;
24. G759: Hovsgol Aimag, Hovsgol Nuur area, E side, Toyn gol (river); 51.4449084N, 100.8178800E; elev.1700 m; 18 July 1997;
25. G761: Hovsgol Aimag, Hovsgol Nuur area, N side, Ikh Horoo gol (river); 51.5889215N, 100.4610175E; elev.1775 m; 19 July 1997;
26. G763: Hovsgol Aimag, Hovsgol Nuur area, N side, Jargalant gol (river); 51.6497219N, 100.5295426E; elev.1765 m; 20 July 1997;
27. G765: Hovsgol Aimag, Hovsgol Nuur area, NE side, Khankh River; 51.5015942N, 100.7691336E; elev.1705 m; 21 July 1997;
28. G767: Hovsgol Aimag, Hovsgol Nuur area, E side, Shagnuul gol; 51.2567353N, 100.8504474E; elev.1700 m; 21 July 1997;
29. H414: Hovsgol Aimag, Hovsgol Nuur area, east shore/ Baturant; 50.52.24N, 100.3444113E; elev. ??? m; 2 July 1995;
30. H415: Hovsgol Aimag, Hovsgol Nuur area, east shore/ Garvan; 50.52.24N, 100.3444110E; 2 July 1995;
31. H419: Hovsgol Aimag, Hovsgol Nuur area, west shore/ Garvan; 50.55.08N, 100.14.41930E; 3 July 1995;
32. H420: Hovsgol Aimag, Hovsgol Nuur area, Hoar Us; 50.56.30N, 100.14.37.102E; 3 July 1995;
33. H427: Hovsgol Aimag, Hovsgol Nuur area, east shore/ Juragol; 51.17.43N, 100.47.17935E; 7 July 1995;
34. H428: Hovsgol Aimag, Hovsgol Nuur area, east shore/ Juragol; 51.17.43N, 100.47.17100E; 5 July 1995;
35. H446: Hovsgol Aimag, Hovsgol Nuur; 7 July 1995;

36. H447: Hovsgol Aimag, Hovsgol Nuur area, east shore; 50.58.46N, 100.42.25930E; 7 July 1995;
37. H453: Hovsgol Aimag, Hovsgol Nuur area, east shore; Modon Hui; 50.59.26N, 100.32.33636E; 7 July 1995;
38. H464: Hovsgol Aimag, Hovsgol Nuur area, Hankh compound; 51.30.33.4N, 100.39.21.0E; 8–16 July 1995;
39. H465: Hovsgol Aimag, Hovsgol Nuur area, Bayan gol; 51.36.48.0N, 100.36.01.3E; 10 July 1995;
40. H467: Hovsgol Aimag, Hovsgol Nuur area, Hankh; 12 July 1995;
41. H468: Hovsgol Aimag, Hovsgol Nuur area, near mouth Hankh gol; 12 July 1995;
42. H477: Hovsgol Aimag, Hovsgol Nuur area, east shore of lake between Hankh and Bayan gol; 13 July 1995;
43. H479: Hovsgol Aimag, Hovsgol Nuur area, Jargalant gol; 51.38.59.0N, 100.31.46.4E; 14–15 July 1995;
44. H484: Hovsgol Aimag, Hovsgol Nuur area, Locaha Island; Southeast shore; 50.57.50N, 100.32.31E; 18 July 1995;
45. H494: Hovsgol Aimag, Hovsgol Nuur area, bridge Egiin gol Hatgal; 50.25.0N, 100.08.55E; 21 July 1995;
46. H495: Hovsgol Aimag, Hovsgol Nuur area, Hatgal; 1 km S. Bridge; 21 July 1995;
47. MP: Hovsgol Aimag, Hovsgol Nuur area, W of Lake, S of SSW of Ar Khilent Lake; 50.45.19N, 100.13.47E; 10 June 1996;
48. En: Hovsgol Aimag, Bugsey gol (river); 50.45.19N, 100.13.47E; 2 Aug 1997;
49. Go: Hovsgol Aimag, Hovsgol Nuur area, Ikh Khoroo gol (between bridge crossing and Lake Shore); 51.57.26.4N, 100.48.108E; 20 July 1999;
50. Hovsgol Aimag, Hovsgol Nuur area, mouth Khoroo gol; 15 July 1995;
51. Hovsgol Aimag, Hovsgol Nuur area, Borsog gol;
52. Hovsgol Aimag, Hovsgol Nuur area, Dalbay gol;
53. Hovsgol Aimag, Hovsgol Nuur area, Sevsuul gol;
54. Hovsgol Aimag, Hovsgol Nuur area, Noyon gol;
55. Hovsgol Aimag, Hovsgol Nuur area, Shagnuul gol;
56. Hovsgol Aimag, Hovsgol Nuur area, Turag gol;
57. Hovsgol Aimag, Hovsgol Nuur area, 6km WNW of Tosontsengel sum, elev 1400 m, 18 June 1968, light trap.
58. Hovsgol Aimag, Hovsgol Nuur area, Tesiin gol, 22 km W of Tsetserleg sum, elev 1820 m, 22 June 1968.
59. Hovsgol Aimag, Hovsgol Nuur area, Delgermoron river., 8 km of Burenkhaan sum, elev 1450 m, 14–20 June 1968.
60. Hovsgol Aimag, Hovsgol Nuur area, Egiin gol., 8 km of Alag Erdene sum, elev 1600 m, 17 July 1968, light trap.
61. Hovsgol Aimag, Hovsgol Nuur area, Tesiin gol, Alag Mort, 42 km NE of Khalzan Sogootiin Davaa, elev 1900 m, 14 July 1968.

