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New data on the stonefly fauna (Plecoptera) of the Northern Kuril Islands

Новые данные по фауне веснянок (Plecoptera) северных Курильских островов

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КЛЮЧЕВЫЕ СЛОВА: веснянки, северные Курильские острова, Камчатка, новые сведения, происхождение, распространение, зоогеография.

ABSTRACT. New data on the stonefly fauna of the Northern Kuril Islands (NKI) are presented. Collecting efforts over four-year period (1996–1999) on the islands Onekotan, Paramushir, and Shumshu yielded a total of seven boreal species belonging to seven genera and five families. Five of these species are recorded from the Kuril Archipelago for the first time: *Arcynopteryx polaris* Klapalek, 1912; *Taenionema japonicum* Okamoto, 1922; *Capnia levanidovae* Kawai, 1969; *Mesocapnia gorodkovi* Zhiltz. et Baumann, 1986; and *Podmosta weberi* Ricker, 1952. The stonefly fauna of this region contains three zoogeographical elements: (1) East Palaearctic, of Angarian origin, four species, *A. polaris, T. japonicum, Alloperla mediata* (Navas, 1925), *Suwallia teleckojensis* (Samal, 1939); (2) Beringian, two species, *M. gorodkovi, P. weberi*; and (3) autochthonous Kamchatian, one provisional endemic, *C. levanidovae*.

РЕЗЮМЕ. В работе представлены новые данные по фауне веснянок северных Курильских о-вов. Совместными усилиями за четырехлетний период (с 1996 по 1999 гг.) на о-вах Онекотан, Парамушир и Шумшу собрано 7 бореальных видов из 7 родов и 5 семейств. Пять из них зарегистрированы на Курильском архипелаге впервые: *Arcynopteryx polaris* Klapalek, 1912, *Taenionema japonicum* Okamoto, 1922, *Capnia levanidovae* Kawai, 1969, *Mesocapnia gorodkovi* Zhiltz. et Baumann, 1986, *Podmosta weberi* Ricker, 1952. В зоогеографическом аспекте, фауна веснянок северных Курильских островов представлена тремя элементами: (1) восточно-палеарктическими видами ангарского происхождения: *A. polaris, T. japonicum, Alloperla mediata* (Navas, 1925), *Suwallia teleckojensis* (Samal, 1939); (2) берингийскими, два вида: *M. gorodkovi* и *P. weberi*; (3) и автохтонным Камчатским, условно эндемичным видом *C. levanidovae*.

Introduction

Heretofore, the Kuril Island stonefly fauna has been fully investigated only in the southern part of the Archipelago. Thirty eight stonefly species in eighteen genera and six families have been recorded from the Southern Kurils, while only two species in two genera and two families were previously known from the Northern Kuril Islands [Zhiltzova & Levanidova, 1984; Teslenko *et al.*, 1997]. Our surveys carried out on fifteen islands in the middle and northern parts of the chain are the basis for the present contribution.

Materials and Methods

According to the geomorphological division of the Archipelago, the Middle and Northern Kuril Islands extend from Simushir (46°58′N, 152°01′E) to Shumshu (50°40′N, 156°24′E) [Gorshkov, 1967]. Although we searched extensively during the summer months of 1996–1999 on fifteen islands of this part of chain, stoneflies were found only on the northern islands of Onekotan, Paramushir, and Shumshu (Fig. 1). Paramushir and Onekotan are volcanic in origin. Most of the volcanic massifs do not exceed 1,500 m in elevation. The average annual precipitation on these islands varies from 700 to 1,000 mm. Climatic conditions are cool. The mean daily air temperatures range between +10 to 19°C in summer; during the long winter the islands are covered with snow. There is enough moisture to maintain mixed forests on Onekotan and Paramushir islands, while Shumshu Island is mainly covered with grass, evergreen, or deciduous dwarf scrub thickets. The flood plains along the rivers and streams contain taiga-type shrub lands. Snow melt, subsoil water, and frequent summer rains are associated with a myriad of small streams. Larger rivers originate at the

