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The Book of abstracts contains materials from the 13th International Conference on Salt Lake Research (ICSLR2017) "Saline Lakes in a Changing World: Ecology, Economics, Nature Management".

The conference Book of Abstracts presents summary of oral and poster talks from scientists studying the formation, evolution, biodiversity, socio-economic use, history, current state and future of world's salt lakes.

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WELCOME FROM ORGANIZING COMMITTEE

It is great pleasure for us to welcome participants of the 13th International Conference on Salt Lake Research. Conferences of International Society for Salt Lake Research are held triennially. This year several Siberian academic research institutes, part of the Siberian Branch of Russian Academy of Sciences, and Buryat State University host the conference in the city of Ulan-Ude, Republic of Buryatia, Russia. As usual, our aim is to provide an opportunity for networking amongst researchers who are globally dispersed.

The city of Ulan-Ude, the capital of Republic of Buryatia, is located in a very specific area. It is trans Baikal territory. The largest in the world freshwater lake is located just 100 km to the north from the city. Somebody may argue that Lake Baikal somehow not belongs to saline lakes. However, there is no borders in science. We believe that many research questions related to aquatic habitats and ecosystems are common. It is strange that studies of freshwater and saline lakes are partially separated. This division is evident when we check programs of limnological or lake conferences. However many fields of science nowadays converge and look for new cross-disciplinary discoveries. We decided that the slogan of our conference would be "Studies of saline and freshwater lakes: In search for a common ground". We are sure that focus not only on traditional topics such as chemistry, biology of physics of saline lakes but also on comparative studies of freshwater and saline lakes will bring new ideas and future fruitful projects.

This time we pay special attention to young scientists. Several funding opportunities were provided to participate in the conference. Traditionally, Bill Williams award will honor best oral and poster presentations by students. There was strong competition between young scientists that applied for travel grants. Award for the best paper on saline lake research was also established. The winners of the award will not only get the prize but also will be honored with an opportunity to present plenary lecture.

Diverse scientific program will be accompanied by pre, mid and post conference field trips to local salt lakes, lake Baikal and natural landscapes. It is great opportunity to get fascinating insights, find new friends and colleagues.

Welcome to the city of Ulan-Ude! Enjoy science and nature of saline and freshwater lakes!

Egor Zadereev, Vice-president of the International Society for Salt Lake Research, leading research scientists at the Institute of Biophysics SB RAS (Krasnoyarsk)

Leonid Ubugunov, the Chairman of the Local Organizing committee, the Head of the Institute of General and Experimental Biology SB RAS (Ulan-Ude)

COMPARATIVE STUDIES OF SALINE AND FRESHWATER LAKES

THE PAST AND FUTURE OF THE BIOLOGICAL RESOURCES OF THE CASPIAN AND THE ARAL SEAS

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The Caspian Sea is the largest lake. It is not a homogeneous lake. Three different water bodies are united within its borders. The distinct differences in physical conditions of them result in distinct differences in biodiversity and biological resources. The northern water body has the richest fauna and flora. It's ensued by the Middle and Southern Caspian, and the lowest biodiversity is observed in the gulf Kara-Bogaz-Gol. However, the overall picture of life distribution in the Caspian won't be full if we do not take into consideration inhabitants of the deltas of the Caspian rivers. Various plants and animals inhabit estuaries of these rivers. The real biodiversity and biological resources of the Caspian Sea is made up of that of all water bodies, including deltas and their wetlands. Practically all inhabitants of the Caspian can be called invaders. However, nowadays they are considered to be indigenous, since most of them have invaded the Caspian millions years ago.

There are number of threats to biological diversity and biological resources of the Caspian Sea. Negative impact of the following factors on inhabitants of the Caspian was analyzed in details: river flow control, poaching, water level fluctuations, pollution, exotic species and climate changes. Oil pollution and recent invasion of the comb-jelly can seriously damage the biological diversity and biological resources of the sea. These effects can be both long-term (chronic) and acute (short-term).

There is a fear that the Caspian Sea, famous for its sturgeon stocks amounting to 90 % the world stocks, can soon loose these highly valuable commercial stocks.

The Aral Sea was the fourth largest lake in the world before 1960. However, it is now four separate water bodies, fed mainly by collector-drainage waters because of excessive upstream irrigation water withdrawals from the two main influent rivers, the Syr Darya and Amu Darya, which is clearly shown on satellite images. The resulting rapid increase in salinity has caused a dramatic decrease in the lake biodiversity and biological resources and loss of a once thriving fishery. Only a small part of the indigenous biota has survived.

The regression of the Aral Sea also has had profound socioeconomic and human impacts on the lake riparian populations. Accordingly, it is encouraging to note the reversal of the degradation of the Northern (Small) Aral Sea after the erection of a dike at Berg's Strait in 1992. This first dike was washed out in 1999, but was replaced with the new structurally-sound Kok-Aral dam in 2004-2005. The water level in the Northern Aral has increased several meters and its salinity has returned to levels that can sustain the pre-1960 ecosystem. The biodiversity also has been somewhat rehabilitated, and the commercial fisheries have revived.

The remnants of the hyperhaline Southern (Large) Aral continue their retreat and salinization. The Large Aral contains no fish species, and almost all the invertebrate species have been lost. The only biological resource here in hyperhaline environment is brine shrimp (*Artemia*), and its eggs are harvested now.

To restore the Aral Sea to its former state would be very difficult, if not impossible, in the foreseeable future. However, a partial restoration of its separate parts is possible. Plans for further rehabilitation of the Small Sea and possible restoration of some parts of the Southern (Large) Aral Sea are discussed.

SPATIAL DIFFERENTIATION OF SALINE SOILS IN LAKESIDE DEPRESSIONS OF THE STEPPE ZONE

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Mineral lakes influence direct on the soil cover of lakeside depressions in the steppe zone. Soil is the least studied part of the halomorphic system. Soil analysis of lakeside landscapes on the example of the Orongoy depression (Buryatia) revealed the soil heterogeneity from the coastline to the top of the local watersheds. Water mineralization of the lake Beloye – 2,3 g/l, pH 9.1-9.5. The source of water is close-lying mineralized ground waters and atmospheric precipitation. Conjugated series of soils from the underdeveloped layered-alluvial saline soils of the primary trunk of soil formation to automorphic chestnut quasi-gley alkaline soils of the accumulative-carbonate department of the post-lithogenic trunk are developed. The lake-accumulative stage of soil formation in accumulative and transit-accumulative landscapes is manifested by polycyclic varieties of soils of the primary stages of pedogenic process (layered-alluvial and chestnut quasi-gley soils) in the presence of salinization and gleying. In the soil profiles of trans-accumulative landscapes, the two-part structure is clearly manifested, associated with automorphic and hydromorphic pedogenic stages. In the saline soils of the coastal zone the type of soil chemistry correspondent to the chemical composition of lake water. On the automorphic eluvial positions soil profile has pronounced zonal features of steppe soil formation with no lake influence. Soils, located on different relief elements, and representing various landscapes, are different in morphology, salt content, texture, and physicochemical indicators. There is micro-ring zoning of the soil cover in the lake depressions due to gradual decrease of ground water level from the center to the periphery.

STRUCTURE ALTERATIONS OF BACTERIAL COMMUNITIES IN SODA AND FRESHWATER RESERVOIRS

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Bacterial communities in aquatic ecosystems often comprise a great number of species. The diversity and abundance depend on the geography and geochemistry of the reservoirs. Commonly a few species are abundant in the ecosystem, whereas most species are present in a small number. High-throughput sequencing of bacterial 16S rRNA genes enables the detection and description of new rare bacterial taxa in aquatic environments (Rinke et al., 2013). Recent studies indicated that rare and abundant bacterial taxa may respond differently to ecological conditions and showed different biogeographical patterns (Logares et al. 2014; Liu et al. 2015). Abundant bacterial taxa are actively growing in aquatic habitats, whereas many rare taxa are dormant or inactive (Epstein 2009; Lennon, Jones 2011). On the other hand, bacterial communities are described with "core" and "specific" taxa. Both abundant and rare bacteria might be included in core microbiome of aquatic ecosystem. The differences between bacterial communities of soda (Lake Doroninskoe), mineral (cold and mineral seeps, Sayan Mountains) and freshwater (Baikal and Gusinoe lakes) reservoirs have been investigated by high-throughput sequencing of bacterial 16S rRNA genes and bioinformatics analysis.

Among wide spread bacterial phyla *Actinobacteria*, *Bacteroidetes*, *Cyanobacteria*, *Firmicutes*, *Proteobacteria*, and *Verrucomicrobia* were detected in abundance >1 % in all reservoirs. Correlation between phyla depended on water temperature and mineralization. *Proteobacteria* and *Bacteroidetes* were dominant and might be included in "core" microbiome of aquatic ecosystems. The distribution of *Actinobacteria, Firmicutes*, and *Verrucomicrobia* correlated with geochemistry of the reservoirs and their composition included both "core" and "specific" taxa. *Cyanobacteria* were more specific for soda and mineral reservoirs, and found only in photic zone of freshwater ones. The number of OTUs, and diversity indexes ACE, Chao1, and Shannon indicated the highest abundance and species richness in deep water bacterial communities of Lake Baikal. Surface layers of Lake Baikal as well as others reservoirs showed equitable diversity of bacterial species. On the OTUs' level, the differences between reservoirs clearly distinguished three type of aquatic ecosystems: freshwater, soda lake, and mineral springs with UPGMA dendrogram, heatmaps, and PCA plots. OTUs effected to the communities shift belonged to the phyla *Actinobacteria, Cyanobacteria, Firmicutes*, and *Verrucomicrobia*.

Our results agree with microbial ecology concept that few sequence-abundant bacterial types are globally dispersed and displayed positive range-abundance relationships. Most bacterial populations are rare, specific to ecosystem and might exhibit a high degree of endemism, explaining the substantial differences in community composition observed over large spatial scales.

