Short communication

ISSN 2658-3518
LIMNOLOGY FRESHWATER BIOLOGY
www.limnolfwbiol.com

Water quality monitoring of the Angara River source

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ABSTRACT. Studies of the Angara River source from March 2017 to April 2020 provided monthly monitoring of the quality of the waters in Lake Baikal. The monitoring of the water from the Angara source based on hygiene indicator bacteria indicated its correspondence to the standards for the quality assessment of the surface waters, except for two samples taken in May 2018 and July 2019 (exceeding number of enterococci). The data on the number of the hygiene indicator microorganisms for the Angara source were generally comparable to the results of the investigations of pelagic samples from the lake and significantly lower than the values for the main tributaries of the lake. The monitoring revealed the number of psychrophilic bacteria was mainly equal to or higher than organotrophic, except for the warmest month, August, when their number was two-three times lower. Peaks exceeding the number of the studied groups of microorganisms by two-three orders of magnitude were observed in December 2018 as well as in February and August 2019. In macro- and microchemical composition, the samples of the water from the Angara source corresponded to the requirements for the drinking water quality.

Keywords: Lake Baikal, the Angara source, coliform bacteria, enterococci, ogranotrophic microorganisms, psychrophilic microorganisms.

1. Introduction

Each year, the problem of drinking water shortage is becoming more urgent. The overall primary concern is the drinking water supply on the Earth, and the secondary one – the quality of this drinking water. Lake Baikal is the world's largest fresh water storage of 23000 km^3, which is approximately 20% of all surface waters on the Earth. The Angara River is the only outflow of Lake Baikal, and the rest rivers and watercourses (over 360) flow into Lake Baikal. The monitoring of dangerous natural and anthropogenic processes in the Baikal region and their possible impact on the state of the lake is a fundamental scientific challenge. The waters from the Angara source and Baikal itself are the cleanest in the world concerning the pollution. For more than 70 years, researchers from Vinogradov Institute of Geochemistry have been studying the chemical composition of the water from the Angara source in the monitoring regime (Grebenshchikova et al., 2018). Previously, E.D. Savilov with co-authors investigated the microbiological composition in the Angara River, and they revealed the presence and antibiotic resistance of opportunistic microorganisms (Savilov et al., 2008; Anganova et al., 2011).

Monitoring the quality of the water from the Angara source is important for the assessment of the current anthropogenic impact and possible preservation of clean water in Lake Baikal.

2. Materials and methods

The study material, the surface water from the Angara source, was sampled opposite the Shaman Stone, in 2 m from the coast from a depth of 0.4-0.5 m. Sampling was carried out every month from August 2017 to April 2020. In total, 30 samples were investigated.

Microbiological methods were used to determine total coliform bacteria (CB), thermotolerant coliform bacteria (TC), enterococci (Ent), total microbial count (TMC) as well as organotrophic and psychrophilic microorganisms (Suslova et al., 2019).

Chemical methods were used to determine macro- and microelemental composition of water (Grebenshchikova et al., 2018).

3. Results and discussion

In the surface water of the Angara source, we detected opportunistic bacteria in 77% of the samples. Only in seven samples, we recorded their absence. They were collected in November 2017, from January to

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March 2018, in January and September 2019, and in January 2020. Therefore, the samples taken in January from 2018 to 2020 indicated the absence of hygiene indicator microorganisms. CBs were from 1 to 10 CFU/100 cm^3 in 16 samples; TCs – from 1 to 4 CFU/100 cm^3 in 11 samples. Higher amounts of CBs and TCs were detected in August 2017 (88 and 12 CFU/100 cm^3, respectively), March 2019 (50 and 27 CFU/100 cm^3), July 2019 (by 72 CFU/100 cm^3), and August 2019 (maximum values of 154 and 76 CFU/100 cm^3, respectively). Ent were detected in 10 of 30 samples in May 2018, July and August 2019, with the maximum values of 60, 66 and 37 CFU/100 cm^3, respectively. In other samples, the number of Ent did not exceed 5 CFU/100 cm^3. Peaks in numbers of CBs, TCs and Ent were observed in July and August 2019. Monitoring of hygiene indicator bacteria in the water from the Angara source indicated the correspondence to the quality of the surface waters, except for 2 samples taken in May 2018 and July 2019 (exceeding number of Ent). Among the samples, 23% (7 samples) corresponded to the parameters of the drinking water quality. The obtained data on the number of the investigated microorganisms in the Angara source were generally comparable with the data on the pelagic samples from the lake and significantly lower in comparison with the study results of the main tributaries of the lake (Fig.).