In the following list of species, the dates of capture for specimens collected as part of the Hovsgol GEF project at sites #51–56 are provided after the site number. Dates for other collections are noted in the list above. Specimens captured during 1995–1997 were identified by T. Soldán in November 2001. All other specimens were identified by S. Enkhtaivan. Species that are newly recorded for Mongolia are indicated with an asterisk (\*).

### Ameletidae

1. \**Ameletus inopinatus* Eaton, 1887 — #1-1L, #6-1L, #8-4L, #9-17L, #17-1I, #18-2L, #21-13L, #31-1L, #35-1I, #37-1L+4I, #39-1L, #42-34L, #43-1I, #44-2L, #47-20L, #51-? I (23 Aug. 2002).  
*Ameletus* sp. — #6-9L, #39-6L, #45-1I(F).

### Baetidae

2. \**Acentrella fenestratus* (Kazlauskas 1963) — #4-3L, #5-17L, #16-1L, #21-1L.  
*Acentrella* “*putoranica*” Kluge (nomen nudum) — #25-8L+9I.  
*Acentrella* “*putoranica*” Kluge (in litt.) — #49-4L.
3. \**Acentrella sibiricus* (Kazlauskas 1963) — #45-2I.
4. \**Baetiella tuberculatus* (Kazlauskas 1963) — #23-2L.
5. \**Baetis bicaudatus* Dodds, 1923 — #16-2L, #19-6L, #21-5L, #51-I (23 Aug 2002), #55-I (02 Sep. 2002, 24 Aug. 2003).
6. \**Baetis feles* Kluge, 1980 — #20-9L.
7. *Baetis fuscatus* [(Linnaeus 1761)] — #14-6L, #23-6L, #57-1F, #58-1F/1M, #59-3F/1M. Previously recorded from Mongolia by Baykova and Varychanova (1978) and Landa and Soldán (1983).  
[*Baetis*] *bioculatus* [Linnaeus 1758];  
[*Baetis*] *venustulus* [Eaton 1885];
8. *Baetis pseudothermicus* Kluge, 1983 — #9-2L, #11-5L, #21-5L, #26-4L, #43-4L, #47-9L, #49-1L+1I; previously recorded for Mongolia by Landa and Soldán (1983).  
*Baetis* sp. — #15-3I, #16-1I, #21-5I, #23-2I, #24-1L, #26-3I, #38-1I; #42-2L, #43-2I; previously recorded for Mongolia by Landa and Soldán (1983).
9. *Baetis ussuricus* Kluge, 1983 — #14-1L; previously recorded for Mongolia by Landa and Soldán (1983).
10. *Baetis vernus* Curtis, 1834 — #14-6L, #15-3L, #16-6L, #22-28L, #25-16I, #28-5I, #38-30L, #49-1L, #60-1M; previously recorded for Mongolia by [Author, date?];  
[*Baetis*] *finitimus* Eaton, 1871;  
[*Baetis*] *tenax* Eaton, 1870;

