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First Finding of Baikalian Amphipod *Micruropus possolskii* Sowinsky, 1915 (Amphipoda, Crustacea) in Lake Ladoga

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Abstract—For the first time, the Baikalian amphipod species *Micruropus possolskii* Sowinsky, 1915 was recorded in the Shchuchiy Bay of Lake Ladoga in August 2012. The species was probably accidentally introduced into lakes of the Karelian Isthmus during intentional introduction of the another Baikalian amphipod species *Gmelinoides fasciatus* (Stebbing, 1899). Later *M. possolskii* penetrated into Lake Ladoga via different waterways connecting the lakes. The period of *M. possolskii* penetration into the lake is unknown. It is suggested that the species can spread in the littoral of Lake Ladoga, but mass development of the species is hardly probable.

Keywords: *Micruropus possolskii*, Lake Ladoga, Shchuchiy Bay, *Gmelinoides fasciatus*, unintentional introduction, biological invasions

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INTRODUCTION

In the 1960s–1970s, the amphipod *Micruropus possolskii* Sowinsky, 1915 and *Gmelinoides fasciatus* (Stebbing, 1899) were purposefully introduced into 44 water bodies of Russia, Kazakhstan and Central Asia to improve fish forage (Zadoenko et al., 1985, Zadoenko, 1995). The Baikalian endemic *G. fasciatus* spread widely in different water bodies of the European part of Russia. In Lake Ladoga, *G. fasciatus* was detected in 1988 (Petrokrepost Bay), and in the littoral of the Shchuchiy Bay, it was found in stands of cat-tail in 1989 (Panov, 1994). But penetration of the species into Lake Ladoga occurred at the beginning or in the middle of the 1980s because by the moment of its finding the species reached mass development in many littoral biotopes from northern skerries to Petrokrepost Bay (Panov, 1996). After penetration into the lake, eurybiontic *G. fasciatus* colonized all littoral biotopes and became a dominant component of the benthos (*Litoralnaya zona*..., 2011). By the end of the 2000s, *M. possolskii* naturalized only in the basin of the Upper Ob (Vizer, 2010) and in the Irikla Reservoir (Filinova, 2012).

For the first time, the Baikalian amphipod species *M. possolskii*, which was new to Lake Ladoga, was detected on August 6, 2012, in the Shchuchiy Bay (61°05′ N, 30°05′ E) in the northwestern part of the lake. The area of the bay is 0.4 km^2, the average depth is 2.0 m, and the maximum depth is 3.6 m. Over two past decades the bay was subjected to the impact of wastewaters from the Priozersk pulp and paper mill that caused deterioration of its ecosystem and extermination of bottom invertebrates (Slepukhina et al., 1993). Restoration of zoobenthos biocenoses started in 1987 after the pulp and paper mill shut down in 1986. The species composition of bottom populations and quantitative characteristics increased every year (Slepukhina et al, 1996; Barbashova, 2001). At the end of the 1990s a new ecosystem was formed in the bay (Raspopov et al., 2003).

The aim of the paper is to present information about *M. possolskii* findings in Lake Ladoga, to assess its quantitative development, and to consider possible ways of its penetration into the lake.

MATERIALS AND METHODS

In the course of long-term monitoring of the ecological state of the Shchuchiy Bay, samples were collected at two stations near the dike and in the central part of the bay on August 6, 2012. The stations were located in different biotopes at different distance from the fill dike toward the open lake (Fig. 1). The dike separates the southern part of the bay where the wastewaters were discharged from the main area of the lake. Table 1 presents the description of the stations.

Benthos samples were collected in two replicates at each station using an Eckman dredge sampler (1/40 m^2). The collected sediments were washed through capronic sieve no. 38 and fixed in solution of 4% formalin. Samples were transported to the laboratory;

