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INVESTIGATION OF PHYTOPLANKTON COMMUNITY IN "YEREVANYAN LICH" RESERVOIR AND THE HRAZDAN RIVER IN THE CONDITIONS OF ALGAL BLOOM

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Phytoplankton quantitative and qualitative parameters in "Yerevanyan Lich" Reservoir and the Hrazdan River were investigated in April and June–August 2015. The results of the study showed that algal bloom registered in "Yerevanyan Lich" Reservoir in summer 2015 created new environmental conditions which led to significant changes in reservoir's phytoplankton dominant complex, affecting also phytoplankton composition in the Hrazdan River sites located downstream from the reservoir.

Keywords: "Yerevanyan Lich" Reservoir, Hrazdan River, phytoplankton, algal bloom, impacts.

Introduction. The Hrazdan River originated from Lake Sevan is the longest tributary (141 *km*) of the transboundary Araks River in the territory of Armenia. This river ecosystem and "Yerevanyan Lich" Reservoir constructed in the Hrazdan River canyon in the south-west of Yerevan City have high importance for the development of Armenian economy as the waters are used for irrigation, energetic, recreational, industrial and other purposes [1]. Previous phytoplankton studies carried out by Stepanyan et al. showed that during the summer period for the years 2003 through 2006, algal bloom occurred in "Yerevanyan Lich" Reservoir, which allows to think that this phenomenon in "Yerevanyan Lich" Reservoir has continuous nature [2–4]. An algal bloom is a rapid increase or accumulation in the number of algal cells [5, 6]. Algae are microscopic plants living in the aquatic environments. They are vital primary producers for both marine and freshwater ecosystems. Their growth is influenced by many different processes ranging from physical, chemical to biological and ecological processes and more [7]. Algal bloom occurs in freshwater as a result of the excess of nutrients in warm and sunny conditions [8, 9]. It may cause eutrophication and the depletion of oxygen level through excessive respiration or decomposition and adversely affect the growth of biological communities [7, 10, 11]. The aim of the present study was to investigate the growth of phytoplankton community in "Yerevanyan Lich" Reservoir and the Hrazdan River in the conditions of algal bloom.

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Materials and Methods. The quantitative and qualitative parameters of phytoplankton community in “Yerevanyan Lich” Reservoir and the Hrazdan River were investigated. Phytoplankton studies in the aquatic ecosystems were performed in 5 monitoring sites: 2 river sites located upstream from “Yerevanyan Lich” Reservoir (no. 1 and 2), 2 river sites located downstream from the reservoir (no. 4 and 5) and a “Yerevanyan Lich” Reservoir site located near the dam (no. 3) (Fig. 1). Phytoplankton samples were collected once a month in April and June–August 2015. A 1-liter water sample taken from each site was preserved with 40% formaldehyde solution (0.4% final concentration) and stored in a dark place. Further study was carried out under laboratory conditions. The fixed phytoplankton samples were settled in a dark space for 10–12 days, and then the volume of the experimental samples was decreased from 1000 mL to 100 mL by a siphon (50 μm). Repeating the same process for the second time, the volume of the experimental samples was reduced to 10 mL [12]. The qualitative and quantitative analyses of phytoplankton were executed under a microscope using Nageotte chamber. Taxonomic groups of phytoplankton were identified using the keys/determinants of freshwater systems [13–17]. Water temperature measurements were conducted in field conditions, using a digital thermometer (ST9265).