11. *Baetopus asiaticus* Soldán, 1978 — #61-2M/1F; previously recorded for Mongolia by Soldán (1978) and Landa and Soldán (1983).
12. *Baetopus montanus* Soldán, 1978 — #61-11M/10F; previously recorded for Mongolia by Soldán (1978) and Landa and Soldán (1983).
13. \**Centroptilum kazlauskasi* Kluge, 1963 — #54-1I (15–25 Aug. 2002).
14. \**Centroptilum luteolum* (Müller 1776) — #53-1I (23 Aug. 2003).
15. \**Cloeon* (*Cloeon*) *dipterum* Linnaeus, 1761 — #52-1I (01 Aug. 2003);  
*Cloeon sinense* (Walker 1853);
16. \**Cloeon* (*Procloeon*) *bifidum* Bengtsson, 1912 — #51-2I (23-31 Aug. 2002, Malaise trap).
17. *Cloeon* (*Procloeon*) *pennulatum* (Eaton 1870) — #23-1, #51-1L (23 Aug. 2002); previously recorded for Mongolia by [Baykova and Varychanova (1978)].

#### Caenidae

18. *Brachycercus harrisella* Curtis, 1834 — #14-6L; previously recorded for Mongolia by Kluge (1991);  
*Eurycaenis harrisella* (Curtis, 1834): Bengtsson, 1917.
19. *Caenis horaria* (Linnaeus 1758) — #7-1L; previously recorded for Mongolia by Landa and Soldán (1983).  
*Caenis dimidiata* Stephens, 1835;  
*Caenis lactella* Eaton, 1884;
20. *Caenis jungi* Braasch, 1980 — #60-1M; previously recorded for Mongolia by Landa and Soldán (1983).
21. *Caenis robusta* Eaton, 1884 — #56-1L (24 Aug. 2002); previously recorded for Mongolia by Braasch (1982); Landa and Soldán (1983); newly recorded for the Hovsgol region;  
*Caenis incus* Bengtsson, 1912;  
*Caenis ulmeri* Brodsky, 1930;  
*Caenis* sp. — #40-1L.

#### Ephemerellidae

22. \**Drunella cryptomeria* Imanishi, 1937 — #14-2L, #15-1L;  
*Ephemerella bicornis* Gose, 1980;
23. *Drunella submontana* Brodsky, 1930 — #59-1M/2F subimagos; previously recorded for Mongolia by Landa and Soldán (1983).
24. \**Drunella triacantha* Tshernova, 1949 — #14-3L, #15-4L;  
*Ephemerella tenax* Tshernova, 1952;  
*Ephemerella eroensis* Gose, 1980;
25. \**Ephemerella aurivillii* Bengtsson, 1908 — #8-16L, #9-7L, #14-11I;  
*Ephemerella aronii* Eaton, 1908;