DEFINITION REVIEW OF SODA LAKES AND PANS BY ASSESSMENT OF LARGE SCALE CHEMICAL DATA SERIES IN EURASIA

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The soda lake in the majority of scientific investigations define as a saline lake containing sodium carbonate/bicarbonate (HCO_3 and CO_3) fraction among the dominant salts in solution, what is also corresponds with the high alkalinity of the water. Consequently, the alkaline term in most cases applies as an analogue to soda lake definition. However, the term 'alkaline' is often established based on the pH values that lead to extensive confusion about the exact classification of water chemical types. In spite of the fact that soda lakes and pans can be found all over the World, this is much less frequent type of saline solutions, which high alkalinity create a unique and extreme aquatic environment for trace elements accumulation and organisms. On the basis of the foregoing, the main aim of this presentation is to suggest the exact objective chemical definition of soda type lakes/pans and to demonstrate the possible role of pH values in that classification. The studied lakes and pans were selected from the different geographical regions of arid and semi-arid zones in Eurasia (Anatolia, Carpathian Basin, Central Asia, Inner Mongolia, Siberia, Tibet), where soda lakes/pans are significantly distributed along with the other (primarily sodium chloride and sulphate) types of saline lakes. The major ion composition (Na, K, Ca, Mg, Cl, SO_4, HCO_3 and CO_3), salinity (TDS) and pH were examined on a large-scale data series from a great number of saline lakes and pans (N=230) with salinity more than 1.0 g L–1 located in Eurasia (Austria, China, Hungary, Kazakhstan, Mongolia, Russia, Serbia, Turkey). The study is based on authors' measurements and published data in the period of 1947–2016. The chemical type of the lakes were classified by the dominant ions method, taking into account 25 equivalent percent threshold (>25e %). Nevertheless, authors also applied the 'soda index' for the soda type characteristic: $C(HCO_3)+C(CO_3)/C(Ca)+C(Mg)>1$ [Valyashko, 1962], there C(ion) is an equivalent mass form of ions. Based on the dominant ion technique (>25e %), 132 lakes/pans (57 %) were classified as soda type. The other lakes were categorized to different types, mainly to sodium chloride and sulphate. The 'soda index' provided a little different results (142 soda lakes/pans, 62 %) than dominant ion technique. However, there were four lakes with more than 40e % of Ca+Mg, which were also classified as soda lakes by dominant ion technique, but not by 'soda index'. Obtained results suggest that both dominant ion method and 'soda index' have to be applied in the assessment for the correct classification of soda saline lakes/pans. Summarizing, the authors suggest the following definition of soda chemical type lakes/pans: Characteristic 1. Na >25e %, 2. HCO_3+CO_3>25e %, 3. 'soda index' > 1. Intermediate 1. Na >25e % 2. Ca+Mg >25e %, 3. HCO_3+CO_3>25e %, 4. 'soda index'

ORGANIC CHEMISTRY OF CHAROPHYTES FROM FRESHWATER AND SALINE LAKES

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We have examined the low molecular-weight compounds within the thalli of *Chara australis* and the thalli and oospores of *Lamprothamnium* cf *succinctum*. There are major biochemical differences between the two genera, perhaps owing to their adaptation to different environments, namely water salinity. While *Chara* is largely from freshwater, our *Lamprothamnium* samples come from a lake with seawater-like chemistry and salinity of 20 per mil.

Organic matter was freeze-dried and Soxhlet-extracted with dichloromethane (DCM):methanol 7.5:1 for 24 h, then separated by silica-gel column chromatography to produce five fractions (or compound classes) that concentrated, sequentially, (F1) n-alkanes, (F2) branched alkanes, (F3) n-alkanols and sterols, (F4) n-alkanoic acids, and (F5) higher molecular-weight compounds. These fractions were analysed by gas chromatography with a flame-ionisation detector (GC-FID) for their constituent compounds.

The n-alkanes from *C. australis* (two localities) have a flat pattern across sequential carbon numbers (C9 to C32) with an isolated higher peak at C17. By contrast, the n-alkanes from *Lamprothamnium* (analysed in triplicate), across the same range of C numbers, have a pronounced broad peak within C23 to C32, with a maximum at C26. The n-alkanols from *Chara* have a maximum abundance at C14, with those from *Lamprothamnium* having a maximum at C16. n-alkanoic acids (or fatty acids) also show differences, with *Chara* demonstrating a maximum abundance at C10 and *Lamprothamnium* at C18. The compound chemistry of the thalli and oospores from *Lamprothamnium* are very similar. The same five extracted fractions were also analysed by gas chromatography-mass spectrometry (GC-MS) to identify higher molecular-weight compounds.

Thus, the low molecular-weight compounds within the thalli of *Chara* show a surprising chemistry that spans the range normally attributed to all marine and terrestrial higher plants. *Lamprothamnium*, by contrast, has a chemistry that aligns with previously, although sparsely, described submerged and floating-leaf aquatic plants. It should be noted that there has been no previous detailed description of the organic chemistry of any charophyte species, either from saline or freshwater lacustrine environments.

MICROBIAL COMMUNITY COMPOSITION OF LAKE BAIKAL COASTAL WATER

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The purpose of the work is to estimate the microbial community composition of Lake Baikal in the coastal zone using new generation sequencing and to study the temperature effect on the microbial community composition under the experimental conditions. Microbial communities of coastal water in three points of the eastern coast of Lake Baikal in different seasons were studied. DNA was isolated using the AxyPrep Bacterial Genomic DNA Miniprep Kit (Axygen, USA). Deep sequencing of V3-V4 16S rRNA amplicons was carried out at the Genomics Center of the SB RAS on the MiSeq (Illumina) platform. The composition of the microbial community of coastal water in three points was similar. Phylums *Bacteroidetes* (average 39 %) and *Proteobacteria* (average 43%) dominated. The microbial community near Turka in April differed sharply from other samples. Percentage of phylum *Firmicutes* increased (50%). Sequences belonging to the genus *Prevotella*, which had a sanitary and epidemiological significance, dominated. Most likely, there was a local anthropogenic pollution associated with the construction of recreational facilities. Thus, microbial community composition of Baikal coastal water was constant, and its sharp detected changes, can be used as an indicator of anthropogenic pollution. Under the experimental conditions, the effect of temperature changes and the addition of organic substances on the microbial community composition was studied. The temperature changes had virtually no effect on the composition of the microbial community. The addition of organic substances stimulated the growth of bacteria and changed of the community composition.

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EFFECT OF INCREASING SALINITY GRADIENT ON THE ZOOPLANKTON STRUCTURE AND FUNCTION: EVIDENCE FROM A STUDY OF 24 LAKES IN NORTH-WEST CHINA

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Salinity is an important environmental driver that represents a physiological constrain to organisms, while decreasing species richness and diversity, it might impoverish communities function and reduce ecosystem resilience. We analyzed changes in zooplankton community structure and function in 24 lakes along a wide salinity gradient (from 0.5 to 115 g L^{-1}) in a semi-arid region in north-west China, in the Ulungur Lake area (from 47˚40´ to 46˚30´ N and 86˚50´ to 88˚20´ E). We hypothesized that zooplankton species richness (S), species diversity (H) and functional diversity (FD) decrease with increasing salinity because only tolerant species would cope the salinity rise, and that zooplankton size and biomass would also decrease due to physiological constraints. Salinity (g L^{-1}) as well as other environmental variables were measured in situ and chemical variables Total nitrogen (TN), total dissolved nitrogen (TDN), total phosphorus (TP), total dissolved phosphorus (TDP), nitrate (NO_3^-), ammonium (NH_4^+), nitrite (NO_2^-) and orthophosphate (PO_4^{3-}) was analysed in laboratory. To calculate fish density and biomass, fishing was undertaken using gillnets with seven mesh sizes located perpendicular to the littoral zones. Zooplankton sampling was performed in the pelagic and in the littoral region to obtain an integrated and representative sample of each lake. For the functional characterization, the different zooplankton taxa were divided into different groups based on several traits such as their feeding strategies, predator avoidance and growth. Rotifers were separated into raptorials and microphagous. Cladocerans and copepods were classified into filtering Ctenopoda, filtering Anomopoda, selective filter feeders, filtering scrapers, microphagous herbivores and microphagous carnivores. From these 8 functional groups, a Functional Diversity index (FD) was calculated for each lake. A total of 70 (1-27 per lake) zooplankton taxa were identified within the groups Rotifera (52 taxa), Cladocera (12 taxa) and Copepoda (6 taxa). The diversity index (Shannon-Wiener) ranged between 0.11 and 2.26 at a salinity level of 21 g L^{-1} and 2.1 g L^{-1}, respectively. S and H decreased with increasing salinity while zooplankton sizes, size range and biomasses did not. The size of the copepods and cladocerans were mainly regulated by the abundance of small fish in lakes with salinity values below 14 g L^{-1}. Above this threshold, large and more saline-tolerant microcrustacean species are favored due to the absence of fish predation. Rotifer sizes depended on different environmental factors other than salinity. The abundance of small fish, fish size diversity and temperature shaped the sizes of microphagous rotifer. Despite salinity did not alter zooplankton sizes, FD decreased with salinity. The clear differentiation between functional groups (FG) along the studied gradient suggests that FD can be not only a good indicator for salinity increasing levels but also a suitable approach for ecological studies.

TEMPORAL AND SPATIAL ENVIRONMENTAL VARIATION OF THE SELENGA DELTA WETLANDS

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Selenga river originates in the Khanghai Mountains in Mongolia and flows into Lake Baikal in Buryat Republic in Russia, contributing more than 50% to the lake's total inflow (Chalov 2014). Delta of the Selenga river is home to numerous threatened and endemic species of flora and fauna and is a conservation site of international significance protected under Ramsar convention.

Despite high conservational value of the Selenga river and its delta, Selenga river basin has been subjected to high levels of pollution mainly due to such pressures as mining, industrial and agricultural activity (Fernandez-Gimenez 1999, Stubblefield 2005). As a result, the basin is considered to be among the most impacted areas with regard to heavy metal pollution in the world (Thorslund et al., 2012). In addition, increased concentrations of pesticides, toxic and persistent organic pollutants, oil products, nutrients, and sediments have been recorded in the Selenga river in recent years (Chalov 2014, Stubblefield et al 2005).

Current study aims to reconstruct environmental conditions of the Selenga Delta wetlands during 20th and 21st century as well as to access the extent of present anthropogenic impact on wetlands of the Selenga Delta. The research is based on the analysis of the ostracod assemblages from contemporary and core sediments retrieved from the Selenga Delta.

Ostracods are microscopic crustacea, with the body fully enclosed by a bivalved carapace. Single ostracod species are sensitive to physical and chemical parameters of the habitat, and respond to changes in the environmental conditions by changes in the assemblage composition. At the same time, ostracod carapace, made of low magnesium-calcite is frequently well preserved in the sediment. These features make ostracod assemblages composition analysis a powerful tool for reconstructing past environments, as well as for accessing modern state of aquatic habitats. The method has been successfully applied for studies of the past environments of saline, as well as freshwater habitats and it is mounting importance for studies of human impact on aquatic systems in conservation research (Holmes and Chivas 2002, Pieri 2012, Mezquita et al. 1999).

Within the framework of the study 15 contemporary surface sediment samples and 31 core samples, obtained from the core at 2 cm interval were analysed, using low-power binocular microscope. Species were identified based on valve morphology following descriptions provided by Meisch (2000) and Fuhrmann (2013). Species-environment relations, as well as spatial and temporal changes in the ostracod communities were investigated using statistical methods, particularly DCA, RDA and Monte-Carlo test. All ordinations and Monte Carlo test were performed in CANOCO 4.5 (ter Braak and Smilauer 2002).

Overall 7826 ostracod valves belonging to more than 20 species of 4 families were retrieved from the samples. No significant variation among the studied lakes in terms of contemporary ostracod assemblage composition was found. Most common species of the modern assemblage were ubiquitous ostracods *P. kraepelini* and *C. cf. ovum*, together making up 67 % of the total adult population. Ostracod communities of the Selenga Delta underwent significant changes, with two major shifts occurring throughout the studied period. Overall, compared to modern assemblage, past assemblages are characterized by more poly-dominant community with higher proportion of mesotrophic species. Prevalence of the two very tolerant taxa *C.cf ovum* and P. *kraepelini* in the contemporary assemblage may result from deterioration of environmental conditions in the Delta, while higher percentage of mesotrophic taxa in the past may indicate lower, compared to present, trophy status of the wetlands. (Külköylüoğlu 2007, Iglikowska and Namiotko 2012). At the same time, presence of viable population of some clearly rare taxa with narrow tolerance ranges is indicative of generally good water quality in the Delta.