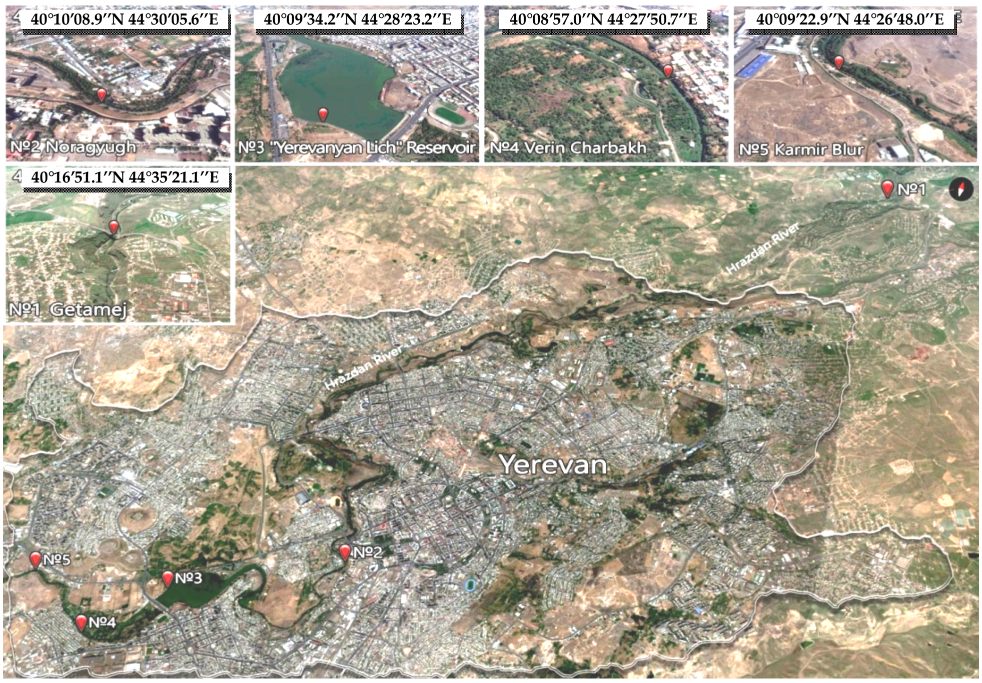

Fig. 1. Map of monitoring and sampling sites in “Yerevanyan Lich” Reservoir and the Hrazdan River.

Results and Discussion. Phytoplankton community in “Yerevanyan Lich” Reservoir was represented by 6 groups: Bacillariophyta (diatom algae), Chlorophyta (green algae), Cyanophyta (blue-green algae), Xanthophyta (yellow-green algae), Euglenophyta (euglenoids) and Dinophyta (dinoflagellates). During the investigation in April, the representatives of diatom algae prevailed quantitatively in “Yerevanyan Lich” Reservoir, nevertheless, a significant change in the phytoplankton community occurred in June: due to green algae bloom in the reservoir, green algae became a quantitatively dominant group in the phytoplankton community, and the quantitative parameters of phytoplankton increased significantly (Fig. 2).