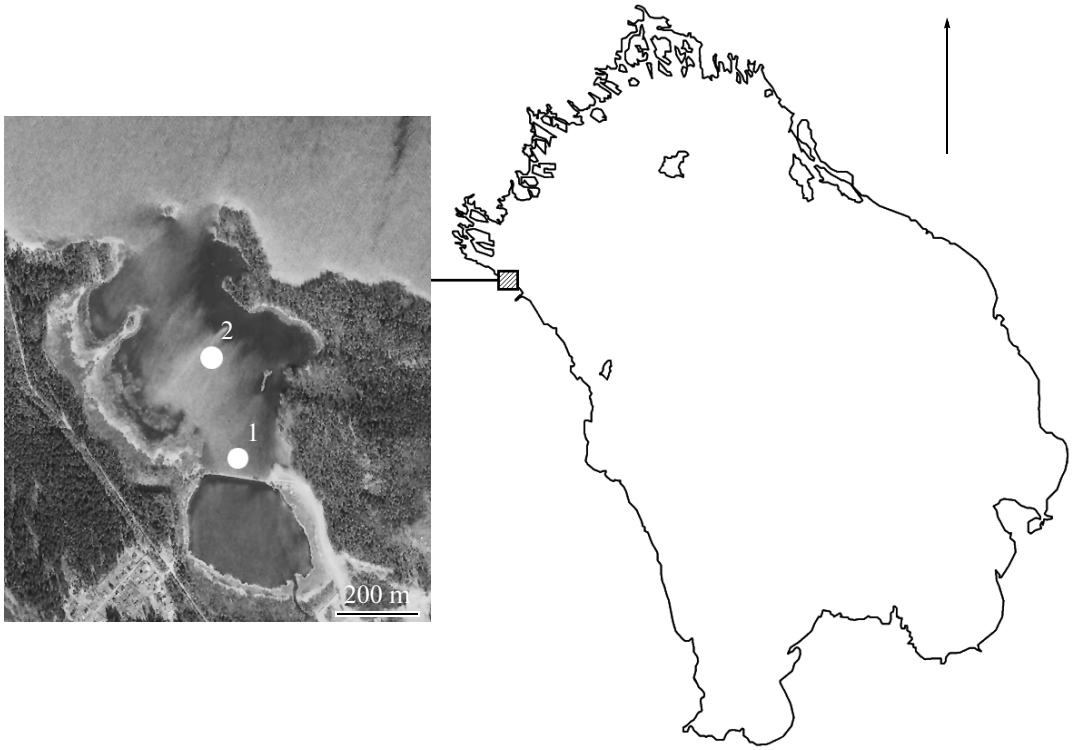

Fig. 1. Map of location of stations (1—near the dike, 2—central part of the bay) in the Shchuchiy Bay of Lake Ladoga (using the materials of the site http://maps.yandex.ru).

benthic organisms were sorted and counted. The mass of animals was measured using a torsion balance.

RESULTS AND DISCUSSION

Both adult and juvenile individuals of the Baikalian endemic *M. possolskii* (Fig. 2) were detected in the biotopes under study.

A total of six groups of bottom invertebrates Oligochaeta, Chironomidae, Amphipoda, Heleidae, and mollusks Bivalvia and Gastropoda were detected in the composition of macrozoobenthos (Table 2). The total abundance of bottom animals near the dike and in the central part of the lake was 5640 ind. m^{-2}, and the biomass was 13.1 and 6.9 g m^{-2}, respectively. Near the dike, the biomass of zoobenthos was mainly formed by mollusks (42.9%), chironbomids (26.6%),

Table 1. Description of biotopes and physical and chemical parameters in the surface water layer at stations in the Shchuchiy Bay of Lake Ladoga (August 6, 2012)

Parameter	Station 1 (near the dike)	Station 2 (central part of the bay)
Coordinates	61°04′91 N, 30°05′51 E	61°05′07 N, 30°05′42 E
Depth (m)	1.0	2.5
Characteristics of grounds	Gray sandy silt with vegetative remains	Gray sandy silt with vegetative remains
Water temperature, °C	18.7	18.3
pH*	7.51	7.67
O_2 mg /L*	9.95	10.42
O_2, % of saturation*	109.8	114.1
$P_{nonorg.}$ μg/L*	5.3	12.5
P_{total} μg/L*	27.5	38.2
Total organic carbon, mgC/L*	8.4	9.7
Specific conductivity, μS/cm*	95.0	98.0

* The data of the chemical analysis are presented by T.N. Petrova and M.A. Guseva, researchers at the Laboratory of Hydrochemistry of the Institute of Limnology of the Russian Academy of Sciences.