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ENVIRONMENTAL MANAGEMENT OF MUGLA PROVINCE'S FRESHWATER LAKES

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Freshwater lakes are important ecologically special ecosystems and have many significant roles such as arranging water regime of the region, enabling characteristic plant and animal groups to live and forming a great source economically, culturally, scientificically and rescreationally. Recently, in settlement areas in Turkey, similar to many other parts of the world, the fresh water systems and natural structures of the sea, especially the ones under the pressure of various organic and inorganic pollutants, are being deformed and these regions which are quite prodictive in terms of fishery products are getting infertile because of the population growth, industrialization, intense agricultural activities and agricultural malpractices. Besides the most environmentally-sensitive areas in Turkey are the well known with their tourism potentials. Mugla Province, with its rich historical, natural and cultural resources, has always been a prominent source of attraction all over the world, due to the abundance of natural fresh waters lakes, salt lakes, antique cities, endemic flora and fauna. This study covers the effects of environmental activities, problems and their solutions the freshwater lakes resources in the Mugla Province.

INFLUENCE OF GEOCHEMICAL CONDITIONS ON THE STRUCTURE AND ACTIVITY OF METHANOGENIC MICROBIAL COMMUNITIES: A CASE STUDY OF THE BOTTOM SEDIMENTS FROM THE METHANE SEEP POSOLSK BANK

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Analysis of the heat flow anomalies, seismic and hydroacoustic studies, carbon isotopic composition of the gas discharged in seeps of the Posolsk fault indicated an inflow of deep fluids (Klerkx et al., 2006; Naudts et al., 2012). The inflow of highly mineralized fluids is considered to cause anomalously high concentrations of some ions in pore waters and influence the formation of microbial communities. For this reason, we have studied under the low-temperature experimental conditions the formation processes of hydrocarbon gases by a microbial community from the bottom sediments (BS) of the methane seep Posolsk Bank different in lithological structure and chemical composition of pore waters. BS were sampled during three years and differed by: (I) the reducing conditions starting from the surface, absence of an oxidized layer, the high acetate ion content (up to 22.35 mg/L); (II) the presence of the 0–10 cm oxidized layer, the acetate ion content less than 3.61 mg/L, the lack of gas hydrates; (III) presence of the 0–10 cm oxidized layer, gas saturation, and the absence of acetate ions.

In enrichment cultures containing BS (I), the culturing of the microbial community from a depth of 55 cm on a medium with CH3COONa and H_2:CO_2 = 6.15:4.51 showed the highest methane concentration. With the sediment depth, the influence of an acetate on the methane generation was less significant; the methane concentration increased due to the activity of hydrogenotrophic archaea. In the surface sediment layers, the methane concentration did not exceed 0.002 mmol/L.

Enrichment cultures with BS (II) and (III) had maximum methane concentrations in surface sediments at depths of 50–80 cm. Acetoclastic methagenesis path prevailed throughout the core (II), while in enrichment cultures with BS (III) hydrogenotrophic methagenesis path prevailed. Notably, the initial presence of acetate ion in the studied sediments, as well as its addition as a substrate in enrichment cultures could not always influence significantly on the methane generation under the experimental conditions. Probably, it can be explained by the dominance of the hydrogenotrophic methanogenic archaea in the studied communities. According to the phylogenetic analysis of 16S rRNA gene libraries of Archaea from “hydrogenotrophic” and “acetoclastic” enrichment cultures, the sequences identified were homologous to the representatives of the archaeal genera *Methanocella* and *Methanobacterium*, either obligatory or facultatively using acetate as a carbon source. Acetoclastic methanogenic archaea were not found. The methane generation in enrichment cultures mainly in the authotrophic way completely corresponds to the isotopy data indicating that in BS from the deep zone of Lake Baikal 75–100 % of methane was generated autotrophically (Namsaraev and Zemskaya, 2000).

Under the experimental conditions, we registered not only generation of methane, but also ethane. Enrichment cultures from the microbial community of the layer close to gas hydrates incubated with CO_2 as a substrate showed the highest concentration of ethane (up to 26.8 vol. %). In these enrichment cultures, we identified the members of the orders *Methanococcales*, *Methanosarcinales*, and *Thermoplasmatales*, as well as the phylum *Bathyarchaeota*.

This work was performed within the framework of the state task No 0345–2016–0007 and supported by the Russian Foundation for Basic Research grant № 16-04-00181.

A MEROMICTIC FRESHWATER LAKE SVETLOE (ARKHANGELSK REGION, RUSSIA) AS AN ILLUSTRATION OFMODERN CONCEPTS OF THE METHANE CYCLE MICROORGANISMS

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Biogenic methane is produced by methanogenic archaea as the terminal stage of organic matter decomposition in anoxic environments. Methane may be oxidized by methanotrophic microorganisms under both oxic and anoxic conditions. Methanotrophs act as a biofilter preventing methane emission from various sources into the atmosphere. Meromictic lakes with stable physicochemical stratification of the water column, which contains the aerobic and anaerobic zones with the chemocline, a redox zone at the interface, are convenient models for investigation of the processes and microorganisms of the methane cycle. Complex microbial communities containing photo-, chemo-, and heterotrophic microorganisms are formed as layers within the water column. Their highest abundance and diversity occur in the chemocline zone. Since sulfate content is low in freshwater meromictic lakes, methanogenesis is the major terminal process of anaerobic decomposition of organic matter. For the same reason, the contribution of sulfate-dependent methanotrophic archaea of the ANME clusters to anaerobic methane oxidation is insignificant. In the absence of sulfate, anaerobic methane oxidation may be carried out by nitrate- and nitrite-dependent methanotrophic archaea and bacteria Candidatus "*Methanoperedens nitroreducens*" and Ca. "*Methylomirabilis oxyfera*," respectively, or by metal-dependent methanotrophs in the presence of Fe(III), Mn(IV), or Cr(VI)). We investigated the methane cycle microorganisms in a meromictic freshwater Lake Svetloe (Arkhangelsk region, Russia) with the depth of 39 m, average water temperature below 8 m ~4°C, and the chemocline at 20–24 m. Sulfate and sulfide concentrations in the water column varied from 2 to 50 μM and from 04 to 2.1 μM, respectively; methane concentration increased from 230 μM in the chemocline to 960 μM in the near-bottom horizon. Molecular genetic analysis of the composition of microbial communities at different depths was carried out using pyrosequencing of the 16S rRNA gene fragments. Low rates of hydrogenotrophic methanogenesis and predominance of methanogenic archaea of the family *Methanosaetaceae* indicated the prevalence of aceticlastic methanogenesis in the lake. The 16S rRNA gene sequences of sulfate- and nitrate-dependent archaea of the ANME clusters and of nitrite-dependent bacteria Ca. "*Methylomirabilis oxyfera*" were not found. Iron-dependent anaerobic methane oxidation was not revealed by incubation experiments. Since the rates of anaerobic methane oxidation in the monimolimnion were low, a contribution of "trace" methane oxidation by methanogenic archaea against the background of methanogenesis is possible. Methane was mostly oxidized aerobically, with the highest methane oxidation rate at the low chemocline layer (23 m). Methanotrophic aerobic gammaproteobacteria of the genus *Methylobacter* predominated in the chemocline methanotrophic community. While type I methanotrophic gammaproteobacteria predominated in aerobic (at 16-18 % O_2) and microaerobic (at 1.5-2 % O_2) enrichment cultures, they differed in morphology. Moreover, incubation experiments with 14C-methane revealed light-dependent methane oxidation in the chemocline water samples. According to the proposed mechanism of this process, light-dependent methane oxidation in anaerobic environments occurs in biofilms containing oxygenic phototrophic bacteria (cyanobacteria) and aerobic methanotrophs, which develop in close contact under conditions of oxygen limitation and low illumination. Cyanobacteria (*Synechococcus* sp. and *Oscillatoria* sp.) predominated in the chemocline zone, where they constituted 27 % of the total microbial number.

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DETECTION OF STRAINS INVOLVED IN NITROGEN CYCLE IN THE CULTIVATED MICROBIAL COMMUNITY OF LAKE BAIKAL BIOFILMS

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Nitrogen is one of the main biogenic elements. The quantity of nitrogen-containing compounds affects the overall productivity of a water body and its water quality. Microorganisms play a leading role in the nitrogen cycle. It is known that in natural ecosystems more than 95-99 % of bacteria form biofilm associations. The nitrogen cycle consists of a number of processes. The most important processes are fixation of atmospheric nitrogen (nitrogen fixation), sequential oxidation of ammonia to nitrites and nitrates (nitrification), and reduction of oxidized nitrogen to gaseous form (denitrification). The study of nitrogen cycle and its individual links is of interest because of the increasing anthropogenic pressure on the ecosystem of Lake Baikal. The aim of this work is to determine the ability of heterotrophic bacteria isolated from biofilms formed on solid substrates in the littoral zone of Lake Baikal to nitrogen fixation, nitrification and denitrification. We studied the collection of heterotrophic microorganisms kept at the Laboratory of Aquatic Microbiology consisting of 108 cultures described and identified on the basis of 16S rRNA gene determination. We used selective media to detect microorganism ability in using various nitrogen compounds. Eshbi medium was used to detect nitrogen fixers. The ability to denitrify was determined using the Giltay liquid medium. At the end of the experiment, we registered accumulation of gas in the float, turbidity and the presence of nitrites in the medium (with the aid of the Griss reagent). The capacity of strains to heterotrophic nitrification was detected on a specialized medium [GOST R 54653- 2011]. The results obtained showed the growth of 67 % cultures on Eshbi's medium which indicates their belonging to oligonitrophiles. The highest growth intensity was recorded in 39 % strains belonging to the genera *Bacillus*, *Pseudomonas*, *Paenibacillus*, *Flavobacterium*, *Massilia*, *Frigoribacterium*, *Rhizobium*, *Yersinia*, *Kocuria*, *Rhodococcus*, and *Serratia*. They are likely attributed to nitrogen fixators. It is known that in addition to autotrophic nitrifiers, there are heterotrophic bacteria that are able to convert reduced nitrogen compounds to final products - nitrites and nitrates without receiving energy. They include bacteria of the genera *Pseudomonas*, *Arthrobacter*, *Flavobacterium*, etc. occurring in many types of natural waters. The possibility to fulfill the first phase of nitrification (oxidation of NH_4^+ to NO_2^-) was detected in 24 % cultures. The most active were three strains represented by the genera *Bacillus*, *Paenibacillus*, and *Kocuria*. Only 9 % of the cultures studied (representatives of the genus *Pseudomonas*) were capable of denitrification. They reduce nitrates to gaseous nitrogen compounds. The ability to reduce nitrate only to nitrite (nitrate respiration) was detected in 39 % strains. This process is the initial stage of denitrification since the product of this reaction is a substrate for further reduction reactions. Thus, the study conducted on the cultivated microbial community of biofilms show the presence of microorganisms that actively participate in the nitrogen cycle in Lake Baikal: nitrogen fixers, nitrifiers and denitrifiers.