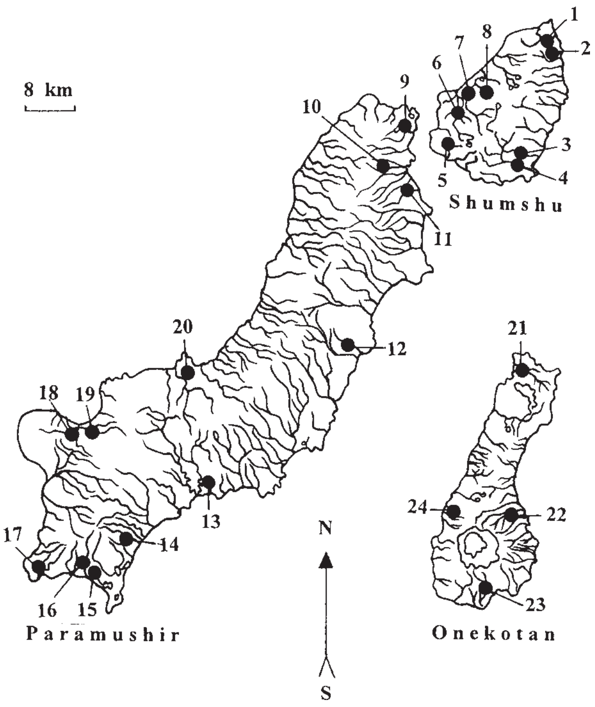

Fig. 1. Collection localities in the Northern Kuril Islands, 1996–1999.

Рис. 1. Места сбора веснянок на северных Курильских островах в 1996–1999 гг.

foot of many glaciers. Typically, streams on Onekotan are associated with mountainous head waters, steep canyon valleys, and fast currents (1.0-4.5 m sec^{-1}).

Stoneflies were collected with kick nets, sweep nets, and beating sheets. Specimens were identified and deposited at the Institute of Biology and Soil Sciences, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia, and at the School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington, USA.

Collection locations and data (Fig.1):

SHUMSHU Island:
1. Unnamed streams, Pochtareva Cape, 8.VIII.97.
2. Koshkina River, Pochtareva Cape, 8.VIII.97.
3. Unnamed stream to NE from Yudina Cape, upstream, 10.VIII.97.
4. Yushanka River, downstream, Babushkina Cape, 10. VIII.97.
5. Unnamed stream on the road from Baikovo to the SE which flows down into the Second
Kuril Strait, after Shutova Mountain, 30.VII.99.
6. Vesennyaya River, downstream, Bol'shoy Reyd, 9.VIII.97.
7. unnamed stream between Vesennyaya River and Ozernaya River, downstream, 9.VIII.97.
8. Ozernaya River, downstream, 9.VIII.97.

PARAMUSHIR Island:
9. Savushkina River, Putyatino locality, 4.VIII.97.
10. Small unnamed streams NE, E shore, Severo-Kurilsk env., 10.VIII–15.IX.96, 50°40′N, 156°06′E.
11. Utesnaya River, upstream, Utesnaya Bight, 1.VIII.96; 11.VIII.97; right tributary of the Utesnaya R., 11.VIII.97.
12. Unnamed stream, Rifovyi Cape, Pujsharia, 30.VII.1999.
13. Small stream, Tukharka Bay, Baklaniy Cape, 17.VIII.97.
14. Shikshanka River, 2 km from the mouth, 16.VIII.97
15. Pernatoye Lake, Vasil'eva Bay, 3.VIII.96.
16. Bol'shaya River, Vasil'eva Bay, 3.VIII.96.
17. Forel'nyy Stream, Vasil'eva Bay, 15.VIII.97.
18. Krasheninnikova River, downstream, Krasheninnikova Bay, 14.VIII.97.
19. Alenushkina River, downstream, Krasheninnikova Bay, 14.VIII.97.
20. Small streams, Shelekhovo Cape, 13.VIII.97.

ONEKOTAN Island
21. Unnamed stream, Nemo Bight, 4.VIII.96.
22. Rezvyy Stream, Mussel' Bight, 7.VIII.96.
23. Trudnyy Stream, NE from Krenitsyna Cape, 9.VIII.96.
24. Small unnamed waterfalls, Subbotina Cape, 5.VIII.96.

Distribution records

Perlodidae

1. *Arcynopteryx polaris* Klapalek, 1912.

