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ABSTRACT BOOK

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The 3rd International Symposium of Benthological Society of Asia is held in Vladivostok, Russia, from 24 to 27 August 2016, then from 27 to 31 August 2016 is continuing as The First International Youth Freshwater Ecology School. Various aspects of freshwater and marine biodiversity, biology and ecology problems are in the focus of the Symposium papers. Special attention has been paid to conservation of waters in the urban and wildlife areas of Asian region. Water quality and transboundary water ecosystem monitoring and control are considered at the international point of view as well as questions of ecological education and involving of public to water resources protection. The future international cooperation in different branches of benthological fundamental and applied sciences is discussed.

The book will be interesting for specialists in biology, ecology and biogeography, for practical workers, students and public deal with the water ecosystems protection, monitoring and control.

Co-Conveners: Academician of RAS Yu.N. Zhuravlev,
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(VP21) ECOLOGICAL CRISIS IN THE COASTAL ZONE OF LAKE BAIKAL (EAST SIBERIA): SHORT DESCRIPTION AND REASONING

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Interdisciplinary investigations of Baikal shallow waters have been performed in 2001–2016. Special attention is paid to the splash zone (SZ) since 2010. SZ of the most Eurasian lakes, as an above-water part of the coastal zone, remains "terra incognita" and has significant value in terms of both: fundamental and practical sciences. Meanwhile, it become conventionally accepted that SZ provides most accurate evidence of immediate ecosystem's response to the current anthropogenic pressure. The term "splash zone" is commonly used by marine biologists in intertidal zonation, denoting a part of the littoral zone subject to water splashes. A similar zone with a variety of environmental gradients, defined by abiotic factors also exists on Baikal extending from the water's edge to the slope foot. It is ca. 2000 km long, the lower margin of the SZ extending 10–30 meters landwards and back as a result of the water level rise. Investigation of the SZ as a significant constituent of the lake ecosystem sets a new trend for limnological studies on Baikal and large Eurasian lakes (Timoshkin *et al.*, 2011). Intense microbiological and biogeochemical processes have been described in this ecotone (Timoshkin *et al.*, 2012 a, b), which functions as a natural buffer and filtrating zone. The following main results were obtained at the first time: classification, seasonal dynamics of the qualitative and quantitative characteristics of the coastal accumulated materials (CAM) and their benthonic infauna (*ab. cit.*), landscape-ecological zonation of the test site (Potyomkina *et al.*, 2012; Levasheva *et al.*, 2012); microbiological, hydrochemical and biogeochemical characteristics of the interstitial pore waters of the SZ and near bottom waters of coastal zone (*ob. cit.*, Tomberg *et al.*, 2012; Kulikova *et al.*, 2012); seasonal dynamics of algae, meio- and macrozoobenthos of the pore waters of SZ (Bondarenko *et al.*, 2012; Popova *et al.*, 2012; Zvereva *et al.*, 2012; Sheveleva *et al.*, 2013); elemental composition of dominant species of Baikal sponges, water lichens, macrophytes, gastropods and trichopterans (Kulikova *et al.*, 2007; 2009; 20011; 2012; Paradina *et al.*, 2011; 2012 *etc.*).

Several negative ecological phenomena have been detected in Baikal coastal zone:

1. Significant changes in the macrophyte belt composition, development and stratification were described (Kravtsova *et al.*, 2011; 2014; Timoshkin *et al.*, 2014; 2015; 2016). In 2013–2015, a mass bloom of *Spirogyra* was detected with maximum biomass in autumn in the shallow water zone throughout much of the lake[1]: Baikalsk, Slyudyanka, Kultuk towns; along the Old Baikalian Rail Way; Listvyanichnoe, Obuteikha, Bolshye Koty, Peschanaya, Babushka Bays; Goloustnoe settlement (South Baikal); some areas of Maloe more Strait; Maksimikha Bay (Middle Baikal); Nizhneangarsk, Severobaikalsk towns; Ayaya, Senogda, Onokochanskaya and Boguchanskaya Bays (North Baikal). Also in 2014, the mass development of *Spirogyra* was noted on Ol'khon Island at two localities (*i.e.*, the ferry harbor

[1] It is easier to indicate areas where the alga was not found: Bol'shoi Ushkani Island, most of the coastline of Ol'khon Isl. (except for Perevoznaya Bay and a coast opposite Khuzhir), and the northwestern coast that stretches from Elokhin Cape to Maloe More Strait.