- Ephemerella norda* McDunnough, 1924;  
*Ephemerella concinnata* Traver, 1934;  
*Ephemerella taeniata* Tshernova, 1952;  
*Ephemerella maxima* Allen, 1971;  
*Ephemerella ezoensis* Gose, 1985;
26. *Ephemerella mucronata* (Bengtsson 1909) — #14-7L; previously recorded for Mongolia by Braasch (1982); Landa and Soldán (1983).  
*Chitonophora kreignoffi* Ulmer, 1920;  
*Chitonophora unicolorata* Ikonomov, 1961;  
*Ephemerella* sp. — #16-33L, #22-15L.  
*Ephemerella* sp. 1 — #14-2L, #15-1L.  
*Ephemerella* sp. 2 — #22-5L.
27. *Torleya ignita* (Poda 1761) — #14-7L, #15-2L, #17-4L, #23-30L+1I, #24-7L, #25-1L, #27-7I, #51-5L/7I (23 Aug. 2002), #59-1M/3F subimagoes; previously recorded for Mongolia by Baykova and Varychanova (1978), Braasch (1982) and Landa and Soldán (1983).
28. \**Torleya nuda* Tshernova, 1949 — #16-18L, #23-19L, #24-11L+1I, #25-56I+30L, #28-4I, #38—1L, #43-1L, #46-1L, #48-5I, #49-1L, #51-3M (24-27 Jul. 2002, 27 Aug. 2003), #55-1M (14 Aug. 2002);  
*Ephemerella thymali* Tshernova, 1952;  
*Ephemerella verrucosa* Kluge, 1980;
29. \**Uracanthella lenoki* Tshernova, 1952 — #14-1L;  
*Uracanthella markevithsi* Belov, 1979;

### Ephemeridae

30. *Ephemera orientalis* McLachlan, 1875 — #59-1F; previously recorded from Mongolia by Baykova and Varychanova (1978), Braasch (1982) and Landa and Soldán (1983).
31. \**Ephemera sachalinensis* Matsumura, 1934 — #13-1I, #14-28L.
32. *Ephemera strigata* Eaton, 1892 — #59-1F; previously recorded for Mongolia by Landa and Soldán (1983).
33. \**Ephemera transbaikalica* Tshernova, 1973 — #14-3L.

### Heptageniidae

34. *Cinygmula cava* Ulmer, 1927 — #9-7L, #25-1L, #26-5L, #32-8L, #39-33L, #43-5L, #47-21L; previously recorded for Mongolia by Braasch (1979), Braasch (1986);  
*Cinygmula guentheri* Braasch, 1979;  
*Cinygmula altaica* Tshernova, 1949;
35. *Cinygmula kurenzovi* Bajkova, 1962 — #45-5I, #60-3M/1F; previously recorded for Mongolia by Landa and Soldán (1983);  
*Cinygmula kaszabi* Landa and Soldán, 1983;



36. \**Cinygmula putoranica* (Kluge 1980) — #16-9L+1I, #23-1L, #51-10I (25 Aug. 2002), #55-3I (14 Aug. - 02 Sep. 2002).  
*Cinygmula* sp. — #2-1L, #8-2L, #9-16L, #16-19L, #22-2L.
37. \**Ecdyonurus (Afghanurus) aspersus* Kluge, 1980 — #23-1I, #51-I (16-27 Jul. 2002 Malaise trap, 26 Aug. 2002).
38. \**Ecdyonurus (Afghanurus) inversus* Kluge, 1980 — #24-12L+1I, #28-14L+9I.
39. *Ecdyonurus (Afghanurus) joernensis* Bengtsson, 1909 — #17-9L, #23-34L, #27-3I, #46-2L; previously recorded for Mongolia by Braasch (1986);  
 [*Ecdyonurus*] *flavomaculatus* [Aro 1928];  
 [*Heptagenia*] *mongolicus* Bajkova and Varychanova, 1978;  
 [*Heptagenia*] *dentatus* Braasch, 1979;  
 [*Ecdyonurus*] *stubbei* Braasch, 1979;
40. \**Ecdyonurus (Afghanurus) simplicioides* (McDunnough 1924) — #14-4L.
41. \**Ecdyonurus (Afghanurus) vicinus* (Demoulin 1964) — #14-??, #15-??.  
*Ecdyonurus* sp. - #22-2L.
42. *Epeorus (Belovius) pellucidus* (Brodsky 1930) — #14-4L, #23-2L, #51- 8I (16-25 Aug. 2002, Malaise trap); previously recorded for Mongolia by Braasch (1979)  
*Cinygmula smirnovi* Tshernova, 1978;  
*Epeorus tshernovae* Braasch, 1979;
43. \**Epeorus anatolii* Sinitshenkova, 1981 — #23-8L, #51-4I (23–31 Aug. 2002, Malaise trap), #56-3I (24 Aug. 2003);  
*Epeorus rautiani* Sinitshenkova, 1982;
44. *Epeorus sinitshenkovae* Tshernova, 1981 — #55-1I (14 Aug. 2002); previously recorded for Mongolia by Baykova and Varychanova (1978).  
*Epeorus ninae* Kluge, 1995;
45. *Heptagenia flava* Rostock, 1877 — #14-2I, #52-1I (24–27 Jul. 2002), #54-1 (15 Aug. 2002); previously recorded for Mongolia by Braasch 1979 and Landa and Soldán (1983);  
*Ephemera citrina* Hummel, 1825;  
*Heptagenia bipunctata* Esben-Petersen, 1916;  
*Heptagenia arsenjevi* Tshernova, 1952;
46. *Heptagenia sulphurea* Müller, 1776 — #14-3L, #15-1L; previously recorded for Mongolia by Braasch (1979); Braasch (1986);  
*Ephemera helvola* Subz., 1776;  
*Ephemera leucophthalma* Strom 1783;  
*Ephemera ferruginea* Gmelin 1790;  
*Baetis costalis* Curtis, 1834;  
*Heptagenia sulphurea* f. *dalecarlica* Bengtsson, 1912;  
*Baetis elegans* Curtis, 1834  
*Baetis straminea* Curtis, 1834  
*Baetis cyanops* Pictet, 1843