This work was carried out within the framework of the budgetary theme 0345-2016-0003 "Microbial and viral communities in biofilms of freshwater ecosystems: taxonomic diversity, features of functioning and biotechnological potential".

STRUCTURAL ADAPTATIONS IN SOME POLYEXTREMOPHILIC OXIDOREDUCTASES

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Biochemical processes in organisms thriving in “extreme environments” have generated great interest; however, at this time the basic of structural adaptations in polyextremophilic proteins is not fully understood. So the aim of this work is focused on molecular mechanisms of adaptation of some oxidoreductases (octaheme nitrite reductases (ONR) and short-chain alcohol dehydrogenases (SDR)) in extremophiles. These mechanisms are especially attractive because they can be applied to the construction of synthetic proteins with high activity and stability at specified conditions, useful for many industrial and biotechnological applications. The comparison of the amino acid composition of proteins from polyextremophilic and nonpolyextremophilic organisms revealed an increase in the Glu, Arg, Phe, Val, Trp content and a decrease in the Lys content for haloalkaliphilic ONRs [1], and an increase in the Glu, Arg, Leu and decrease in the Ile, Thr for hyperthermophilic halophilic SDRs, compared to nonpolyextremophilic proteins [2]. Apart from changes in the amino acid composition of poliextremophilic proteins compared to non-poliextremophilic, structural adaptation associated with distribution of different amino acid residues in the structure plays an important role. The most crucial structural locations are solvent-accessible surface, intersubunit contacts, and protein core. Using structural analysis we found: an increase in the number of arginine and glutamate residues and a decrease in the number of lysine residues on the protein surface in poliextremophilic proteins compared to non-poliextremophilic (Fig.1); an increase in the area of intersubunit hydrophobic contacts for poliextremophilic proteins; an increase in the core in the number of residues with bulky hydrophobic side groups. Molecular dynamics of hyperthermophilic SDRs (hthSDRs) adapted to different thermal environments revealed the thermally stable and thermally sensitive regions at different temperatures (300 K and 358 K). The comparison of RMSFs of the residues in hthSDRs at 300 K and 358 K revealed an existence of stable residues at 358 K. These residues form the Nucleus of Rigidity in hthSDRs, which is surrounding the active center. Molecular dynamic simulations of hthSDRs at different temperatures revealed new salt bridges networks at 358 K, which is formed by excess charged residues and connected all subunits. Thus, abundance of charged residues pays an important role in stabilization of the poliextremophilic proteins. An improved capacity to predict protein stability may be useful for selecting the best candidates for protein crystallography, the development of protein-based therapeutics. All simulations were performed using the facilities of the Supercomputer Centers "Lomonosov" [3] and "Arian Kuzmin" (NEFU, Yakutsk, Russia).

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DETERMINATION AND DISTRIBUTION OF SULFUR IN THE SEDIMENTS

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Sulfur is mainly found in nature in the form of sulfides, sulfates and elemental substances, and excessive amounts of sulfides can cause negligible damage to the human environment. The classical methods for sulfide analysis are spectrophotometry, ion chromatography, ion selective electrode method, infrared absorption spectrometry and iodine method and so on. These methods have their own advantages, but because of their good stability, simple and quick operation and little sample consumption, iodimetry is still a common method at present. In this paper, the iodimetry was adopted for analyzing of the three sulfur species of ES, AVS, MPS in sediment of freshwater River, and the vertical distributions of sulfur species in sediment were demonstrated. Through experiments, it is found that the sulfur content of sediments in Jintang is low, and the average values are ES, 0.058 m/g, AVS, 0.044 mg/g, MPS and 0.056 mg/g. The content of the three is ES>MPS>AVS. The change of ES content was not obvious with the increasing of depth, but the content of ES in the upper sediment fluctuated slightly, among which the peak value appeared at -2 cm, the content was 0.162 mg/g. The change of AVS content is not obvious with the increase of depth, the maximum value is 0.094 mg/g at the interface, and the overall trend is gentl. With the increasing of depth, the distribution trend of MPS content was from high to low, with an average value of 0.056 mg/g. The maximum is 0.163 mg/g. Except for a mutation point at -10 cm, the rest of the site is gently moving.

DISTRIBUTION OF ABUNDANCE AND DIVERSITY OF BACTERIA IN FRESHWATER GUSINOYE LAKE (BURYATIA, RUSSIA)

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Lake Gusinoe is the largest freshwater oligotrophic reservoir in Buryatia. The lake waters use industrially, fishery, rescreationally, and as the source of drinking water. One of the main polluters of the lake is the Gusinoozerskaya thermal power plant. The lake waterbody is used as a reservoir-cooler, and the lake is exposed to thermal stress. Bacteria plays an important role in the functioning of freshwater lakes, participating in production and destruction processes and is used an indicator of changes in the ecosystem of the lake, including anthropogenic.

The purpose of this study is to determine the abundance and diversity of bacterioplankton in different parts of Lake Gusinoye. The total number of bacteria was 0.1-2.5 million cells/ml. The abundance increased at 4 stations of anthropogenic influence: near the discharge of warm waters of the thermal power plant, near the mouth of the Zagustay River where there is a discharge of sewage household water, near the mouth of the Teli River, and near the railway station Barati. In seasonal dynamics, the abundance increase in May during the spring peak of phytoplankton growth. Metagenomic analysis of the microbial community showed a predominance of representatives of the phylum *Cyanobacteria* (average 28 %), *Actinobacteria* (average 28 %), *Proteobacteria* (average 22 %), *Firmicutes* (average 9 %), and *Bacteroidetes* (7 %). Near the mouth of the Teli River a high number of the representatives of the phylum *Cyanobacteria* (60 %) was found. It may indicate intensive production processes in the near-mouth area of rivers. The composition of phylums at the station of discharge of warm waters of Gusinoozerskaya thermal power plant did not differ from compositions at other stations. The diversity index of Chao1 varied from 50 to 260, increased in the autumn period compared to summer, and was less than the index of diversity of bacterioplankton in Lake Baikal. Thus, in the place of thermal contamination (discharge of thermal power plant) and in the ice-free discharge channel there are no significant differences from the lake's water area in abundance and diversity of water bacteria. The number of microorganisms in the discharge channel was comparable with the number in the mouth areas. Perhaps in the discharge channel a “barrier zone” characterized by the increase of the number and activity of microorganisms is formed as in the mouths of rivers.

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MICROBIAL POLLUTION OF THE MONGOLIAN AQUATIC ECOSYSTEM

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Aquatic ecosystem of Mongolia can be seen as the following problems which affect significantly the quantity and quality of water resources: impact of global climate change, overexploitation of water resources, diffuse pollution, mining, water supply and waste water treatment in rural and urban areas, protection of ecological functions and nature conservation. Stockholder and agriculturist residences in rural areas with water systems that are not adequately regulated, monitored, and updated could have drinking water that poses a health risk. The purpose of this study is to investigate water quality on Kharaa, Orkhon, Khovd, Buyant, Onon Rivers and the Lake Ugii; water and biofilm samples were collected from 69 sampling sites all together, which influenced through livestock, mining industrial and agricultural activities.

Number of heterotrophic bacteria (CFU) of Ugii Lake water was determined by the spread plates method using meat-peptone agar medium. Water samples were collected in September, the greatest total number of bacteria was found ($2.7x10^4$ cells/ml), and the lowest number 0.11×10^4 cells/ml. Total coliform bacteria had lower values, usually ranging from 0.2×10^2 to 4.3×10^2 cells per 100 ml Ugii Lake water. The current study were isolated a total of 33 isolates from Ugii Lake water samples collected. Presence of *Lysinibacillus sphaericus* (95 %), *Elizabethkingia meningoseptica* (94 %), *Kocuria rhizophila* (94 %) species were detected by semiautomatic test VITEK®2.

The result of PCR amplification of Ugii Lake and stool samples from cow, ship and horse was shown that microbial populations of Ugii Lake were similar in samples collected form the lakeshore and lake center. And, microbial population composition from the lake intake stands apart from all other lake water samples. From the microbial population comparison, cow feces may be the major contamination sources in Ugii Lake. And, at least 15 common bacterial OTUs were found from all water and fecal samples and some of them were host-specific species. It is possible that lake water has been affected by all three types of feces.

In the Onon River water, the total numbers of microorganisms were ranged between 0.2×10^2 to 0.8×10^2 cells/ml. Twenty three isolates were isolated from Onon River water. Pathogenic bacteria such as *Brevudimonas dininita* (97 %), *Pseudomonas fluorescens* (99 %), *Serratia liquefaciens* (99 %) and *Granulicatella elegans* (97 %) were detected by semiautomatic test VITEK®2.

Estimates for the total number of microbes on the river Orkhon, Khovd and Buyant were usually around 3×10^4 cells/ml, 1.7×10^4 cells/ml and 1.4×10^4 cells/ml respectively. Coliform bacteria were detected in rivers water 182 cfu/100 ml, 280 cfu/100 ml and 264 cfu/100 ml.

For the Kharaa River, *E. coli* and coliforms were enumerated from water samples by Membrane filter (MF) techniques using Endo agar and some pathogenic were enriched using Meat peptone broth (MPB) and selective medium. Twelve isolates were selected randomly from MPB, purified and were preserved on Nutrient agar for further studies. The susceptibility of pathogenic isolates to various antibioticswas tested by the disk diffusion method. The following antibiotics discs were used: Gentamicin (10µg/ml), Erythromycin (30µg/ml), Cefazolin (30µg/ml), Ciprofloxacin (30µg/ml), Oxacillin (10µg/ml),

Benzilpenicilline Natrium (6µg/ml), Tetracycline (30µg/ml), Fortum (30µg/ml), Nystatin (15µg/ml), Claforan (30µg/ml) and Chloramphenicol (15µg/ml).

Total of 219 bacterial pure cultures (*Staphylococcus* spp. n = 53, *Escherichia coli* n = 18, *Salmonella* spp. n = 64, *Clostridium* spp. n = 40 and *Streptococcus* spp. n =44) were isolated from Kharaa river and tributaries. *Staphylococcus* spp. isolates of the samples of summer were exhibited the lowest percentage of antibiotic resistance (9.1 %), followed by *Streptococcus* spp. (36.4 %), *Escherichia coli* (54.5 %) and *Staphylococcus* spp. isolates of the samples of Spring and *Streptococcus* spp. of Summer samples (63.6 %). On the other hand, *Clostridium* spp. showed evidence of highest percentage of antibiotic resistance (100 %). The sizes of inhibition zone of the antibiotics of the isolated microorganisms were ranged between 11-58 mm. More than 70 % of the bacteria were sensitive to Benzilpenicillinenatrium, Gentamicin, fortum, Cefazolin, Chloramphenicol, Erythromycin, Tetracycline, Claforan, Oxacillin, Ciprofloxacin and Nystatin. Conversely, the highest resistance rate of 72.2 % was recorded against Benzilpenicilline natrium.