Shumshu: (3) 2 ♂♂, 17 ♀♀, 32 nymphs (n), Paramushir; (10) 3 n; (18) 21 n.; (20) 1 ♀, 8 n.

New to Kuril Islands. East Palaearctic: Altai, Mongolia, widespread in the Russian Far East (RFE) from Chukotka and Kamchatka, to Primorye.

Chloroperlidae

2. *Alloperla mediata* (Navas, 1925).

Shumshu: (5) 1 ♂, 4 ♀♀ ; Paramushir: (10) 3 ♂♂, 16 ♀♀; (12) 1 ♀; (18) 2 ♂♂, 2 ♀♀.

New to the Northern Kuril Islands. East Palaearctic: known from Siberia, Altai, and Northern China. Very abundant species in the RFE including Kurils (Zeleonyi, Kunashir, Iturup, Shumshu, Paramushir islands).

3. *Suwallia teleckojensis* (Samal, 1939).

Shumshu: (1) 29 ♂♂, 14 ♀♀; Yudina Cape, 1 ♀; (4) 46 ♂♂, 46 ♀♀; (7) 18 n; (5) 54 ♂♂, 62 ♀♀; (7) 49 ♂♂, 33 ♀♀; Paramushir: (9) 3 ♂♂ , 2 ♀♀; (10) 29 ♂♂, 29 ♀♀, 19 n; (14) 40 ♂♂, 46 ♀♀, 17 n; (17) 6 ♂♂, 3 ♀♀; (16) 25 ♂♂, 13 ♀♀; (12) 3 ♂♂, 4 ♀♀; (18) 40 ♂♂, 55 ♀♀, 3 n; (13) 1 ♂; (11) 47 ♂♂, 44 ♀, 1 n; (20) 24 n.

East Palaearctic: Altai, East Sayan, Mongolia. One of the most common and abundant species in the RFE: Sakhalin, Kamchatka, Kurils (Shikotan, Kunashir, Iturup islands), and Japan: Hokkaido.

Taeniopterigydae

4. *Taenionema japonicum* Okamoto, 1922.

Shumshu: (1) 1 ♂, 4 ♀♀; (3) 3 ♂♂, 4 ♀♀; Paramushir: (14) 1 ♂, 7 ♀♀; (10) 3 ♀♀; (17) 1 ♀; (16) 1 ♀; (18) 1 ♀; (20) 2 ♂♂, 1 ♀.

New to Kuril Islands. East Palaearctic: Altai, Yenisey, Mongolia, Primorye, Magadan Area, Sakhalin, Kamchatka, Japan: Hokkaido, Honshu.

Nemouridae

5. *Podmosta weberi* Ricker, 1952.

Paramushir: (14) 1 ♀.

New to Kuril Islands. Amphipacific: Alaska, Yukon, Chukotka Peninsula, Kolyma River Basin, Kamchatka.

Capniidae

6 .*Capnia levanidovae* Kawai, 1969.
Onekotan: (24), 1 ♀.
New to Kuril Islands. Conventional endemic of Kamchatka.

7. *Mesocapnia gorodkovi* Zhiltz. et Baumann, 1986.
Paramushir: (9) 1 ♂, 1 ♀, (17) 18 n.
New to Kuril Islands. West Beringian: Chukotka, Wrangel Island, Magadan Area, northern part of Khabarovsk Province.

Discussion

Seven plecopteran species were collected on the Northern Kuril Islands. Of these, five species (*A. polaris, T. japonicum, C. levanidovae, M. gorodkovi*, and *P. weberi)* are new to the fauna of the Kuril Archipelago. All seven species are boreal. No species of the southern origin were found. Our data indicate that the Northern Kuril stonefly fauna contains three zoogeographical elements.

The first group includes four East Palaearctic species (*A. polaris, A. mediata, S. teleckojensis, and T. japonicum*), that are widely spread throughout the Asia and the Far East. Their origin and ranges are within the limits of former Angarian Landmasses situated in the present-day northeastern Asia, western North America and the Bering Strait in the Tertiary.