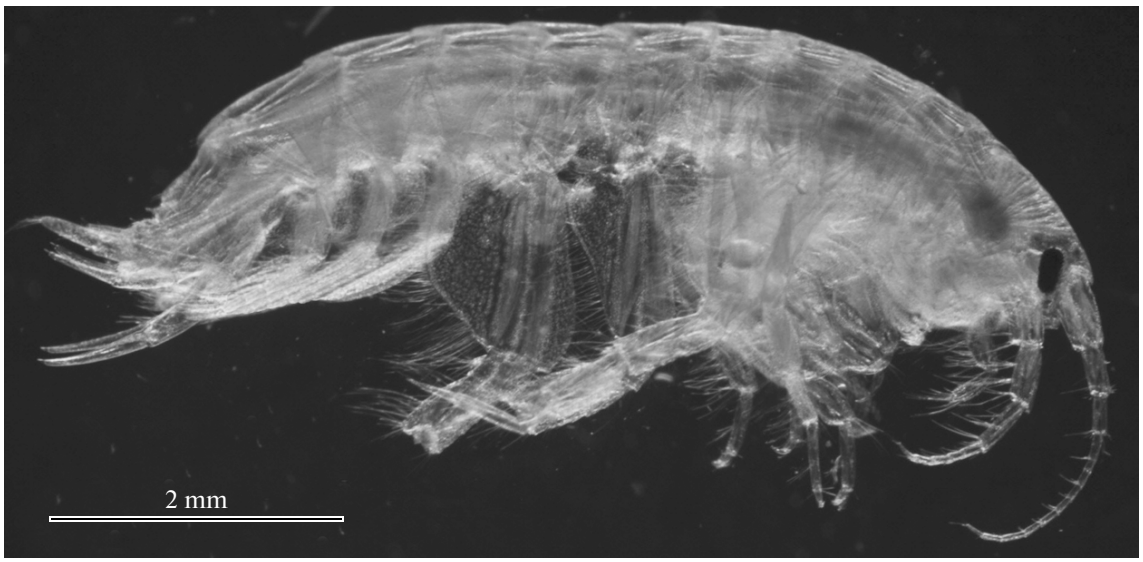

Fig. 2. *Micruropus possolskii* (♂) from the Shchuchiy Bay of Lake Ladoga. Photo by S.A. Malyavin.

oligochaetes (18.3%), and amphipods (10.7%). Amphipods were represented by two species *G. fasciatus* (400 ind. m^{-2}, 0.7 g m^{-2}) and a new invader *M. possolskii* (1040 in. m^{-2}, 0.7 g m^{-2}); the latter amounted to 72% of abundance and 50% of biomass of crustaceans. In the central part of the bay, chironomids played a significant role (78% of abundance and 58.6% of biomass). Of amphipods, only *M. Possolskii* was found. The density of its population and biomass were low, 520 ind. m^{-2} and 0.96 g m^{-2}, respectively.

M. possolskii belongs to the Baikalian endemic genus, which comprises many species. Its typical features are short antennae of both pairs, accessory flagellum of antennule consisting of one segment, and elongate frontal angle of the coxal plate (Fig. 3A); baseopodite of pereopod V is expanded but tapered towards the distal end (Fig. 3B); the anterior margin of the distal part of its basipodite is concave and covered with setae; uropods I and II in the medium part of endo- and exopodites are without spines (Fig. 3C); short uropods III (hence, the name) with smaller endopodite and exopodite without an accessory segment (Fig. 3D); extended first and second segments of the palp of mandibule (Fig. 3E); intensive armament of coxal plates and basipodites with long thin setae. Some of these features (shortened antennae and uropods, accessory expansion of flat parts, thick long setae) and habitus are the result of adaptation to a burrowing mode of life.

Table 2. Abundance (*N*, ind. m^{-2}) and biomass (*B*, g m^{-2}) of macrobenthos groups at stations in the Shchuchiy Bay of Lake Ladoga (August 6, 2012)

Group	Station 1 (near the dike)		Station 2 (central part of the bay)	
	N	*B*	*N*	*B*
Oligochaeta	2220	2.4	620	0.8
Chironomidae	1500	3.48	4400	4.04
Amphipoda	1440	1.4	520	0.96
M. possolskii	***1040***	***0.7***	***520***	***0.96***
G. fasciatus	***400***	***0.7***	–	–
Heleidae	60	0.2	–	–
Mollusca (Bivalvia)	380	2.58	60	0.8
Mollusca (Gastropoda)	40	3.04	40	0.3
Total benthos	5640	13.1	5640	6.9

"–" Means the species is not found.