The multiple antibiotic resistance values of the present study indicated that the isolated bacteria received high risk exposure to the tested antibiotics. Therefore, we may conclude that Kharaa River were contaminated with antibiotic residues.

The significant microbial counts were obtained for lake and river's water which raises major human and environmental health concerns. The effectiveness of current monitoring and clean-up by respective authorities and district municipalities should be revised to include techniques which accurately reflect the contamination levels of the aquatic systems.

This study was performed in the laboratory of Microbial Ecology and Biotechnology at National University of Mongolia and in the Laboratory of Microbiology at Graduate Institute of Environmental Engineering, National Taiwan University, Taipei, Taiwan.

ECOLOGICAL PASSPORTIZATION OF ARTIFICIAL WATER RESOURCES OF KALMYKIA

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The waters of almost all the reservoirs of Kalmykia are now salty and highly saline. Average long-term values of salinity of water in reservoirs range from 1.7 to 10.5 g/l. The annual water demand of the republic is 800 million m^3, of which only 50 million m^3 can be provided by own water sources. The deficit, which is constantly being tested by the Republic's water sector, is covered by water supply from adjacent territories. As a result, the majority of Kalmykia's water bodies exist on the drawn stock. The monitoring carried out by the staff of the Institute for Complex Studies of Arid Territories since 2001 includes obtaining during the year various indicators: hydrological (level and area of the reservoir), hydrochemical (mineralization, type of chemical), ecological composition of limnophilous avifauna, hydrobiological state of water bodies, ecotone functioning System "water-land" on the coast. Within the framework of the multi-year monitoring, a detailed geodatabase has been created, which includes information from ground-based field studies and laboratory data, analysis of space survey materials, based on the application of GIS technologies. The database was created as a basis for the development of a standard environmental passport for a water body as a new form of targeted monitoring that monitors and assesses the state and use of water and biological resources of a particular water body and its impact zone on the coast. The structure of the created ecological passports consists of three sections: 1) the ecological cadastre; 2) infrastructure of reservoirs; 3) information on permits (licenses) for nature use and nature protection activities (if any). The key objects of monitoring and certification are water reservoirs that are most significant in the republic's water sector and located in different landscape areas: the Tsagan-Nur, Deed-Khulsun and Krasinsky reservoirs (the Caspian lowland); Chogray reservoir, Manych-Gudilo reservoir and Sostinsky reservoirs (Kumo-Manych depression); Reservoir Arshan-Zelmen (Ergeninskaya upland). Creation of eco-passports of water objects was carried out according to the developed and proven method of complex geo-ecological assessment of artificial reservoirs and ecotone zones "water-land" for arid territories. Field studies included topoecological instrumental profiling of ecotone (adjoining reservoirs) territories, accompanied by the establishment of key areas and sampling for study: the mineralization of surface waters; Structure and salt regime of soils; Species composition, abundance, projective coverage of plant communities; The depth and mineralization of groundwater. Field research was conducted in the spring and autumn periods (April-May, September-October). The key areas of long-term observation were located in different parts of reservoirs, usually in the central part, near the wedging of the backwater and in the dam portion. The global geoecological problem of Kalmykia's artificial reservoirs is now an increase in the mineralization of their waters, the shallowing of water bodies, which leads not only to a deterioration of the hydrological and geochemical properties of surface waters, a deterioration in the fodder base of fish, a decrease in the fish population, but also to significant changes in ecotone areas. In this regard, the ecological certification of water bodies is an important link in solving the problem of environmental monitoring of the state of natural and anthropogenic systems, managing their development, making forecasts and measures for their further use and improvement.

SALINITY MODULATES THERMOTOLERANCE, ENERGY METABOLISM AND STRESS RESPONSE IN AMPHIPODS *GAMMARUS LACUSTRIS*

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Temperature and salinity are important abiotic factors affecting survival and performance of aquatic invertebrates and setting limits to their geographical distribution (Pörtner, Farrell, 2008).

The aim of this study was to determine whether adaptation to habitats with different salinity regimes modulates the energy metabolism, cellular protective responses to temperature stress and thermal tolerance of amphipod *Gammarus lacustris* Sars (Sars, 1863).

We collected amphipods from two different habitats (a freshwater habitat in Irkutsk city and a saline Lake Shira) within Eastern and Western Siberia (Russia). We exposed the amphipods to several thermal scenarios (acute and gradual warming) and determined their survival, activity of major antioxidant enzymes and parameters of energetic metabolism in order to gain insights into the physiological and cellular mechanisms of temperature-salinity interactions in this ecologically important eurybiont species.

Our study shows that adaptation to different salinity regimes can influence thermotolerance and modulate key characteristics of cellular metabolism and stress responses in Holarctic amphipods *G. lacustris*. Amphipods from a freshwater Irkutsk population were more sensitive to the thermal challenge experiencing higher mortality during acute and gradual warming compared to the amphipods from the saline Lake Shira.

The thermal challenge led to a significant increase in activities of all tested antioxidant enzymes (peroxidase, GST and catalase) in the freshwater population of amphipods. Elevated levels of antioxidant enzymes during the thermal challenge may reflect a temperature-induced increase in generation of reactive oxygen species (ROS) in the less tolerant freshwater population requiring upregulation of the cellular antioxidant capacity to protect the organism against oxidative stress. This is unlikely to indicate a direct thermal damage to the antioxidant enzymes given high tolerance to heating in this population but may rather reflect a decrease in the ROS production at intermediate temperatures. Metabolic responses to thermal challenge notably differed in the freshwater and saltwater populations of the studied amphipods. The stable levels of ATP during the acute temperature stress in the saltwater amphipods indicates that the compensatory onset of anaerobic ATP production in combination with the aerobically produced ATP is sufficient to prevent ATP depletion. Significantly lower baseline levels of glucose in a freshwater population of amphipods indicates that this population may be energy-limited. Activation of glycogenolysis, and the onset of anaerobiosis (indicated by lactate accumulation) occurs much later in the freshwater amphipods.

Our data indicate that higher thermal sensitivity of the freshwater population of amphipods is associated with a lower baseline activity of antioxidant enzymes and a decreased ability to maintain energy balance and curb oxidative stress, compared to their saltwater counterparts, during exposure to

acute and gradual temperature increase. High sensitivity of the freshwater population to warming was associated with energy limitations, possibly reflecting a trade-off between the energy demands for osmoregulation and protection against the temperature stress. These findings suggest that freshwater populations of amphipods may be more vulnerable to the global climate change than those from saline habitats. On the other hand, brackish waters may serve as potential refuges during the climate change for eurysaline amphipod species such as *G. lacustris*.

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THE RESPONSE OF *DUNALIELLA SALINA* TO THE WATER FROM CHARHAN SALT LAKE

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Charhan Salt Lake is located in Golmud City, Qinghai Province, an area of 5800 square kilometers, the largest salt lake of China. It was reported that only microorganism was found in the lake. *Dunaliella salina* is one of the most salt-tolerant plants.This paper analyzed the quality of the lake water and the response of *Dunaliella salina* to the water from the lake.The water was collected from the lake area of Golmud River water folwing in, and then was taken to laboratory for water quality analysis and *Dunaliella salina* culturing test. The salinity of the water was 150 ‰ and the pH was 9.1. The content of Mg^{2+}, Ca^{2+}, Cl^{-}, HCO_3^{-}, total nitrogen and total phosphorus in the water were 4435.9 mg/L, 176 mg/L, 25303.3mg/L, 250mg/L, 21.9 mg/L, 0.25 mg/L respectively. The average growth rate of *Dunaliella salina* in the lake water was 1.15 /d during 15 days culturing. And some physiological and biochemical indicators of *Dunaliella salina* were also determined at 15 days of culturing. The dry weight was 395.6 mg/L, the chlorophyll content was 28.9mg/L, the nitrate reductase activity was 0.73 μgNO_2^{-}/g pro·h, the net photosynthetic rate was 135.6 $\mu molO_2$/mgChl·h, and the respiration rate was 31.3$\mu molO_2$/mgChl·h. These results indicated that *Dunaliella salina* could live in Charhan Salt Lake water. Charhan Salt Lake is considered as ecological fragile areas for only life was decomposers. This paper found the primary producer *Dunaliella salina* could grow in the water of Dabson Lake estuary area. It means the Dabson Lake ecological environment can be changed by inoculating *Dunaliella salina.*

INLAND LAKES IN A CHANGING WORLD: ANTHROPOGENIC AND CLIMATE CHANGE EFFECTS ON HYDROLOGY, CHEMISTRY AND ECOLOGY

GEOMORPHOLOGIC CHANGES OF LAKE URMIA AND ITS NEGATIVE EFFECTS ON RESTORATION PROGRAMS

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Water crisis and its disastrous effect on Lake Urmia is leading to a catastrophe much beyond an environmental crisis. Climate change combined with excessive consumption of underground and surface water are the main external factors caused drying of 20th largest saline lake in the world. As a result of shrinking, huge amount of salt and minerals sedimentation on the bed of the lake has made irreversible geomorphologic changes that neutralizes the efforts for its restoration.

Our studies during last 20 years shows that the lake is facing the gravest situation in the past 100 years. According to the satellite and ground data, the lake has lost over 90 % of its water, leaving behind hundreds of thousands of hectares of salt fields which can fuel salt storms. The salt storms will destroy precious fertile soil and ruin the health of those living in the surrounding regions. According to many studies; the existing problem is partly due to climatic changes and drought that started about 20 years ago, but it is also attributable to human activity, ineffective regional water policies and wasteful usage of water resources in the agriculture sector. According to the estimates, over 6 billion tons of salt have settled on the bottom of the lake, most of that is already exposed to are and gradually being moved by wind.

The surface area of the Lake Urmia was about 5500 km^2, deepest area was about 16 meters and the average depth about 6 meters. Total water volume was about 33 BCM and the average water salinity was 160 ppt. The lake desiccation started in 1995, 50 % reduction in inflow and increased evaporation resulted in saturation of lake water with salt in 2006. Salt sedimentation begun from 2006, added to the bottom sediments layer by layer. The water level decreased by more than seven meters during past 20 years (Fig. 1), currently the water depth at deepest area of the lake is less than three meters, proving that sediment thickness is almost 4 meters in these areas. The salt sediments are seen over an area of 3500 km^2. Sedimentation of huge amounts of salt and other minerals has converted the lake into a very flat and shallow playa with the rate of slope at about 20 cm in 10 km. Due to this fact inflowing water spreads over a very large area, increasing the evaporation surface but at the same time decreasing the water holding capacity of the lake significantly. Calculations proves that due to the significant change in the lake morphology, the evaporation capacity per unit volume of water in the lake has doubled. Therefore restoration of the lake using conventional methods seems to be impossible, but implementation of a wise and realistic adaptive restoration plan based on availability of water is the most essential step that should be considered.