- Heptagenia soldatovi* Tshernova, 1952  
*Heptagenia f. dalecarlica* Bengtsson, 1912  
 Subsp. *Heptagenia sulphurea. albicauda* Kluge, 1987
47. *Rhithrogena bajkova* Sowa, 1973 — #15-12I, #56-2M (24 Aug. 2003); previously recorded for Mongolia by Landa and Soldán (1983).  
 [*Rhithrogena*] *quadrinotata* Sinitshenkova, 1982;  
*Rhithrogena* gr. *lepnevae* — #14-1L.
48. *Rhithrogena lepnevae* Brodsky, 1930 — #23-24L+1I, #55-1I (24 Aug. 2003), #59-20M/30F; previously recorded for Mongolia by Bajkova and Varychanova (1978), Braasch (1979) and Landa and Soldán (1983);  
*Rhithrogena unicolor* Tshernova, 1952;  
*Rhithrogena binotata* Sinitsh, 1982;
49. *Rhithrogena sibirica* Brodsky, 1930 — #14-3I, #45-4I, #59-2M, #60-1M; previously recorded for Mongolia by Braasch (1979a) and Landa and Soldán (1983).  
*Rhithrogena* sp. — #14-1I+1F, #59-1M/3F.

#### Isonychiidae

*Isonychia* sp. — #14-10L.

#### Leptophlebiidae

50. \**Paraleptophlebia strandii* Eaton, 1901 — #4-2L, #10-5L, #23-3I+1L, #27-4I, #52-1I (05 Aug. 2003), #54-3L (15 Aug. 2002, 24 Aug. 2003), #55-I (14 Aug. – 02 Sep. 2002 Malaise trap), #56-10L (24 Aug. 2002);  
*Leptophlebia lunata* Tshernova, 1928;

#### Metretopodidae

51. *Metretopus alter* Bengtsson, 1930 — #51-3I (21–26 Aug. 2002); previously recorded for Mongolia by [Author, date?].  
*Metretopus* sp. — #14-14L, #16-6L+1I, #22-5L, #27-1I.
52. \**Metretopus tertius* Tiunova, 1999 — #14-11L.

#### Polymitarcyidae

*Ephoron* sp. — #14-7L.

#### Siphonuridae

53. \**Siphonurus* cf. *chankae* Tshernova, 1952 — #16-1L.  
 54. \**Siphonurus chankae* Tshernova, 1952 — #16-5L, #19-24L, #33-28L.  
 55. \**Siphonurus immanus* Kluge, 1985 — #51-5M/5F (14 Jul. - 26 Aug. 2002).

