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Under Ice Bloom of Phytoplankton in Southern Baikal in 2013

Maria L. Kostrikina, Svetlana V. Shimaraeva, Lyudmila S. Krashchuk, Elena V. Pislegina,

Olga O. Rusanovskaya, Eugene A. Silow*

Institute of Biology, Irkutsk State University, Lenin str., 3, Irkutsk-25, 664025, Russian Federation.

Abstract

The results of observation of under-ice phytoplankton at Baikal Point #1 in February-April of 2013 are discussed. The under-ice bloom (decrease of transparency from 24 m to 10.5 m) took place. There were 35 forms of phytoplankton belonging to 7 orders: Bacillariophyta, Chlorophyta, Chrysophyta, Dinophyta, Cryptophyta, Ochrophyta, Cyanophyta. All endemic for Baikal species of diatoms, dinophytes and cyanophyta *Synechocystis limnetica* were present. Despite high diversity, number of diatoms was low, while *Synechocystis limnetica, Koliella longiseta, Rhodomonas pusilla* demonstrated really mass development as well as *Gymnodinium baicalense*. 2013 can be counted as "gymnodinium year", not "melosira year".

Key words: Lake Baikal, Phytoplankton, Under-ice bloom.

1. Introduction

Lake Baikal occupies special place among deep lakes of the World due to its natural features. It is one of the oldest lakes by origin, its flora and fauna are extremely rich by species number and diversity. Many of species inhabiting Baikal are endemic. Baikal contains large volume of exceptionally pure fresh water and is exceptionally picturesque. Baikal was included in the list of World Heritage of UNESCO in 1996. Lake Baikal ecosystem, like ecosystem of the Ocean works mainly due to functioning of pelagic community [1].

That is why phytoplankton of the lake is the basis of its life. Specific feature of Baikal is the spring development of phytoplankton not after ice melting, like other dimictic temperate lakes [2], but directly under thick layer of ice (1-1.5 m). It is explained by extreme transparency of ice and lack of snow cover on it due to very strong

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Correspondence to: Silow EA, Institute of Biology, Irkutsk State University, Lenin str., 3, Irkutsk-25, 664025, Russian Federation.
Email: eugenesilow@gmail.com

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winds. Light penetrates through ice and provides sufficient illumination for photosynthesis. This under-ice season is responsible for creation of lion share of primary production in the lake [1].

Under-ice development of phytoplankton was first systematically studied by M.M. Kozhov [3], later by specialists of Irkutsk University [1, 4-7] and Limnological Institute of RAS [8]. Usually these blooms are caused by mass development of diatoms, that is why they are called "melosira years" [3] (due to former name of *Aulacoseira* sp. – *Melosira* sp.), but sometimes these blooms are formed due to mass development of Dinophyta algae [4]. The aim of current work is the study of qualitative and quantitative composition of phytoplankton of upper 0-50 m (trophogenic for Baikal [1, 4, 8]) layer during one of such blooms, previously not described in literature, in 2013.

2. Experimental

2.1. Site Description and Methods

"Point #1" is situated 2.7 km from the southwestern shore of Lake Baikal, where depth is approximately 800 m (N – 51° 52′ 48″, E – 105° 05′02″). Point #1 is often considered a good representative for Lake Baikal's entire Southern basin [2-3]. Samples were collected approximately every 7-10 days February - April, 2013. Water samples for phytoplankton diversity analyses were collected with a 7-L Van Dorn bottle (bathometer) from the depths of 0, 10, 25, 50, 100, 150, 200, 250 m. Water temperature was measured with a mercury thermometer inserted in the bathometer, and water transparency was estimated with a 35-cm in diameter Secchi disk. Phytoplankton samples were fixed with Utermöhl solution, settled for 2 weeks, and analyzed with light microscope (with magnification up to x1000).

3. Results and Discussion

Temperatures at Point #1 in 0-50 m layer in February-April 2013 varied from 0.2 to 1.4°C increasing with depth, average-weighted was 0.72±0.21°C. Secchi transparency in the beginning of observations was 24 m, but decreased to 10.5 m, indicating phytoplankton bloom. 35 taxons of algae, belonging to 7 orders were registered (Table 1). The most diverse were Bacillariophyta-14 species. All endemic for Baikal species of diatoms were present. Despite their diversity number of them was low. Numbers varied from 0.02×10^3 cells l^{-1} for *Synedra ulna* to 44.61×10^3 cells l^{-1} for *Synedra acus.* Such weak development of diatoms is in contradiction with widely spread opinion on their key role in production of most primary organic matter in the lake [8] but supports previously published hypothesis about real share of diatoms in total phytomass in Baikal [6].

