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The publication includes the proceedings of International Scientific Forum «Achievements of Academic Science in the South of Russia», International Youth Scientific Conference «Oceanology in the XXI Century: Contemporary Facts, Models, Methods, and Means» in Memory of Corresponding-Member RAS D.G. Matishov, and All-Russian Scientific Conference «Aquaculture: World Practices and Russian Developments», which took place during the period of 13 – 16 December 2017 and were devoted to the 15-year Anniversary of the Southern Scientific Centre RAS.

The results, obtained by the leading researchers of scientific organizations of the South of Russia, young scientists, students and PhD-students when implementing basic and applied studies within the priority spheres of science aiming at ensuring the provision of integrated solutions of technological, engineering, ecological, geopolitical, economic, social, humanitarian problems for and in the interests of sustainable development of the southern regions of the Russian Federation, are presented.

The proceedings of scientific events aim at a wide range of readers, and may be of interest to researchers, universities teachers, PhD-students, students of higher educational establishments, as well as the ones interested in the achievements of modern science.

The publication has been financially supported by the Federal Agency for Scientific Organizations.

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REVEALING DIFFERENT TYPES OF WATER POLLUTION OF LAKE SEVAN BASIN RIVER MOUTHS AND LITTORAL ZONE BY GENOTOXIC AND HYDROBIOLOGICAL METHODS

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Introduction. As it known, Lake Sevan is one the biggest high-altitude freshwater reservoirs in the world, and the biggest one in South Caucasus region. It has huge strategic and economic importance for Armenia due to its unique water and bioresources. On the other hand it experiences serious ecological problems as a result of mismanagement of its resources. Besides anthropogenic pressure, water quality of its tributaries and littoral zone is not the same due to geologic and geomorphic features of watershed. As a result of differences in factors influencing on water quality, different types of pollution are possible. Thus, there is a strong demand in implementation of complex studies of water quality.

Even though different scientists carried out separate genotoxic [Simonyan et al., 2016; Avalyan et al., 2017] and hydrobiological studies [Даллакян, Асатрян, 2012; Епремян, 2011; Экология, 2010; Asatryan, Dallakyan et al., 2017] of water quality of Lake Sevan tributaries, but it's a first attempt to combine genotoxic and bioindication methods to reveal the different types of water pollution in the coastal zone. Current study based on complex assessment of differences in water toxicity by crayfish and *Tradescantia* clone 02 plant as well as organic pollution by benthic macroinvertebrates.

Material and method. The studies were carried out during 2015–2017. For revealing genotoxic effects of water 7 sampling sites were chosen, and for revealing the rates of organic pollution the structure of benthic macroinvertebrates of rivermouth parts of 5 permanent rivers were studied (fig. 1). Sampling sites has been chosen from almost all parts of Lake Sevan which also allows comparing the spatial differences in pollution types.

The assessment of genotoxic effects were realized through revealing the level of DNA damage on haemocytes of crayfish (*Astacus leptodactylus* Eschscholtz, 1823) by Comet assay(single cell gel electrophoresis) in vivo method [Tice, Agurell et al., 2000;] as well as by revealing thefrequency of pink and white mutation events (PME and WME) in stamen hairs of *Tradescantia* (clone 02) plant species [Ma, Cabrera et al., 1994a, b]. The percent of DNA-tail was used to quantify the DNA-damage of crayfish.

Comparison of DNA damage results from samples of different stations has been realized by Multiple Range Test and the differences of mutation events has been analyzed by Student t-test usingStatgraphics Centurion 16.2 (StatPoint Technologies, Inc. USA; Warrenton, VA) software.

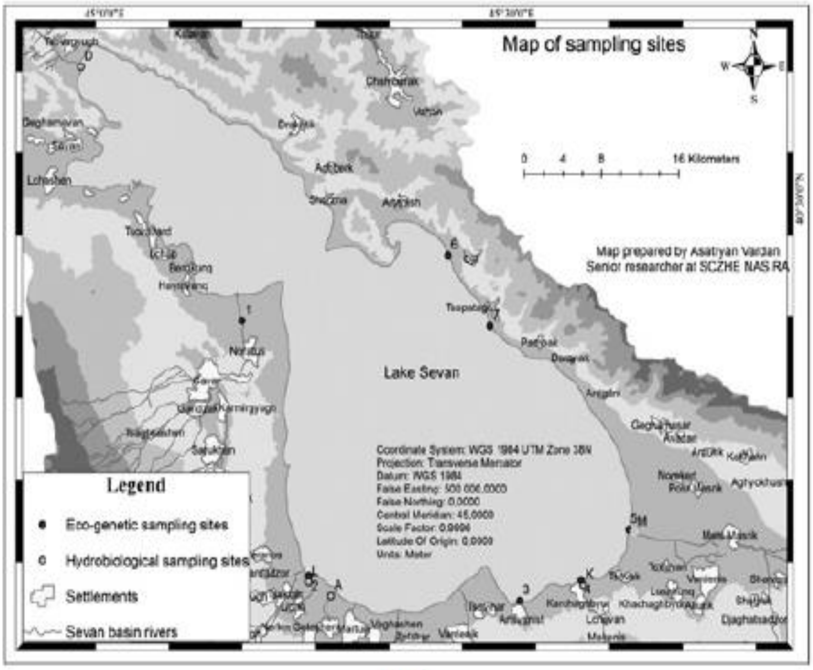

Fig. 1

Map of sampling sites (1 – Noratus; 2 – Lichq; 3 – Martuni; 4 – Karchaghbyur;
5 – Masrik; 6 – Artanish; 7 – Tsapatagh; A – Argichi; D – Dzknaget; K – Karchaghbyur; L – Lichq; M – Masrik)

Samples of benthic macroinvertebrates were collected and laboratory processed by standard hydrobiologic methods [Manual, 2002]. For the assessment of differences in organic pollution of water two widely used biotic indices – Biological Monitoring Working Party (BMWP) and Average Score Per Taxon (ASPT) were used [Семенченко, Разлуцкий, 2010]. Pinder & Farr, analyzing the sensitivity of BMWP and ASPT indices, concluded, that this combination is the best system of bioindication [Pinder, Farr, 1987]. Map of sampling sites were created by ArcGIS 10.1 software.