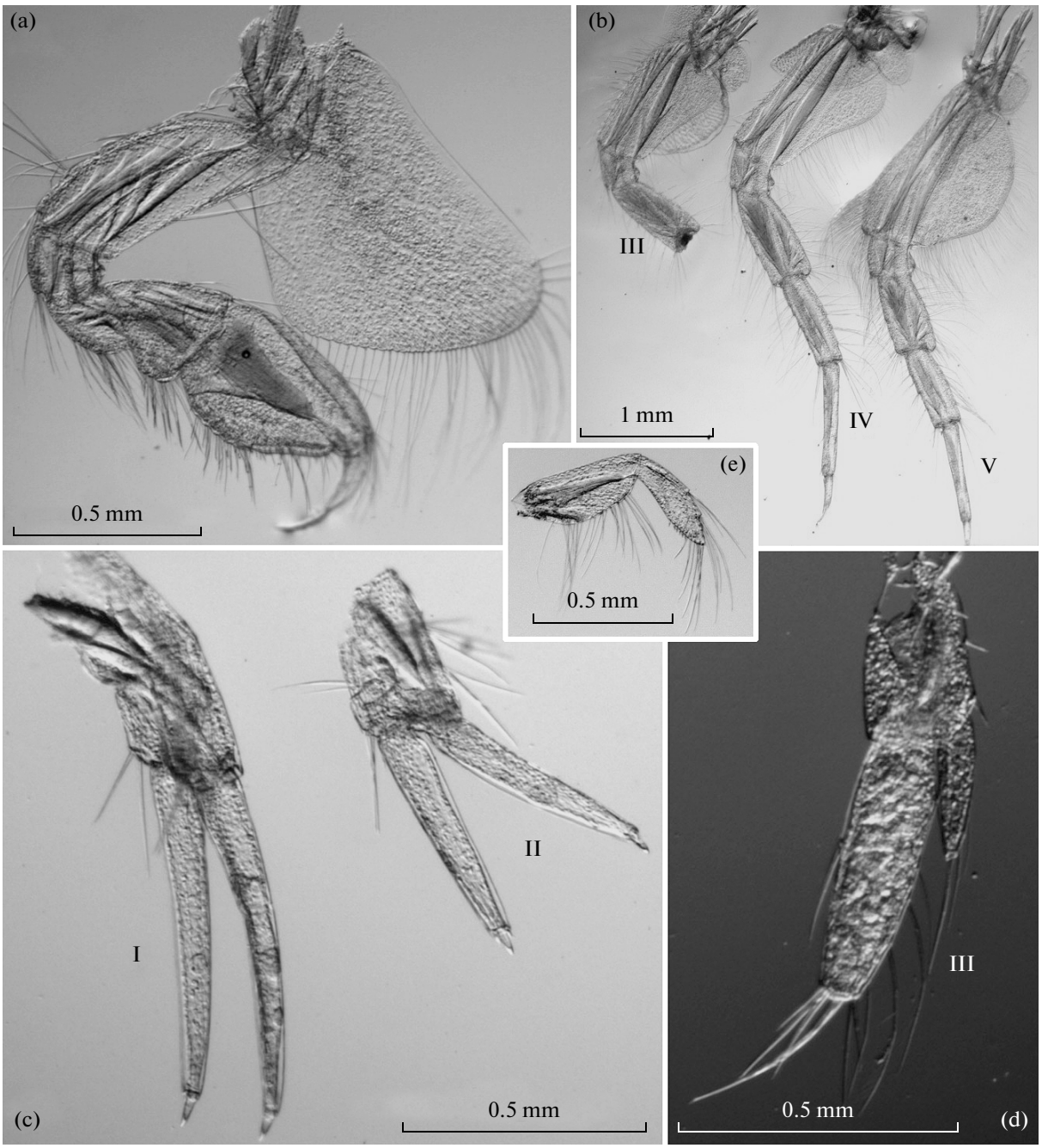

Fig. 3. Appendages of the specimen presented in Fig. 2. (A) Gnathopod I; (B) pereopods III, IV, and V; (C) uropods I and II; (D) uropod III; (E) mandibular palp.
Photo by S.A. Malyavin.

M. possolskii is distributed in inlets, shors, and bays of Lake Baikal; in Lakes Goryachee and Gubinskoye in the delta of the Selenga River and its canals; and in Lake Zagli-Nur on Olkhon Island. In the open part of Lake Baikal, the species was detected only in the Selenga River region and in the Maloye Sea. Its density is extremely high on silty sands and silts in bays and inlets (Bazikalova, 1962).