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SALT LAKES OF SOUTH AMERICA, FLAMINGOS AND CLIMATE CHANGE

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Climate change predictions suggest temperature increases and changes in precipitation regimes throughout world. These changes would generate variations in wetland number, wetland extent, wetland seasonality, and wetland salinity. Flamingos are filter-feeding birds that live in a wide range of salty and hipersalty wetlands, which demonstrate physical, chemical, and geomorphological heterogeneity. These wetlands show high seasonal and inter-annual fluctuations in conditions and resources. There are three species of flamingos that inhabit in the south cone of South America. The Andean Flamingo and Puna Flamingo (*Phoenicoparrus andinus* and *P. jamesi* respectively) are the least abundant flamingos in the world. Both are categorized at Vulnerable and Near Threatened by the IUCNS species Survival Commission (IUCN 2013), and are included in Appendix I of Convention of Migratory Species (CMS 2013). *P. chilensis*, the third specie, is the most abundant. High Andes Flamingos Conservation Group is an international network that studies flamingos and their habitat, working in Argentina, Bolivia, Peru and Chile. The objective of this study was to summarize the general results obtained by this international network during 20 years about wetlands and flamingos and to analyze how climate change might affect them. We concluded that many aspects of the biology of these species may be negatively affected by climate change as they use saline wetlands as their primary habitat.

ECOLOGICAL EVALUATION OF THE EFFECTS OF MINE DEWATERING ON A LAKE IN THE GREAT WESTERN WOODLANDS OF WESTERN AUSTRALIA
Monitoring of Chalice West Lake from 2010 to 2016, after Dewatering of Chalice Pit

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Higginsville Gold Operations (HGO) is in the Eastern Goldfields of Western Australia, approximately 60km north of the town of Norseman and 110km south-south-east of Kalgoorlie. HGO's Chalice pit is located 23km southwest of the Higginsville mine and about 50km northwest of Norseman. In 2010 HGO proposed to re-establish mining operations in the then unused Chalice pit which was flooded.

Before mining could resume, the mine workings needed to be dewatered. Between January 2011 and April 2012, 895,997m^3 of pit water were directed to a nearby un-named saline lake, called for the purposes of this project, Chalice West Lake. In April 2014, the discharge restarted and a further 249,355m^3 was discharged from April 2014 till August 2014 whereupon the discharge ceased. A total of 1,145,352m^3 was discharged in total to Chalice West Lake.

The objective of this project was to evaluate the changes to the Lake due to the mine dewatering discharge and included the ongoing monitoring of Chalice West Lake. Salt load was to be measured before, during and after the dewatering discharge to ascertain the length of time taken for the salt load in the Lake to return to pre-discharge levels.

The objective of monitoring the fringing vegetation sites at Chalice Lake and the control lakes was to document any changes to the fringing vegetation during the period of mine dewatering discharge and then afterwards, by measuring the following parameters:

- Species richness in quadrats within transects.
- Percentage cover in quadrats within transects.
- Species richness between transects.
- Percentage cover between transects.

EFFECTS OF CLIMATE CHANGE ON THE WATER BALANCE OF LAKE BAIKAL

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After the adoption of the Russian Federation Government Resolution № 234 in March 26, 2001 "On the limit values of the water level in Lake Baikal in the implementation of economic and other activities" the level fluctuated in the meter range (456.0-457.0 m), but on February 25, 2015, for the first time since 2001, it dropped below the mark of 456.0 m. This is primarily the result of the low water period, which was established in the middle of 90th years of the last century that was the highest rate ever recorded. The situation with low-water level in Lake Baikal basin escalated in June of 2014, continued throughout 2016-2017 years and will continue in 2017. The analysis of the inflow of water into the Baikal is made. The minimum and maximum water flows, the volume flow of major rivers of Lake Baikal basin were considered. It was found that the runoff of the Upper Angara river and the Barguzin river has remained within the long-term average rate, while the Selenga river reduces at the moment and now stands at 65 % of normal during the last 20 years. Together these three rivers provide 70 % of the annual inflow of Lake Baikal. It was established that the level of the lake is almost depends on the water content of the Selenga river. A good alignment between the inflow fluctuations in Lake Baikal and runoff of the Selenga river was established, which is confirmed by the high values of correlation coefficients between these variables: for the observation period (1934-2014 years) – 0.85, with the dry periods (1954-1958, 1976-1982, 1996-2014) – 0.68 [1]. An analysis of the meteorological series of air temperature and precipitation was held along the whole basin of Lake Baikal based on the initial data of weather stations and a global database of geospatial meteorological parameters Climate Research Unit – CRU. On the basis of CRU data a statistically significant trend of increasing temperature and decreasing rainfall in the basin of Lake Baikal was found. Two distinct periods were found: 1980-1998 – an above average wet period; 1999-2015 years – an above average dry period. The wet period is characterized by increasing precipitation totals for almost the entire basin of Lake Baikal, with the highest growth rate observed for Khamar-Daban ridge (– 14 mm/annual), and for the area of the Middle Baikal (– 10 mm/a). During the dry seasons of 1998 to 2016 precipitation decreased. Extreme reduction occurred at the Khamar-Daban ridge (average of 30 mm/a). In the Upper Angara and the Barguzin river basins the rate of decreasing reaches -18 mm. From 1885 to present time the average annual air temperature in the Trans-Baikal region increased by 2.0°C [2] (note that at the same time, the annual average temperature around the globe increased by 0.85°C). The temperature increase is observed for the entire catchment area of Lake Baikal, while the areas with low growth rates of surface temperature are interspersed with areas with high growth rates, both in latitudinal and longitudinal directions. Thus, a significant transformation of the natural environment is currently observed in the Baikal Lake basin. In particular, a statistically significant trend of increasing temperature and decreasing precipitation is established with the identification of wet and dry periods. In recent years, due to abnormally high air temperature and almost complete absence of atmospheric precipitation, water flow into the Lake Baikal has been extremely low during the whole period of instrumental observations. As a result, there were problems with the level of the Baikal Lake regime.

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TRACE METAL CONTAMINATION AND ACCUMULATION IN SEDIMENT AND MACROPHYTES OF HONGZE LAKE, CHINA

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Aquatic macrophytes are unchangeable biological filters and they carry out purification of the water bodies by accumulating dissolved metals and toxins in their tissue. The concentrations of heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) in soil and macrophytes collected from different locations of Hongze Lake, China were investigated. The concentration of several metal elements (Cd, Cr, Cu, Ni, Pb and Zn) in sediment and plant samples collected from different sections of the Suoxu River, China was investigated. Results show that the concentrations of trace metals in the sediment and plants are similar and are found in the order of Zn > Cr > Pb > Cu > Ni > Cd. Among the macrophytes most of the species were efficient to take up and translocate more than one heavy metal from roots to shoots. The analyses of these macrophytes have shown the importance in accumulation of heavy metals and maintaining the clarity of water bodies. This aim was to define the level of pollutants in Hongze lake and understanding the importance of these aquatic macrophytes in accumulation of toxic metals and to evaluate whether these species could be useful for the preservation and restoration of ecosystem.

Key words: Honggze Lake, Macrophytes, Sediments, Accumulation, Toxic metals.

COMPARATIVE STUDY OF THE IMPACTS OF GLOBAL WARMING AND ASSOCIATED WATER ABSTRACTION ON LAKE ECOSYSTEMS WITH CONTRASTING SALINITIES

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According to the Intergovernmental Panel on Climate Change (IPCC) report released in September 2014, unprecedented changes in temperature and precipitation patterns have been recorded globally in recent decades and further change is predicted to occur in the near future, mainly as the result of human activity. In particular, projections show that the Mediterranean climate zone will be markedly affected with significant implications for lake water levels and salinity. This may be exacerbated by increased demands for irrigation water. Based on long-term and snap-shot data from lakes and reservoirs covering a geographical gradient of fifty two degrees of latitudes as well as controlled experiments we elucidate how changes in water level and salinity related to climate change and water abstraction may affect the ecosystem structure, function, biodiversity and ecological state of lakes and reservoirs. We further discuss mitigation measures to counteract the negative effects on ecological status that are likely toresult from changes in climate and water abstraction practices.

ENVIRONMENTAL CHANGE SINCE 5000CAL. aBP IN THE SOUTHERN OF INNER MONGOLICA PLATEAU BASED ON THE PALYNOLOGICAL AND GEOCHEMICAL RECORD IN THE ANGULI-NUUR LAKE

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A sediment sequence from Anguli-nuur Lake located at the southern margin of Inner Mongolica Plateau was selected to reconstruct the history of vegetation and climate since 5000cal. aBP based on high resolution pollen analysis, sediment grain size and major elements analysis, combined with ^{14}C dating data. The results showed the lake has been shrinking since 5000cal. aBP and the drought has been become more and more serious since 2000cal. aBP, especially since 1000 cal. aBP. From 5000 to 1000cal. aBP, the pollen concentrations are more than 5000granins/g, and the average grain diameter is the smallest with the lowest sediment deposition rate and the high percentage of silt sand. Also the drought index ((K+Na+Ca+Mg)/(Fe+Mn), alkali index((CaO+ K_2O+ Na_2O)/Al_2O_3) and CaO/MgO values reach to minimum, indicating relative stable climate and stable water area and depth. While at the Medieval Warm Period from 1000-600cal. aBP, the average pollen concentrations decreased to 3200 grains/g, and the average grain diameter and variable amplitude enlarge, with the percentage of fine sand increase but silt sand decrease. In the meantime, the drought index, alkali index and CaO/MgO values increase rapidly, suggesting that the regional climate not only become very unstable but the drought were enhanced rapidly. At the Little Ice Age from 600 to 100cal. aBP, the pollen concentrations averagely decreased to 2100 grains/g, and the average grain diameter and the variable range reach the maximum in the whole sediment sequence, combined with the highest drought index and alkali index. The period from 1458 to 1698AD, should be the maximum of Little Ice Age, because of the lowest pollen concentrations, the highest percentage of fine sand and maximum of drought index and alkali index. Since 100 cal. aBP, the climate has turned warm and wet with the decrease of drought index and alkali index and increase of pollen concentrations, but because of more and more serious human impacted, especially the reconstruction of reservoir, the lake areas and depth continue shrink indicated by higher CaO/MgO values.

Key words: Anguli-nuur, Pollen analysis, Grain size analysis, Element analysis.

WATER LEVEL FLUCTUATION OF LAKE ENRIQUILLO, DOMINICAN REPUBLIC

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The Dominican Republic is located between 17°36'- 19°58' North latitude and 68°19'-72°01' West longitude, occupying about 2 thirds of the island Hispaniola, Antilles Majors, with an area of about 48,442 km². Lake Enriquillo is located in the southwest of the country near the border with Haiti, and is the largest of the Antilles with a surface area of approximately 265 km², but is currently approaching 400 km^2 due to the continuous increase in the level of its waters since 2004. It is an endorheic system that receives a great influence of springs, rivers and glens that provide part of its water through the subsoil. Its salinity normally fluctuates between 80 and 110 ppt, but the increase of its water level dropped it considerably to a low 20 ppt in 2013. During its history Lake Enriquillo has experienced fluctuations in the level of its water, but the present growth has been more rapid than usual. While some researchers attribute this to climate change, others believe that the cause of the phenomenon is unknown.