56. *Siphonurus lacustris* Eaton, 1870 — #61-1F; previously recorded for Mongolia by Braasch (1982) and Landa and Soldán (1983);  
*Siphonurus zetterstedii* Bengtson 1909;  
*Siphonurus pyrenaicus* Navas 1930;  
*Siphonurus nuessleri* Jacob, 1972;  
*Siphonurus* sp. — #3-3L, #4-38L, #6-3L, #7-2L, #10-31L, #12-11L, #16-4L, #21-2L, #27-2L+1I, #29-6L, #30-1L, #34-4L, #36-4L, #41-5L, #45-1I(F).

### Discussion and Conclusion

If climate change continues at the same rate and trend as now, what will happen to region's biodiversity, including its mayfly fauna? The answer to this question can only be provided by long-term monitoring of temperature, permafrost and fauna. Such monitoring is very compatible with the goals of a Long-Term Ecological Research Site like this one at Lake Hovsgol, Mongolia. The data provided in this paper establishes a baseline for mayfly diversity against which future monitoring can be compared.

Does excessive grazing decrease favorable habitats for insects and contribute to biodiversity loss? The different grazing intensities in the six rivers of this study and differences in their mayfly taxa richness may provide some important insight to this question. Figure 1 shows that the highest mayfly richness occurs in Borsog River, a stream that has been affected least by humans and their cattle in recent years.

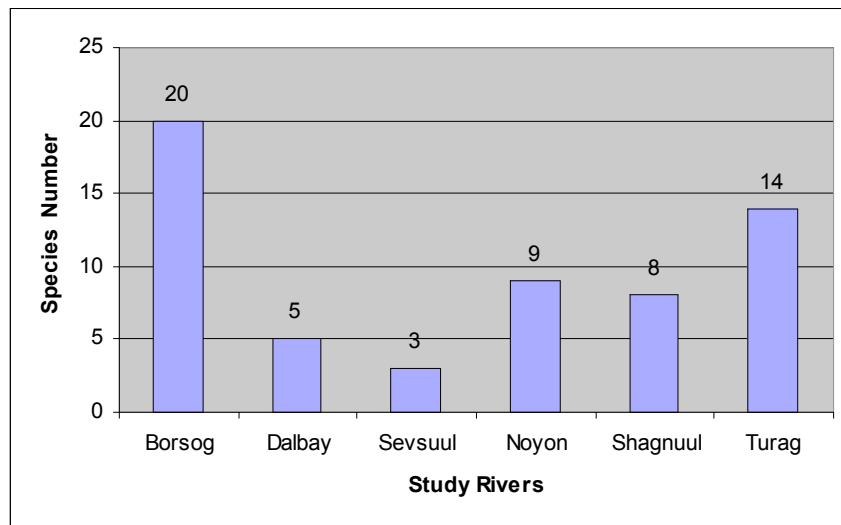


Figure 1. Comparison of six valleys by mayfly taxa richness.

Other streams have some kind of over grazing and intensive livestock. However, grazing intensity is not otherwise well-correlated with mayfly diversity in these other streams: Turag is one of the most heavily grazed valleys but has the next highest number of mayfly species, whereas Dalbay is one of the least heavily grazed valleys but has nearly the lowest number of mayfly species. Clearly, mayfly taxa richness cannot be explained solely by grazing density.

Despite increasing temperature and human influence, we expect that additional intensive sampling in the Hovsgol region will uncover additional national and regional records and undescribed species because the mayfly species fauna of the Hovsgol region and Mongolia are still very incompletely known. Thus, more careful study is needed to understand mayfly habitat requirements before humans disturb the ecosystem further. Including mayflies and other macroinvertebrates in a national water monitoring program in Mongolia would help obtain that knowledge. This biological monitoring will more-likely happen if better illustrated keys can be made available to Mongolian scientists and water quality regulators.