The species is found in the water column at depths to 5–10 m in sites which are protected from the affect of cold deep waters of Lake Baiklal. It inhabits different grounds from gravel sand to gray silts but prefers silty sands. The preference for well-heated biotopes is a typical feature of *M. possolskii*. The gas regime in the habitats of this amphipod is favorable. Calcium carbonate components with a significant portion of sulfates and magnesium prevail in the salt composition of

water. Total mineralization of water in most biotopes is rather low.

M. possolskii has a hidden mode of life. It burrows into the upper layer of sediments and sometimes swims over its surface. It mainly feeds on detritus. In its intestine, the remains of plankton and small benthic organisms are found (Bekman, 1962).

Habitat conditions in the Shchuchiy Bay (isolation, small depths, silty-sand grounds, low water mineralization, and high concentrations of oxygen (Table 1)) are favorable for *M. possolskii* and have promoted its naturalization. The fact of naturalization is confirmed by the presence of juvenile species in samples.

Published data on the introduction of *M. possolskii* into the lakes of the Karelian Isthmus are not available. In the course of intentional introduction of amphipods (Baikalian gammarids) into different water bodies, several species were present in the seeding material, but *G. fasciatus* constituted the main portion. Probably, *M. possolskii* was unintentionally introduced into the lakes of the Karelian Isthmus in 1971–1975 together with *G. fasciatus* from Posolskii Sor of Lake Baikal (Nilova, 1976; Arkhiptseva et al., 1977, Lavrentieva and Mitskevich, 2007). Later, the Baikalian amphipod *M. possolskii* as well as *G. fasciatus* penetrated into Lake Ladoga as the result of self-spreading.

The period of penetration of *M. possolskii* into the lake is unknown. It probably appeared together with *G. fasciatus* in the 1980s, but compared to *G. fasciatus*, it did not spread widely and did not form mass populations, which is why it was not recorded in our samples. Taking into consideration the deterioration of the ecological state in the Shchuchiy Bay at the end of the 1980s to the beginning of the 1990s (Raspopov et al., 1998), the species probably penetrated into the the bay after improvement of the environmental conditions at the end of the 1990s to the beginning of the 2000s. Bekman (1962) wrote that the conditions of purely
1 eutrophic or dystrophic waterbodies with an overload of organic-rich sediments, with a neutral to acid environment common to them and a significant lack of oxygen, do not satisfy the requirements of *M. possolskii*.

In contrast to *M. possolskii*, the amphipod *G. fasciatus* is a more plastic species. It can stand high eutrophication, is resistant to some pollutants, can adapt to a complex of unfavorable factors, and takes the lead in colonization of biotopes which are polluted with industrial sewage (*Biologicheskie invazii...*, 2004). The Baikalian endemic *G. fasciatus* was one of the first bottom invertebrates which colonized biotopes in the Shchuchiy Bay after the stoppage of industrial wastewater discharge from the Priozersk pulp and paper mill.

The presence of *M. possolskii* in other sites in the lake littoral is possible, but it is not confirmed by findings.

When analyzing the possibility of further spreading of *M. possolskii* in the lake, one should take into consideration that the distribution of the amphipod is restricted to littoral shallows which are protected from the affect of cold deep waters. But the shores of the southern bays are slightly uneven and are subjected to the surf along the whole length, and the water in the Volkhov Bay is weakly mineralized. Hence, under such conditions, a wide distribution of the amphipod is hardly possible. Most likely, its distribution will be local and the species will populate only isolated bays and quiet sites in the littoral zone of the lake. The probability of the formation of mass accumulations of the species is rather low. At present, it is difficult to predict the consequences of the introduction of M. *possolskii* into the lake, but its influence can hardly be comparable to the role of *G. fasciatus*.

Thus, taking into consideration that all age stages of *M. possolskii* were recorded in samples, and the fact that the species appeared in the European part of Russia as the result of introduction measures in the 1970s, we can state that the species has naturalized in the basin of Lake Ladoga. Intensive study of the littoral zone, especially in sites which are suitable for habitation of the new species, is necessary for assessment of the consequences of invasions and prediction of the distribution of the alien species *M. possolskii*.

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SPELL: 1. waterbodies