COMBATING EUTROPHICATION IN LAKE BAIKAL NEED COMPREHENSIVE SOLUTIONS

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Lake Baikal is the oldest and deepest freshwater body on earth, containing 20 % of the world's liquid freshwater. Recently if faced the threat of eutrophication with development of benthic and planktonic algae. The Government of the Russian Federation, federal and regional agenices developed a priority programme with a goal to protect a unique ecosystem of the Lake and to facilitate environmentally-oriented economic development of the three regions adjacent to the Lake Baikal – Buryat Republic, Irkutsk and Transbaikal regions. The author will present an overview of the current situation on Lake Baikal and the goals of the project.

ECOSYSTEM OF THE HYPERSALINE LAKES OF OB-IRTYSH INTERFLUVE

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The domestic as well as foreign market needs starter feeds. Thus, it is necessary to assess the resource potential of the Russian saline lakes. The multi-year researches conducted on the territory of Western Siberia found about 90 Artemia lakes. The most part of the lakes is on the Altai Territory (more than 40 lakes are 74 % of the general fund of the saline lakes in East and West Siberia). The fund of the hypersaline lakes in the Altai Territory is 1200-1300 km^2. Most of them are small-area, shallow water bodies. But some water bodies are of the highest economic importance in the region. They are the ultrasaline Lake Kulundinskoe, the largest in the Russian Federation, and a deep Lake Big Yarovoe. The lakes are actively used for economic and recreational purposes. In Western Siberia the natural area of the shrimp is confined to the arid and partially arid flat zones. On the north it is bounded by Barabinsk – Tyukalinsk – Ishim – Shadrinsk line, on the south it is adjacent to the Kazakhstan area of the shrimp in saline lakes of the semidesert zone. The vast majority of the hypersaline lakes in the Altai Territory belong to the categories of very small or small water bodies according to depth of lake basins. Lake classification includes the following size classes: small-sized 1–5 km^2, middle-sized 5–10 km^2, large-sized 10–50 km^2, and oversized – more than 50 km^2. According to area most hypersaline lakes belong to the class of small-sized ponds. 8 lakes are referred to the middle- and large-sized classes, and only 3 lakes (Kulundinskoe, Kuchukskoe, and Big Yarovoe) belong to the oversized class. Artemia is an important component of hypersaline water bodies that have environmental and economic importance. The extraction volume estimates (capture level) of Artemia (cyst stage) are about 10 t in the hypersaline water bodies of Eastern Siberia. At present Artemia cysts which are stored in the southern water bodies of Western Siberia, provide with starter feed almost all fish farms in the country. Moreover, the significant part of Artemia cysts is exported abroad. The largest cyst reserves are concentrated in the Altai Territory water bodies, it is about 2696 t. The Kurgan Region is the second with total reserves of 992 t, and then the Omsk Region goes with 352 t. The most productive hypersaline water bodies of the Altai Territory are Lake Kulundinskoe, Big Yarovoe and Small Yarovoe. They have a stable storage of biomaterials and annually produce 100 - 600 t. For the last 11 years, the cyst storage amount in the Altai Territory water bodies has stabilized at 709 t level. During this period, estimated volume of potential Artemia cyst catching varied from 926.0 (2002) to 1720.0 t (2007) in the hypersaline lakes of the Altai Territory. The development of the allocated quota ranged from 50 to 89 % with the long-time average annual value 57±14 %. The actual fluctuations in the volume of industrial storage are due to climatic conditions (change of water content phases, temperature and low fishery intensity). The actual extraction volume (capture) is 10.4 kg/ha from 1 ha area with the stock volume of 37.5 kg/ha according to the long-time average annual data. Thus, the valuable bioresource is not fully developed. As a significant potential reserve, extraction volume of Artemia shrimp cysts can be increased (fishery amount may be more than 2000 tonnes, with the total reserve of 6-7 th. tonnes). Furthermore, Artemia biomass stock is 82000 tonnes, and usable stock is 40 000 – 50 000 tonnes. A productive time frame for Artemia cyst capture is specific for each water body depending on its hydrological characteristics. While calculating the volume of possible yield, not a full lake volume but only its certain parts were included in the "residential" zone of aquatic organisms. A layer-by-layer distribution of cysts and shrimps was considered for deep water reservoirs, such as Lake Big Yarovoe. It was made to avoid overestimation of the resource stock volume. Layer separation of cysts according to depths is obsereved in Lake Big Yarovoe (Fischer coefficient (Fф) is 5.63). They rise from the bottom during water warming in spring. In June and July the main mass is in the upper layers, from 0 to 4.0 m. They subside to the depth of 6.0-8.0 m since August. However, a 4-meter layer is "borderline". Its cyst density varies depending on the vertical movement processes. The most productive is the layer of 0-2.0 m.

EPIZOOTIC CONDITION OF OPISTHORCHID FLUKES METACERCARIAE CONTAMINATION IN CYPRINID FISH IN THE TRANSIENT REGION OF THE NOVOSIBIRSK WATER RESERVOIR AND THE UPPER OB

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The Novosibirsk reservoir was built in the Upper Ob area in 1957 and has an area of 107 thousand hectares. Hydroelectric power plants construction inevitably raises the necessecity to dam the river flow. Formation of artificial reservoirs generally causes negative changes in the complex of abiotic environmental factors. When reservoirs are created, flooding adjacent lands and forests, development of silting processes, and processing coastal slopes become inevitable. The change in hydrological and hydrogeological conditions, flora and fauna already in the process of their exploitation is diverse. The formation of fish parasites fauna in reservoirs is influenced by a number of biotic and abiotic factors. Among them the determinant ones are the level and temperature regime, the current, presence of higher aquatic vegetation, fish eating birds, the qualitative and quantitative composition of zooplankton and zoobenthos representatives that are intermediate hosts of many parasites, etc. In addition, it depends on the host's ecology and physiological state. 83 reservoir parasites are registered in the Novosibirsk reservoir. Meanwhile, in the Upper Ob, according to literary data, there are about 209 species of parasites. Fish in the Novosibirsk reservoir serve as a source of infection with the metacercariae of opisthorchid flukes. Out of local cyprinid fish, in the upper Ob and the reservoir there live the roach, the ide, the gudgeon, the crucian carp and the prussian carp, the minnow, the dace, out of introduced species – the bream, the sunbleak, the common carp. In natural water bodies contamination with parasites is detected at the level of carriage, parasitosis is rare, however in fish there is growth retardation, decrease in fatness, immunological status weakening and reproductive function decrease and less often death. The ecological situation in the reservoir is not considered safe, since its hydrochemical regime is affected by sewage water from settlements located near the reservoir. According to the Novosibirsk branch of the FSBSI "Gosrybtsentr" during the research period from 2009 till 2012, five fish species were subjected to parasitological analysis for the presence of metacercariae of opisthorchiidae: *Opisthorchis felineus*, *Metorchis bilis* in cyprinid fish (the roach, the bream, the common carp, the ide, the dace). The results of the research showed that all fish species are suitable for marketing and settling, except for the ide from the Ob in the boundaries of the hydroelectric power station, whose contamination with opisthorchiidae reached 55 % in 2010, the intensity of invasion reached 1-4 specimens, in 2011 – 48 %, the intensity of invasion – 1-8 specimens. During the research from 2013 till 2015 metacercariae of opisthorchis were not recorded. The main carriers of opisthorchiasis invasion are the ide, the roach, the dace, the bream and the sunbleak. In the upper Ob in the reservoir area, metacercariae of opisthorchis infected the ide most severely – 82.3 %, the Siberian roach (15 %) and the dace (6 %) were less affected. After the construction of the reservoir, metacercariae were found only in the ide (the extent of invasion was 13 %) in the upper zone of the reservoir (Kamen-na-Obi), where the first intermediate host of the opisthorch, the mollusc codelle, is preserved. In the upper part of the reservoir, the roach was infected more than before flooding the reservoir – 26 %. The bream, introduced here, also began to serve as an intermediate host of opisthorchis. Its contamination was 31 %. According to the Altai branch of the FSBSI "Gosrybtsentr" during the research period from 2010 till 2014 three cyprinid fish species were subjected to parasitological analysis for the presence of metacercariae of opisthorchis Opisthorchis felineus and Metorchis bilis (the roach, the ide, the bream). The causative agents of the opisthorchiasis during this period were found only in the ide caught in the Ob in the boundaries of the Pervomaisky district of the Altai Territory. Extensity of invasion was 70 %, intensity of invasion – 2-8 parasite specimens. In subsequent years, observations of the opisthorchiasis source area within the boundaries of the Novosibirsk reservoir transient region were not carried out. The current opisthorchosis state of the Novosibirsk Reservoir and the upper Ob, which is dangerous for humans and animals, and which also reduces the quality of fish, can be generally described as unfavorable. In connection with the problem urgency, further in-depth studies on the distribution and species diversity of fish parasites of epidemiological importance are needed.

VEGETATION CHARACTERISTICS AND ENVIRONMENTAL CHANGES SINCE THE LAST INTERGLACIAL PERIOD IN WESTERN QAIDAM BASIN

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The Qaidam Basin has undergone drought for a quite long time, and the deep lacustrine facies in the western Qaidam Basin records the process of environmental evolution. Based on the analysis of sporo-pollen in the sediments from Borehole ZK06 in Dalangtan and total concentration change of pollen deposition as well as migration, mutual growth and decline change of regional representative coniferous tree plants and herbaceous plants and peak features of fern spore, in combination with the U-series dating data, vegetation succession and environmental evolution since the last interglacial period in study area were discussed and the climate and environment in various stages of MIS5 - MIS2 in the western Qaidam Basin were compared. It is concluded that along with the phased uplift of the Tibetan Plateau and under the influence of global climate change, regional vegetation showed obvious vertical zonality, in mountain areas of the northwestern Qaidan Basin was distributed the cryophilic and hygrophilous temperate coniferous forest, in the lowlands was distributed the temperate grassland composed of xeric herbaceous plants including Artemisia, Chenopodiaceae, Gramineae and Compositae. Although the overall regional vegetation alteration is not obvious, yet the pollen concentration was very low in the salinization period of lake water, reflecting that the vegetation was sparse under dry salinization environment. The total pollen concentration was higher in clastic sedimentary period of lake water desalination, indicating that the climate turned humid, the area of montane forest around the basin increased and basin grassland expanded. In the relatively-warm and wet period (corresponding to the first and third stages of the borehole), coniferous and broadleaf mixing forest or broadleaf forest composed of oak, willow, birch and spruce was sporadically distributed in local mountain areas with ferns such as selaginella and polypodiaceae growing in the shady and humid areas under the dense forest. In cold and drought period, the vegetation declined, aquatic plants decreased and A/C decreased. In contrast, in warm and humid period, the vegetation was luxuriant, aquatic plants increased and A/C increased. The vegetation was defined as sparse forest- shrub-grassland, including each vegetation zone of vertical vegetation zonation in the study area. Along with the temperature and humidity changes, the forest line rose and fell, grassland expanded and shrank, aquatic plants increased and decreased corresponding to the expansion and shrinkage of the lake, however, the vertical vegetation zonation overall remained unchanged, in the fourth stage, desert-grassland may be related to the special tectonic event. Since MIS5 stage, the overall trend was that the thickness of salt gradually increased, the thickness of mud debris layer gradually decreased, the total pollen concentration gradually decreased, herb pollen percentage gradually decreased and tree pollen percentage gradually increased. The frequent dry-humid and cold-warm alternations occurred, and the overall trend gradually turned cold and dry. From the view point of four climate evolution stage features divided based on the borehole pollen, the features of phased change showed good synchronization and direction with change characteristics reflected by the parosoil, oxygen isotope and salt lake facies indicators, indicating that the evolution of vegetation and environment in the study area was mainly controlled by global climate changes. There was a bit phase advanced or lagging time, which may be due to the difference of lithology and sedimentation rate in different sedimentary areas. According to the comparative analysis to the existing data, it was known that there was obvious difference between the vegetation alteration regularities since last interglacial and existing horizontal zone features at the same period in the eastern part of China. It indicated that the vegetation alteration not only was controlled by global changes, but also was typically characteristic of local environment evolution, further explaining that Qinghai-Tibet Plateau had uplifted