Allochthonous organotrophic microorganisms (TMC, 37°C) were detected in 12 of 30 samples, with the maximum number of 1412 CFU/100 cm^3 in February 2019. The number of psychrophiles was either higher or equal to the number of organotrophs, except for the warmest month, August 2017, 2018, and 2019, when their number was two-three times lower. The presence of microscopic moulds, which are active destructors, from August 2017 to June 2019 was a distinctive feature of the water from the Angara source. Peaks in numbers of organotrophs and psychrophiles were observed in December 2018, February and August 2019, when their numbers were higher by two-three orders of magnitude. The maximum peak was recorded in February 2019.

The chemical analysis of micro- and macroelements in September 2019 revealed maximum peaks for many elements: rare elements (Li, Be, Rb and Nb) and the Fe group elements (Ni, Co, Cr, Pb and Mn) as well as U and As. For the entire study period, the samples from the Angara source corresponded to the chemical requirements for the drinking water quality.

4. Conclusions

Monitoring of the hygiene indicator bacteria of the water from the Angara source indicated the correspondence to the quality of the surface waters, except for the samples taken in May 2018 and July 2019. Among the samples, 23% corresponded to the parameters of the drinking water quality. The obtained data on the number of the investigated microorganisms in the Angara source were generally comparable with the data on the pelagic samples from the lake. The chemical composition of the samples from the Angara source for macro- and microelements corresponded to the drinking water quality.

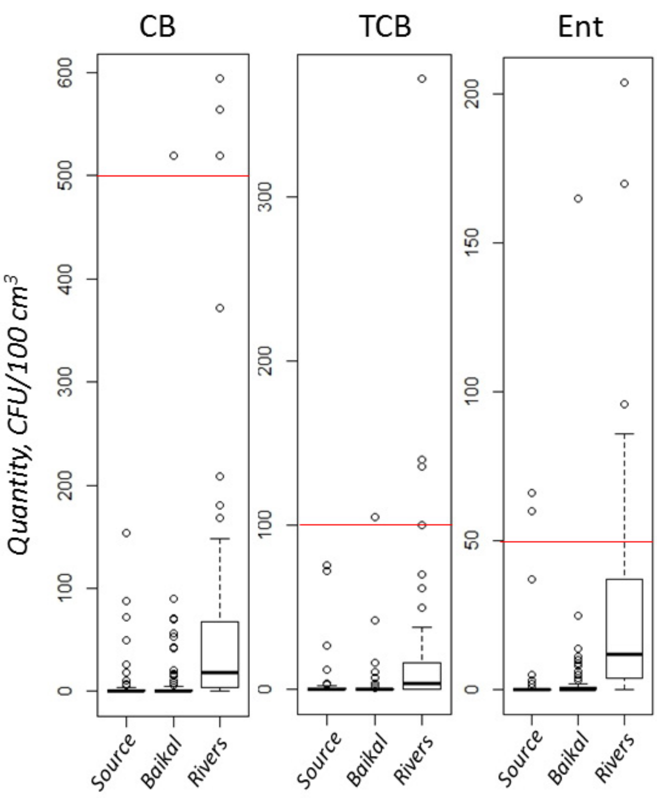

Fig. Distribution of the number of opportunistic bacteria in the Angara source from August 2017 to April 2020; the pelagic zone of Lake Baikal and its main tributaries in the spring-autumn of 2017-2019 (Suslova et al., 2019). CB – coliform bacteria, TCB – thermotolerant coliform bacteria, Ent – enterococci, CFU – colony-forming unit.

Acknowledgements

The study was carried out within the framework of State Task No. 0345-2019-0003 (AAAA-A16-116122110061-6), and the RFBR_ofi-m grant No. 17-29-05022.

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