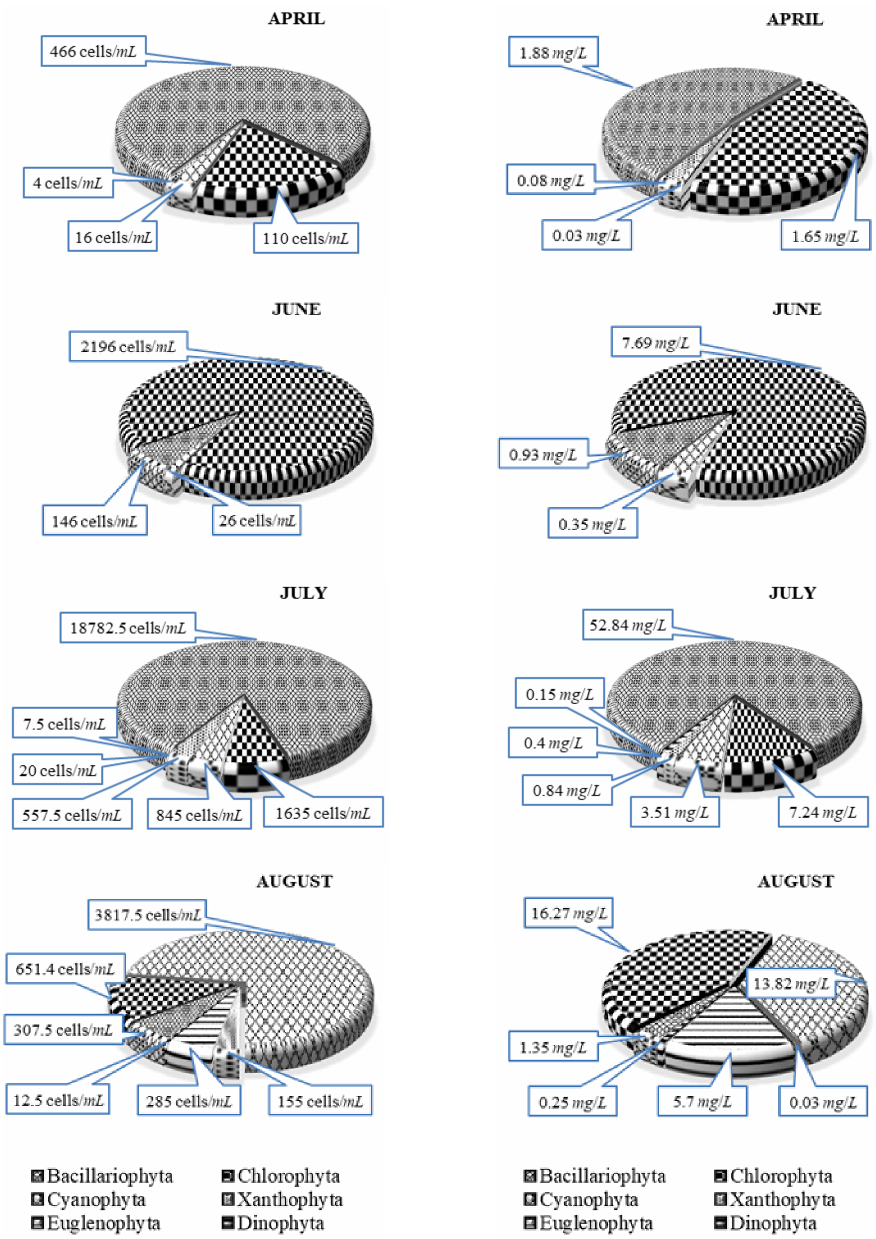

Fig. 2. Quantitative parameters (abundance in left side and biomass in right side) of phytoplankton in "Yerevanyan Lich" Reservoir (sampling site no. 3).

Green algae bloom in the reservoir was on account of the increased growth of such species as *Chlorella vulgaris* (1288 cells/*mL*, 6.44 *mg*/*L*), *Monoraphidium contortum* (282 cells/*mL*, 0.23 *mg*/*L*) and *M. griffithii* (550 cells/*mL*, 0.46 *mg*/*L*).

However, significant changes in the quantitative parameters of phytoplankton groups also occurred during July–August, and phytoplankton groups causing an algal bloom were shifted as follows: green algae–diatom algae–blue-green and green algae (Fig. 2). Rapid increase in the quantitative parameters of diatom and blue-green algae in the reservoir was mainly on account of the increased growth of the organic pollution indicator species *Fragilaria crotonensis* (diatom algae) (18625 cells/*mL*, 52.15 *mg*/*L*), *Dolichospermum flos-aquae* (1462.5 cells/*mL*, 0.52 *mg*/*L*) and *Aphanizomenon flos-aquae* (blue-green algae) (1380 cells/*mL*, 9.66 *mg*/*L*) and may have been conditioned by increased organic matter level resulted from algal blooms (it's known that algae are short-lived, and algal bloom in a reservoir may result in the elevated level of organic matters) [7, 18].

Table 1

Phytoplankton abundance (cells/mL) in the Hrazdan River (NR is not registered)

Taxonomic group	Sampling site number															
	1				2				4				5			
	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug
Cyanophyta	25	NR	368	378	108	24	38	20	44	14	84	138	38	32	52	42
Bacillariophyta	664	462	3285	687	152	94	40	40	462	72	78	212	942	202	74	50
Chlorophyta	10	NR	35	15	NR	NR	NR	NR	NR	2	54	12	20	82	NR	NR
Xanthophyta	2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Euglenophyta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	4	NR	NR	NR	2
Total	701	462	3688	1080	260	118	78	60	506	88	216	366	1000	316	126	94

Table 2

Phytoplankton biomass (mg/L) in the Hrazdan River (NR is not registered)