The Beringian elements yielded two species with Beringian disjunction, *P. weberi* and *M. gorodkovi*. Except of the Kamchatka Peninsula, they are distributed on the landmasses of the outlying Pacific Seas. These species represent Beringian faunal fragments left behind after final disintegration of the Bering land bridge. *Podmosta weberi,* with its Amphipacific Amphiberingian distribution, is believed to have originated in the mid- to late Pliocene in Beringia [Levanidova, 1982]. The majority of the species of *Podmosta* species are more diverse in the Nearctic region (e.g., four North American and one Asian species), which suggests that stonefly dispersal was primarily from east to west across Bering land bridge [Stewart & Stark, 1988] when it was available for terrestrial exchange three to six times during the Pleistocene. According to Ricker [1964], these historical events permitted the probable arrival of some Holarctic species into Asia, and *P. weberi* most probably being among them. Ancestors of the West-Beringian species *M. gorodkovi* appeared in the Angarian mountains in the Tertiary [Levanidova, Zhiltzova, 1976]. During glacial Pleistocene periods, pre-existing Pliocene fauna was displaced to the plains and low mountain streams, including Beringia. Pleistocene glacial events that occurred on both sides of the Pacific, divided an ancestral form of the *Mesocapnia* into eastern and western populations: the West-Beringian *M. gorodkovi* is most closely related to the Nearctic species *M. bergi* (Ricker) in the western North America. They both may be considered the product of Beringian disjunction and subsequent speciation.

Capnia levanidovae, belongs to the third group of autochthonous origin as provisional endemics of Kamchatka.

The stonefly fauna of the Northern Kuril Islands should be considered an improverished remnant of the fauna of Kamchatka, characterized as derived from the ancient Angarian and Beringian faunas [Levanidova, 1982]. For the Northern Kuril Islands, the main source of colonization is the Kamchatka Peninsular, being an island until the end of the Middle Pleistocene [Melekestsev, 1974]. However, the modern Kamchatka stonefly fauna retains insular features. A predomination of weak endemicity and allochthonous species should be noted. Stonefly fauna improverishment may be explained by arctic climatic conditions and low-lying landscape of the Kamchatka isthmus, which acted as a barrier to continental rheophylic fauna colonization [Levanidova, 1982]. On the other hand, ocean level fluctuations, volcanic activity, and great glacial screens reduced the potential faunal dispersal in Kamchatka during the Pleistocene. Opportunities for dispersal have appeared with the last glaciation termination and glacial degradation during the Holocene climatic optimum [Chereshnev, 1998]. In the Holocene, after the final continental separation and Beringian discontinuance, the expansion of some Angarian and Beringian species to northeastern Asia and Kamchatka occurred. In Central Kamchatka during the glacial period, a river refugium that existed in a depression free of ice [Chereshnev, 1998] was a great importance for the genesis of the Kamchatka and Northern Kuril Island faunas. Paramushir and Shumshu were jointed with Kamchatka about 18–20 thousand years ago [Melekestsev, 1974]. This landmass stretched up to what is presently the Forth Kuril Strait, suggesting a Pleistocene dispersal of stoneflies from Kamchatka to the Northern Kuril Islands. The last glacial period came to an end 10,000 years ago when the temperature increased. The melting of the ice sheets and ocean transgressions in the Holocene separated Shumshu Island from the southern extremity of Kamchatka. The isolation of Paramushir occurred later, about 9,000 years ago [Velizhanin, 1976].

As result of our investigation, conventional endemics of Kamchatka, finding *C. levanidovae* on Onekotan has been established. Onekotan is an oceanic island and belongs to Kamchatka geomorphologically, but it was never jointed to the peninsula [Aprelkov et al., 1980]. Most students of plecopteran biogeography explain the absence of stoneflies on oceanic islands by their stringent ecological requirements and poor flight capabilities of imago. The low vagility of adult stoneflies suggests the subsequent necessity for former land bridges or vicariant events when accounting for range disjunctions [Stark & Gaufin, 1976; Surdick, 1985]. Among the alternative and infrequent ways of overcoming sea-barriers, unfavorable stonefly transference by air during storms and typhoons seems to be the most probable. The appropriateness of the sea current and air mass cyclonic circulation orientations, and the regularity and duration of this factor action might have been of great importance in the history of the settlement of the Kuril Ridge, if the possibilities of former terrestrial connections with mainland are ignored [Velizhanin, 1970].

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