Results and Discussion. Based on the results of assessment of crayfish DNA damage levels, chosen sampling sites can be distributed by their pollution rates in the following order: Karchakhbyur<Lichq<Masrik<Noratus<Artanish<Martuni<Tsapatagh (Fig. 2):

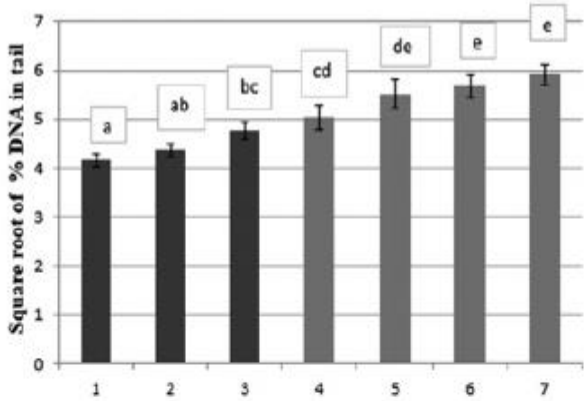

Fig. 2

Mean of squre root of % DNA in tail measured in hemocytes of crayfishes from different sampling sites (1 – Karchaghbyur; 2 – Lichq, 3 – Masrik, 4 – Noratus, 5 – Artanish, 6 – Martuni, 7 – Tsapatagh). Values are shown as mean ± SE. There are significant differences ($p < 0{,}001$) between the varieties are marked on bars with different letters

Compared with reference (distilled water) statistically reliable rise of frequencies of PMEhas been observed on plants which were treated by water from Noratus, Lichq, Martuni and Tsapatagh stations. The rise of frequencies of WME has been observed at all treated plants (tab. 1).

Table 1

GENOTOXIC EFFECTS OF WATER SAMPLES FROM CHOSEN STATIONS IN THE SOMATIC CELLS OF *TRADESCANTIA* (CLONE 02) PLANT
(* – p < 0,05, ** – p < 0,01, * – p < 0,001)**

Samplingsite	Somatic mutations	
	(PME/1000) ± m	(WME/1000) ± m
Artanish	0,8 ± 0,31*	12,6 ± 1,2***
Karchaghbyur	0,7 ± 0,28*	9,6 ± 1,0***
Noratus	1,8 ± 0,44**	10,8 ± 1,1***
Masrik	0,7 ± 0,29*	13,1 ± 1,2***
Tsapatagh	1,2 ± 0,29**	15,1 ± 0,65***
Lichq	1,6 ± 0,34**	16,0 ± 1,1***
Martuni	1,2 ± 0,29**	9,4 ± 0,82***
Reference	0,4 ± 0,27	3,6 ± 0,67

Thus, according to eco-genetic studies higher genotoxic effects are revealed in Noratus, Martuni and Tsapatagh sampling sites, meanwhile, the less effect was registered in Karchakhbyur sampling site.

Due to lack of water treatment plants in the basin of Lake Sevan, all tributaries experiencing the domestic and agricultural wastewater impact, which lead to organic pollution. Rivermouth parts are the most representative for revealing the ecological state of the water which inflows into the Lake. Based on determination of benthic macroinvertebrates up to family levels water qualities of chosen rivermouth parts have been assessed. The results of assessment of water quality by BMWP index shows that studied parts can be distributed by the level of organic pollution in following order: Argichi<Dzknaget<Masrik<Karchakhbyur<Lichq (tab. 1). The values of Argichi, Dzknaget and Masrik rivers are corresponding to "good" water quality, and the values of Karchakhbyur and Lichq – to "Not high", which is in one category lower. Taking into consideration seasonal changes of the values of BMWP, we can state that the only river which water quality never reaches "good" status is Lichq. The differences in BMWP score among 4 rivermouth parts is small and taking into consideration seasonal variations it's more preferable to say that their pollution rate is almost equal.

Table 2

WATER QUALITY ASSESSMENT RESULTS BY BMWP AND ASPT INDICES

Sampling site	BMWP score	ASPT value
D	63	4,2
M	53	4,4
L	35	3,5
K	49	4,45
A	69	4,3

The order of rivermouth parts of studied rivers based on ASPT index is slightly different: Karchakhbyur<Masrik<Argichi<Dzknaget<Lichq. At the same time ASPT index proves that Lichq river water quality is lower than the others by one category, which means that it more polluted. Even though water quality of Dzknaget, Masrik, Karchakhbyur and Argichi rivers mainly corresponds to "good" quality, but some organic pollution is exist.

Conclusion. Comparisons of the results have shown that eastern (Tsapatagh) and western parts (Noratus) as well as adjacent to Arpa-Sevan tunnel (Martuni) of Lake Sevan littoral zone are more exposed to the influence of pollutants. Some level of organic pollution has been revealed in all sampling sites, but the south-west part is under higher level of organic pressure which can also be the result of denser vegetation coverage. Also it's been shown that parallel use of genotoxic and bioindication methods can become a good technique for biomonitoring.

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