Taxonomic group	Sampling site number															
	1				2				4				5			
	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug	Apr	Jun	Jul	Aug
Cyanophyta	0.07	NR	1.50	1.00	0.25	0.05	0.10	0.05	0.10	0.04	0.30	0.40	0.11	0.13	0.14	0.10
Bacillariophyta	3.05	1.75	14.50	4.10	0.97	0.53	0.20	0.20	2.66	0.40	0.40	1.00	3.98	0.98	0.30	0.40
Chlorophyta	0.04	NR	0.20	0.10	NR	NR	NR	NR	NR	0.01	0.25	0.01	0.09	0.37	NR	NR
Xanthophyta	0.04	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Euglenophyta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	NR	NR	NR	0.10
Total	3.20	1.75	17.50	5.20	1.22	0.58	0.30	0.25	2.76	0.45	0.95	1.61	4.18	1.48	0.44	0.60

Planktonic algae groups recorded in the investigated observation sites of the Hrazdan River were the followings: Bacillariophyta, Chlorophyta, Cyanophyta and Xanthophyta in the observation site no. 1, Bacillariophyta and Cyanophyta in the observation site no. 2, Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta in the observation site no. 4 and 5. No obvious regularity in monthly phytoplankton dynamics in the Hrazdan River sites located upstream from the reservoir (no. 1 and 2) was registered, and phytoplankton growth in these river sites was probably affected by natural and non-permanent anthropogenic factors. It's necessary to mention that in June, a significant increase in the quantitative parameters of green algae was registered in the observation site no. 5, which is explained by the impact of "Yerevanyan Lich" Reservoir. An increase in the abundance and biomass of green algae wasn't expressed in the observation site no. 4, because the river velocity in this site increased (due to water let out from "Yerevanyan Lich" Reservoir), and most of phytoplanktonic organisms were moved by the water flow (Tabs. 1, 2).

Table 3

Thermal regime in the Hrazdan River and "Yerevanyan Lich" Reservoir waters

Sampling site number	Water temperature, °*C*			
	Apr	Jun	Jul	Aug
1	13.1	16.8	19.8	14.5
2	16.2	18.9	20.3	18.2
3	19.6	25.9	27.6	26.2
4	13.9	18.8	21.0	18.5
5	15.0	19.8	21.8	20.1

It's known that blue-green algae grow well at high temperature conditions [19]. Despite decreased water temperature in August, the quantitative parameters of blue-green algae in the river observation site no. 4 increased significantly, which is explained not only by the direct impact of the rapid growth of blue-green algae in "Yerevanyan Lich" Reservoir, but also increased river organic matter and nutrient level caused by the reservoir algae bloom (Tabs. 1–3). In August the significantly increased quantitative parameters of diatom algae in this river site was mainly registered on account of the species *Fragilaria crotonensis* (88 cells/*mL*, 0.25 *mg*/*L*), which is also explained by the impact of "Yerevanyan Lich" Reservoir, where this species reached massive growth in July (18625 cells/*mL*, 52.15 *mg*/*L*) and August (252.5 cells/*mL*, 0.71 *mg*/*L*) (Tabs. 1, 2). In July and August, the appearance of the representatives of the group Euglenophyta in the river observation site no. 4 and 5 and "Yerevanyan Lich" Reservoir (observation site no. 3) is explained by increased organic matter level caused by the reservoir algae bloom as this group generally abundant in waters rich in organic matters (Fig. 2, Tabs. 1, 2) [20].

Conclusion. The results of the study have confirmed the opinion that algal bloom in "Yerevanyan Lich" Reservoir occurs every year in summer period. Algal blooms registered in "Yerevanyan Lich" Reservoir in summer 2015 caused water quality loss in the reservoir, which in turn led to significant shift in quantitatively dominant complex of reservoir phytoplankton (green algae–diatom algae–blue-green and green algae) and resulted in the increased growth and appearance of phytoplankton organic pollution indicator species not only in the reservoir, but also the Hrazdan River sites located downstream from the reservoir.

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REFERENCES

1. Chilingaryan L.A., Mnacakanyan B.P., Aghababyan K.A., Toqmajyan H.V. *Hydrography of Armenian Rivers and Lakes*. Yer., AgroPress (2002), 49 p. (in Armenian).