Chrysophyta was the second order by biodiversity - 6 species. The most multiple was *Chrysochromulina parva* with number varying from 0.18 to 27.51×10^3 cells l^{-1}. There were 5 species of Cryptophyta, their number was from $0.02\cdot10^3$ cells l^{-1} (*Cryptomonas marssonii*) to 84.01×10^3 cells l^{-1} (*Rhodomonas pusilla*). Order Chlorophyta was represented by 4 species. Among them *Koliella longiseta* had the maximum number 1347.57×10^3 cells l^{-1}. Minimum number was for *Elakatothrix lacustris* – 0.01×10^3 cells l^{-1}. Order Dinophyta also had 4 species, with maximum numbers varied from 0.21 to 150.37×10^3 cells l^{-1}. All these species are quite typical for under-ice community of Baikal [1, 5, 8].

Table 1. Algae species at Point #1 under-ice in 2013.

Order	Species	Endemism
Bacillariophyta	*Aulacoseira baicalensis* (K. Meyer) Simonsen	+
	Aulacoseira scvorzowii Edlund, Stoermer, Taylor	+
	Stephanodiscus meyerii Genkal et Popovsk.	+
	Cyclotella baicalensis (K. Meyer) Skv.	+
	Cyclotella minuta Antip.	+
	Nitzschia acicularis (Kutz.) W. Sm.	-
	Synedra acus Kutz.	-
	Asterionella formosa Hassall	-
	Synedra ulna (Nitzsch) Ehrenberg	-
	Nitzschia sp.	-
	Cocconeis sp. sp.	-
	Navicula sp. sp.	-
	Gomphonema sp.sp.	-
	Amphora sp.	-
Chlorophyta	*Koliella* sp.	-
	Koliella longiseta (Vischer.) Hind.	-
	Monoraphidium pseudomirabile (Korschik.) Hindak et Zagorenko	-
	Elakatothrix lacustris Korshikov	-
Chrysophyta	*Dynobryon cylindricum* Imh.	-
	Dynobryon sociale Ehr.	-
	Chrysochromulina parva Lackey	-
	Mallomonas sp. sp.	-
	Mallomonas vannigera Asmund	-
	Pseudopedinella sp.	-
Dinophyta	*Gymnodinium baicalense* Antip.	+
	Gymnodinium coeruleum (G.fuscum) Antip.	-
	Glenodinium sp. sp.	-
	Peridinium baicalense Kiselev & Cvetkov	+
Cryptophyta	*Rhodomonas pusilla* (Bachm.) Javor	-
	Chroomonas sp.	-
	Cryptomonas sp.	-
	Cryptomonas marssonii Skuja	-
	Cryptomonas gracilis Skuja	-
Ochrophyta	*Tribonema angustissimum* Pascher	-
Cyanophyta	*Synechocystis limnetica* Popovskaja	+

Unidentified cocci of 1.2-2 µm in diameter (probably *Synechocystis limnetica*) were present in huge quantities. They were dominant in phytoplankton samples. Their maximum number reached 9381.86×10^3 cells l^{-1}. Other unidentified algae were noted: cells of pico(nano)planktonic blue-green algae, flagellates, diatoms, cysts of Chrysophyta.

Dominant by average-weighted number species of algae for 0-50 m layer in February 2013 (excluding unidentified ones) are listed in table 2. In March *Monoraphidium pseudomirabile* and *Gymnodinium baicalense* joined to their list.

Table 2. Dominant species of phytoplankton at Point #1 in February 2013.

Species	Number (10^3 cells l^{-1})
Koliella longiseta	465.92
Synedra acus	19.67
Rhodomonas pusilla	28.17

Total average-weighted number of phytoplankton (excluding pico(nano)plankton) in 0-50 m layer started to increase since middle of February and reached its maximum in the beginning of April. Total number of phytoplankton (including whole unidentified phytoplankton) was maximal since end of February-beginning of April. The composition of phytoplankton remains practically the same as described previously [1, 4, 5, 7, 8].

4. Conclusion

Relatively weak development of diatoms is in contradiction with widely spread opinion on their key role in production of most primary organic matter in the lake Baikal. Mass development of Dinophyta (up to $150 \cdot 10^3$ cells l^{-1}) points to the fact that they were the main primary producers (as they are rather large-cell) in Spring 2013, it means the year was not "diatom-rich", but "dinophyta-rich". In whole, under-ice phytoplankton remains practically the same as described previously. There was no significant change for it in 2013.

5. Conflicts of Interest

The authors report no conflicts of interest. The author along are responsible for content and writing of the paper.

6. Acknowledgment

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