in Perevoznaya Bay and Shamanka Bay opposite the town of Khuzhir on Ol'khon Island). By 2015, mass growth of *Spirogyra* was reported at several new localities along the west coast of South Baikal (Emelyanikha, Sennaya Bays and a coast opposite Polovinnyi Cape) as well as Maloe More Strait (*i.e.*, coastal zone off Sakhyurte Settlement and Kargante Bay). In summary, *Spirogyra* spp. developed massively and even dominated the benthic macroalgal community along much of the eastern coast, and in many places along the western coast of Lake Baikal. Interestingly, the maximum development of *Spirogyra* – a comparatively thermophilic algae (optimal temperature for growth is *ca.* 20 °C), was detected during autumn (September–October) with water temperatures ranging within 4–8 °C. Two of sites (*i.e.*, Listvennichnyi Bay in south basin and Tyya–Senogda coast in north basin) investigated to date were characterized by year-round mass blooms of *Spirogyra* spp. which sometimes include other filamentous algal species (such as *Oedogonium* sp., *etc.*) that previously were non typical for open parts of Lake Baikal. Mass development of *Spirogyra* has also been detected since May–June 2016 in the littoral opposite of Baikalsk City (at 3–6 m depths) and several wooden harbors (Khuzhir, Bolshye Koty settlements). It means, that the number of areas with the all-the-year round *Spirogyra* spp. mass development is gradually increasing. The *Spirogyra* morphotype, which has simple cell walls, 4 chloroplasts in the beginning of the filament vegetation (later on they became homogeneously distributed within the algal cell), attached to the rocks by rhizoids, has been dominating in these areas of the lake's rocky littoral within 2013–2016. As a rule, this morphotype of *Spirogyra* has patchy distribution in the coastal zone (especially sharply expressed along to the western and Olkhon Island coasts), the blooms are mostly concentrated opposite of the settlements and recreation centers (without any sewage water purification systems).

Spirogyra blooms underwent drastic day and night variations of the near bottom temperature (for example, from 8 to 17.3 °C, HOBO logger data, measured every 30 mins within August 2015, Bolshye Koty Bay, at 3 m depth; Timoshkin, unpublished). At the 3 areas mentioned above the alga proliferates even under very low winter (around 0^0C at the depths of 2–7 m) and comparatively low permanent temperatures at the depths below 20 m (*ca.* 3.4 °C). According to Prof. M. Shimaraev (pers. comm.) the surface water temperature at 5 monitoring stations have negative tendency within the last 13-year long cycle (*i.e.*, since 1995–2000). It clearly evidences, that the temperature shall not be considered as the key factor, limiting the *Spirogyra* mass development in Lake Baikal.

Rosgidromet data show (www.lin.irk.ru), that the lowest water level (455.27 m) was detected in 1981. No any crisis consequences, such as mass proliferation of non-typical algae or the mass Lubomirskiid sponge extinction were found. Afterwards the Lake's water level fluctuated within the limits (456–457 m) determined by Russian Government Regulation No 234. In conclusion, neither global warming nor the cases of the comparatively low water level provide us any arguments to consider them as the key factors, influencing mass *Spirogyra* development in Baikal coastal zone. Moreover, the minor, but permanently entering the coastal zone nutrient additions from non-purified sewages provide possibility to overcame the depths of 20 (North Baikal) or even 30 (South Baikal – I.V. Khanaev, pers. comm.) meters! The alga should be considered as a perfect indicator of the sewage water contamination in oligotrophic ecosystems such as Baikal.

2. Giant amounts of the coastal accumulated material, mostly consisting of algal detritus, has been detected in the north and south tops of the Lake and opposite of Maksimikha settlement (Barguzin Bay). Several blooms represented by non-typical for the lake's ecosystem filamentous algae of *Spirogyra* genus. Intensive development of macrophytes in Maksimikha Bay was due to *Cladophora* sp. (*glomerata*?) (*ca.* 50 % of the total wet biomass), Characeae,

Elodea and other higher water plants. The strongest blooming of *Spirogyra* was found in the Northern Basin, opposite of Severobaikalsk city. Wet biomass of this algal CAM in the autumn of 2013 reached up to 90 kg/m^2. All mentioned regions belong to the near-shore settlements or bays – natural harbors for numerous vessels. The blooms shall be considered as the clear evidence of "indirect" eutrophication in many particular regions of the coastal zone. Evidently, the natural buffer and filtrating ability of Baikal's SZ is limited. Abundant amount of nutrients can reach the interstitial and near-bottom water layers through the ground of the SZ and cause the blooms. The distribution pattern of the fecal indicating bacteria (see below) strongly support this supposition and can be used as good sewage tracers. Due to the huge size of the lake and permanent intense water-wind activity (mixing) high nutrient concentrations often can not be detected by commonly accepted hydrochemical analyses in the surface and near-bottom water layers.

3. Increase of the typical Baikalian macroalgae productivity in some areas of the shallow water zone. According to the world literature, it should be considered as the first symptom of the eutrophication.