2. Stepanyan L.G., Hambaryan L.R., Hovhanisyan R.O. The Dynamics of Phytoplankton Community in Lake Yerevan. *Annals of Agrarian Science*, **9** : 4 (2011), 65–67 (in Russian).
3. Stepanyan L.G., Hambaryan L.R., Hovhannesyan R.H., Miqaelyan A.L. Investigation of Phytoplankton Community in "Yerevanyan Lich" Reservoir in the Period of Algal Bloom in 2003 and 2005. *Biological Journal of Armenia*, **58** : 1–2 (2006), 158–160 (in Russian).
4. Stepanyan L. Investigations of the Seasonal Dynamics of Phytoplankton Community and Hydrochemical Parameters in "Yerevanyan Lich" Reservoir. *Science and Technology*, **11** (2005), 13–16 (in Armenian).
5. Nwabueze A.A. Health Implications of Harmful Algal Blooms in Tank Culture of Catfish. *Agriculture and Biology Journal of North America*, **2** : 1 (2011), 56–60.
6. Zhi X.R.Ch., Yun Zh. Impact Assessment of Climate Change on Algal Blooms by a Parametric Modeling Study in Han River. *Journal of Resources and Ecology*, **3** : 3 (2012), 209–219.
7. Kamatchi S.N., Kumar S.S. Simulation of Algal Bloom Detection System Using Modified ABR Algorithm. *International Journal of Innovative Research in Computer and Communication Engineering*, **3** : 3 (2015), 1885–1892.
8. Borrione I., Schlitzer R. Distribution and Recurrence of Phytoplankton Blooms around South Georgia, Southern Ocean. *Biogeosciences*, **10** : 1 (2013), 217–231.
9. Lee S.O., Kim S., Kim M., Lim K.J., Jung Y. The Effect of Hydraulic Characteristics on Algal Bloom in an Artificial Seawater Canal: A Case Study in Songdo City, South Korea. *Water*, **6** : 2 (2014), 399–413.
10. Sellner K.G., Doucette G.J., Kirkpatrick G.J. Harmful Algal Blooms: Causes, Impacts and Detection. *Journal of Industrial Microbiology and Biotechnology*, **30** : 7 (2003), 383–406.
11. Shukla J.B., Misra A.K., Chandra P. Modeling and Analysis of the Algal Bloom in a Lake Caused by Discharge of Nutrients. *Applied Mathematics and Computation*, **196** : 2 (2008), 782–790.
12. Abakumov V.A. (ed.). *Guide on the Hydrobiological Monitoring of Freshwater Ecosystems*. St. Petersburg, Gidrometeoizdat (1992), 320 p. (in Russian).
13. Kiselev I.A., Zinova A.D., Kursanov L.I. *Determinant of Lower Plants*. *V. 2*: *Algae*. M., Sovetskaya Nauka (1953), 312 p. (in Russian).
14. Linne von Berg K-H., Hoef-Emden K., Melkonian M. *Der Kosmos-Algenführer*: *Die Wichtigsten Süßwasseralgen im Mikroskop*. Kosmos (2012), 368 p.
15. Proshkina-Lavrenko A.I. *Plankton Algae of the Caspian Sea*. Leningrad, Nauka (1968), 290 p. (in Russian).
16. Streble H., Krauter D. *Das Leben im Wassertropfen*. Stuttgard, Kosmos (2001), 415 p.
17. Tsarenko P.M. *Short Guidebook of the Chlorococcal Algae of the Ukrainian SSR*. Kiev, Naukova Dumka (1990), 208 p. (in Russian).
18. Barinova S.S., Medvedeva L.A., Anissimova O.V. *Diversity of Algal Indicators in Environmental Assessment*. Tel Aviv, Pilies Studio (2006), 498 p. (in Russian).
19. Paerl H.W., Huisma J. Blooms Like it Hot. *Science*, **320** : 5872 (2008), 57–58.
20. Kumar A., Bohra C., Singh L.K. *Environment, Pollution and Management*. New Delhi, A.P.H. Publishing Corporation (2003), 604 p.