The following 28 species are newly recorded for Mongolia: *Ameletus inopinatus*, *Acentrella fenestratus*, *Acentrella sibiricus*, *Baetiella tuberculatus*, *Baetis bicaudatus*, *Baetis feles*, *Centroptilum kazlauskasi*, *Centroptilum luteolum*, *Cinygmula putoranica*, *Cloeon* (C.) *dipterum*, *Cloeon* (Procloeon) *bifidum*, *Ecdyonurus* (Afghanurus) *aspersus*, *Ecdyonurus* (Afghanurus) *inversus*, *Ecdyonurus* (Afghanurus) *simplicioides*, *Ecdyonurus* (Afghanurus) *vicinus*, *Epeorus anatolii*, *Ephemera sachalinensis*, *Ephemera transbaikalica*, *Drunella cryptomeria*, *Drunella triacantha*, *Uracanthella lenoki*, *Ephemerella aurivillii*, *Ephemerella nuda*, *Paraleptophlebia strandii*, *Metretopus tertius*, *Siphonurus chankae*, *Siphonurus immanus* and *Siphon* cf. *chankae*.

### Acknowledgments

This study was made possible by World Bank GEF funding provided to the Mongolian Academy of Sciences for a study entitled “Dynamics of Biodiversity Loss and Permafrost Melt in Lake Hovsgol National Park, Mongolia.” Thanks to Drs. Clyde Goulden, John Morse, Jon Gelhaus and Barbara Hayford for their valuable advice and support. Thanks also to Drs. Pat McCafferty (and his students), Riley Nelson and Richard Baumann for help with taxonomic identifications. S. Enkhtaivan is grateful to the Scholarship Subcommittee of the Permanent Committee of the International Conferences on Ephemeroptera for providing a Ryzord Sowa scholarship and to the USA NSF Biotic Surveys and Inventories grant (DEB-0206674) that helped her to participate in this meeting. Thanks to colleagues and family for continuing encouragement.

## Literature Cited

- Baatar, D., R. Samiya, and C. E. Goulden. 1997. Long-Term Ecological Research in Mongolia. Pages 67–75 in King, H-B., S. P. Hamburg, and Y. Hsia, editors. Long-Term Ecological Research In East Asia-Pacific Region. Taiwan Forestry Research Institute.
- Braasch, D. 1977. *Rithrogena piechockii* n.sp. aus der Mongolei (Eph. Heptageniidae). Ergebnisse der Mongolisch-Deutschen Biologischen Expeditionen seit 1962. Entomologische Abhandlungen (Dresden) **21**(9):140–142, illust. (with English and Russian summary).
- Braasch, D. 1979. Die Eintagsfliegen (Ephemeroptera, Heptageniidae) der Mongolisch-Deutschen Biologischen Expeditionen seit 1964 und 1977. Ergebnisse der Mongolisch-Deutschen Biologischen Expeditionen seit 1962. Entomologische Abhandlungen (Dresden) **23**(5):65–76.
- Braasch, D. 1980. *Ecdyonurus klugei* n.sp. (Ephemeroptera, Heptageniidae) aus der Mongolei. Ergebnisse der Mongolisch-Deutschen Biologischen Expeditionen seit 1962. Entomologische Abhandlungen (Dresden) **24**(3):41–43.
- Braasch, D. 1982. Die Eintagsfliegen der Mongolisch-Deutschen Biologischen Expeditionen 1964 (Ephemeroptera). Dt.Entom.Z., N. F. 29, Heft 1-3, Seite 43-47.
- Braasch, D. 1986. Eintagsfliegen aus der Mongolischen Volksrepublik (Ephemeroptera, Heptageniidae). Entomologische Abhandlungen (Dresden) **30**(2):77–80.
- Kozhova, O. M., O. Shagdarsuren, A. Dashdorj, and N. Sodnom (eds). 1989. Atlas of Lake Hövsgöl. Cartographic Ministry of USSR, Moscow (in Russian).
- Landa, V., and T. Soldán. 1983. Ephemeroptera from Mongolia. Entomologica Hungarica Rovartani kozlemenyek. **44**(2):189–204.
- Soldán, T. 1978. Two new species of *Baetopus* (Ephemeroptera, Baetidae) from Mongolia with a special reference to related genera. Vestnik Ceskoslovenske Spolecnosti Zoologicke, Svazek XLII-Cislo3-1978-Str. 209–214.