4. Mass development of the «saprophytic» (proliferating on sponges and died macrophytes, see below) and «free-living» blue-greens in several areas of the lake. Significant amount of the Oscillatoriales filaments have been first found by the author in the drudge benthonic samples, taken from 10–15 m depth, southern of Peschanaya Bay (South Baikal), in summer of 2013 and 2014. In 2015–2016 their mass blooming found as well in the shallows of Bolshye Koty, Barguzin bays, *etc.* (*Phormidium, Oscillatoria, Tolypothrix* spp. and others). Most unusual is the mass penetration of the *Tolypothrix, Oscillatoria* and other cyanoprocaryote spp. into the first algal belt, usually created by green filamentous alga *Ulothrix zonata*. In September 2015 the blue-greens abundantly developed on the shore line rocks and nearby at Bolshye Koty. Abundant *Tolypothrix* colonies were observed there already in the end of June 2016.The «saprophytic» representatives of *Phormidium* and *Oscillatoria* genera, dwelling in Baikal, are not able to fix the atmospheric nitrogen. Their development is limited by nitrogen. This limitation does not exist near the dying sponges macrophytes. Their destroying bodies extract abundant nutrients (=special type of eutrophication!) (I.V. Tomberg, O.A. Timoshkin, unpublished), which can be easily utilized by the «saprophytic» blue-greens what provides possibility for their mass proliferation. *Vice versa*, the most evident reason of "free-living" blue-green proliferation (which are able to fix N) is "indirect eutrophication" first of all due to enrichment by non-organic phosphorus.According to O.I. Belykh (pers. comm.), both types of the cyanoprocaryotes are able to produce different toxins (including saxitoxins). Such abundant blooming of Oscillatoriales in general and within the first algal belt in particular has never been detected in the lake before.

5. Mass Gastropoda extinction (mostly – representatives of *Lymnaea* genus) is described in 2013–2014: billions of the died shells found on the sandy beaches between Tyya River and Senogda Bay at the north top of Baikal. These "cemeteries" are located along the areas of the most abundant *Spirogyra* development and influenced by sewages from Severobaikalsk City. Less abundant *Lymnaea* shell accumulations found along the splash zone, off Maximikha settlement in Barguzin Bay (June 2015).

6. Mass extinction and several kinds of diseases of endemic Lubomirskiidae sponges at the scale of the entire lake were described in 2013–2014 (Bormotov, 2011; Timoshkin *et al.*, 2014; 2015). All 3 ecological forms of the sponges (branched, encrusting, globular) can be sick. Over than 50 dives performed in 2014, 40 – in 2015. Depending on area, from 30 to 100% of branched *Lubomirskia baikalensis* specimens were found to be either sick or damaged and died. According to Dr. Ch. Boedecker (pers. comm.), in most of the studied areas of South

basin (September 2014) the sick sponges were mostly found at the depths above 15–20 m. However, deeper leaving sick specimens of the branched sponges were found already in June 2015. It was described, that the most distributed sponge illness is accompanied by mass development of the "saprophytic" blue-greens of *Phormidium* genus (Timoshkin *et al.*, 2014; 2015). Their filaments are comparatively large, cherry-red and mobile. Light-microscopic analysis evidences, that each affection patch on the sponge surface consists of 1–2 dominating blue-green species (90–95 %). Different deformations and damages of the external surface of the sponge body (=beginning stages of its extinction) in most cases (50–80 %) happen prior to the mass blue-green development. According to preliminary data, the branched sponges, dwelling in the South Basin (Listvyanichny, Bolshye Koty Bays, off Chernaya River mouth) are most of all affected by illness. For example, almost 100 % of *Lubomirskia baikalensis* specimens, dwelling off Chernaya River mouth along the standard bottom transect (South Baikal, 1 m wide and 10 m long; 3–12 m deep) were either damaged, or thick and died (A.B. Kupchinsky, S. Aurich, pers. comm.). Much less damaged or even healthy *L. baikalensis* specimens were found in September 2014 around the north-western coast; area, approximately located between Elokhin Cape and Bolshye Olkhonskye Vorota. To my mind, the most probable reason of the Lubomirskiidae mass extinction is the physiological abnormalities in the relations between the sponge endosymbionts (such as green *Zoochlorella*) and the tissues. Some precise processes and nutrient exchange mechanisms between algal symbionts and the sponge cells, elaborated during the long coevolution and coexistence in the oligotrophic waters, may be easily broken due to miserable but permanent addition of the sewage nutrients. It may cause the destruction of the sponge bodies, which has been detected so frequently. Analogous processes, causing the mass death of another sedentary Metazoan group – corals (which as well coexist with endosymbiotic blue-green algae), also inhabiting oligotrophic ecosystem of the ocean, are happen due to miserable but permanent eutrophication process (Yamamuro *et al.*, 2003; Bell *et al.*, 2014).

7. High concentrations of the fecal indicating bacteria have been determined in the surface and near-the-bottom water layers along the coasts opposite the settlements. The same is true for the interstitial waters (especially – under the coastal accumulated algae) of the splash zone. For example, the enterococci concentrations often exceed 2000 colony forming units per 100 ml (V.V. Malnik, pers. comm.). The governmental schemes of the limnological monitoring of the deep large lakes of the planet are often not effective due to "superconcentration" of the efforts exclusively on the pelagial. In order to detect, understand and properly describe the anthropogenic changes of the ecosystems at the full scale we have to include the monitoring of the coastal zone (the splash and near-shore zones including) and, especially – of the benthonic communities. As distinct of planktonic communities, the precise investigations and monitoring of zoobenthos is almost "extinct direction" in limnological surveys of many countries.

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Key words: *monitoring of the coastal zone, macrophytes, freshwater algae, invertebrates, seasonal dynamic, anthropogenic pressure*