to a certain height in the early Late Pleistocene and had caused the changes of the monsoon circulation pattern, resulting in that the basin gradually turned cold and dry and regional vegetation became extremely poor. The cause making the vegetation in the southeastern part within the basin relatively developed than northwestern part lay in the following facts, one was that because of uplift of mountain areas around the basin by the tectonic movement, only a small amount of southwest/southeast monsoon blew from southeast to northwest. Another was that the last uplift of Tibet Plateau made the northwest basin dip to southeast, causing the catchment centre of surface runoff to move to southeast. Because the changes of river flows induced by the glacial meltwater in the study area greatly affected water supply to the lake, the glaciers accumulated during the last glacial maximum ablated during the interglacial, resulting in the increase of surface runoff to the lake. There was advancing or lagging displacement for the lake water level corresponding to cold and warm periods, the factors affecting the change of lake water level were more complex, rapid ablation of glaciers and increase of precipitation contributed more to surface runoff in the study area. It is speculated that the characteristics of climate in Western Qaidam Basin may exist four patterns, namely cold and dry -- cold-humid – warm and dry -- warm and humid. In the MIS1 stage Dalangtan Saline Lake in western basin completely dried up, different from water balance pattern in the typical monsoon region, in the Holocene megathermal period the rise of lake water and desinilazation did not appear, perhaps resulting from the control by the regional tectonic movement effect.

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PHYSICAL PROCESSES IN SALINE LAKES

ONE-DIMENSIONAL MODEL OF VERTICAL STRUCTURE OF SALINE LAKE UCHUM (KHAKASIA, SOUTH SIBERIA)

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The seasonal dynamics of the vertical structure of the small salt meromictic Lake Uchum, located in the steppe arid zone of the South of Siberia (the Krasnoyarsk Territory), was simulated with one-dimensional computing model. The model was previously developed by Belolipetskii et al. (2002) for Lake Shira (Khakasia, South Siberia). For the case of Lake Uchum the model was modified and tested on the measured profiles of Lake Uchum. The processes of salt displacement into the solution during the formation of ice contribute to the maintenance of permanent stratification. The simulated profiles corresponded well to measured ones for all the seasons of 2015-2016. The calculations have shown that the lake is strongly meromictic under current surface level and salinity gradient. The model can be used for predicting the mixing regime under different water levels, hence for reconstruction the redox conditions in the water column of the lake in the past from bottom sediments. Also the model can be used for creating models of water quality and studying the therapeutic properties of lake mud.

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EXPLOITATION AND UTILIZATION OF SALT LAKES RECOURSES IN CHINA

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Salt lakes in China are widely distributed in the area of the Qinghai-Xizang (Tibet), the Autonomous Regions of Xinjiang and Inner Mongolia, and there are a lot of valuable inorganic resources such as potassium salts, lithium salts, magnesium salts, sodium salts as well as the double salts of chlorides, sulfates and borates [1]. The following four aspects are concerned: Firstly, studies on the stable and metastable phase equilibria on several types of salt lake brine systems are reported [2-5]. Secondly, the established online database of the salt-water systems and the software of solubility prediction systems for the aqueous systems are introduced [6]. Thirdly, the industrial potassium fertilizer productions on potassium chloride and potassium sulfate are included. Finally, some novel techniques for lithium and boron recoveries from salt lakes in China are also introduced.

Key words: Exploitation and Utilization; Phase Equilibrium; Database of salt-water system; Software of solubility prediction

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CHANGES IN THE STRATIFICATION REGIME OF THE SALINE LAKE SHIRA (SIBERIA, RUSSIA)

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Meromictic lakes are lakes in which the deep recirculation does not include the entire water body [1]. In meromictic state the nutrients accumulated in the monimolimnion with the sedimentation flow of organics are not available for the primary producers. Thus, in case of meromixis destruction, nutrients are released from the monimolimnion, resulting in outbreaks of phytoplankton bloom, i.e. in deterioration of water quality and changes in the species composition of planktonic organisms [2]. In this work we analyze the long-term field data on the vertical structure of Lake Shira and demonstrate for the first time the documented change in the lake stratification regime: from meromictic to holomictic. The purpose of this work is identify the factors that determine the regime of Lake Shira stratification and its transitions from meromictic to homomictic state. The Schmidt stability in Lake Shira shows an annual cycle with the lowest values occurring in winter, when vertical density gradients are low because of seasonal cooling at the surface. We estimate the contribution of salt stratification as stability calculated at a constant temperature. It was shown the influence of main factors: water level, wind energy and ice thickness. In the winter of 2015 for the first time an unusually deep position of the redox zone was registered: 21 and 22 m (January and March, respectively). In May 2015, the complete absence of hydrogen sulfide from water column was registered for the first time. Also in the winter 2016 the position of mixolimnion was as deep as 23 m. Therefore, the scenario of 2015 year was in 2016 year: the lake was holomictic However, in January 2017 the profiles demonstrated a stable stratification, and mixing Mixolinium was only up to 14 m, i.e. The lake became meromictic again. The rise in water level since 2003 till 2007 caused the increasing water stratification in lake Shira. The increasing of water density gradient depends on the thickness ice in winter. In 2007 and 2014 a strong spring wind led to decrease in stability. For the first time, it was recorded changing of stratification regime as a result of strong wind and absence of water rising.

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THREE-DIMENSIONAL NUMERICAL SIMULATION OF WATER MIXING PROCESSES IN LAKE SHIRA UNDER WIND STRESS IN AUTUMN

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Lakes hydrophysics study is an important task of land hydrology. It allows us to understand the patterns of both the formation of the quality of water in lake ecosystems and their functioning (Khenderson-Sellers, 1987). Thus, currents in lakes affect the distribution of hydrophysical and hydrobiological characteristics (Astrakhantsev, 2003, Belolipetsky et al., 2010). Three-dimensional numerical modeling has a number of advantages and allows us to obtain a complete picture of the distribution of hydrophysical fields (Kompaniets and Yakubaylik, 2015). Many salt lakes are of the meromictic type, that is, they are stratified lakes in which the whole water column is not mixed up to the bottom for at least one year. In such lakes, an upper layer saturated with oxygen and a bottom layer without oxygen but with hydrogen sulphide accumulated are formed. There is a water layer with a large density gradient between them, while in the upper and near-bottom layers density gradients are small. In case of mixing of the upper and the deep layers, an ecological catastrophe can occur. The salt stratified Lake Shira refers to meromictic type reservoirs. A few rare cases of its complete mixing are known. The last one occurred in winter 2014-2015. Deepening of the upper mixed layer depends on many factors. Investigation of the influence of each of them separately is the task of mathematical modeling. In the article (Belolipetsky et all, 2016) some analytical criteria were obtained showing the possibility of complete mixing of a stratified reservoir. Thus, based on the analysis of the two-layer model, it was found that with a wind force of more than 17 m/s in the autumn period, a salinity gradient, which promotes complete mixing of the reservoir after freezing at a certain thickness of ice, appears. It was found that with a decrease in salinity greater than defined constant, ice of such thickness forms, which contributes to complete mixing of the lake. A simple three-dimensional mathematical model based on Boussinesq and hydrostatics approximations made it possible to analyze the effect of wind of different strength and direction on the variation of the salinity gradient both for the simplest basin of a rectangular shape and for a model reservoir with Shira Lake shoreline and a flat bottom. A series of experiments was also carried out for a reservoir with real Lake Shira bathymetry. The salinity gradient change in the closed stratified reservoir has been analyzed in this paper according to the results of three-dimensional numerical modeling. The “variation S” dependence on the wind force, the basin length, the coastline ruggedness, the bottom unevenness and the Coriolis force has been studied. The decrease in the length of the basin, the ruggedness of the shoreline, as well as the unevenness of the bottom, reduces “variation S” and thereby increases the stability of the reservoir to complete mixing.

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GEOLOGY AND GEOCHEMISTRY OF SALINE LAKES

THE DISTRIBUTION OF CHEMICAL ELEMENTS IN THE LANDSCAPES OF SULPHATE AND SODA LAKES (WEST TRANSBAIKALIA)

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A landscape-geochemical system can be characterized by a certain specificity of the interaction of its constituent components: rocks-natural waters-soils-vegetation. These components create individual features of migration, transformation and accumulation of matter in the system [3]. The leading role in migration, redistribution and accumulation of chemical elements in landscape-geochemical processes is occupied by the soil. The soil has polyfunctional properties and acts as a system of geochemical barriers [1]. Depending on the place of formation, one type of soil can be presented by different combinations of geochemical barriers, each of them has its own association of chemical elements. Soda and sulphate lakes are the landscape-geochemical systems in which the high concentrations of carbonates, hydrocarbonates or sulphates in the brine create specific conditions for the accumulation of a number of elements [2]. In the surface waters of soda lakes, the concentrations of microelements are directly proportional to their mineralization; in sulphate lakes such relationships are not observed [4]. We have studied the distribution of chemical elements in water, soils and vegetation in the landscapes of mineral lakes.

The objects of the study were the landscapes (floodplain and steppe) of four mineral lakes of the Barguzin depression in Transbaikalia. These lakes differ in the chemical composition of water: Bolshoye Alginskoe – sulphate lake; Sagan-Nur, Nukhe-Nur I and Nukhe-Nur II – soda lakes.

A characteristic feature of the steppe landscape of the lake Bolshoye Alginskoe is the predominance of chestnut mealy-carbonate soils with small areas of distribution of salt marshes in the northwestern part of the lake. The vegetation of the steppe landscape is represented by the plant communities: *Leymus chinesis – Artemisia frigida – Achnatherum* and *Salsola*. The floodplain landscape is represented by alluvial meadow-gley (with the *Trifolium repens – Agrostis clavata* plant community) and soddy-gley (with the *Carex duriuscula – Potentilla – Artemisia frigida – Achnatherum* plant community) soils.

The steppe landscape of the lake Sagan-Nur is developed on chestnut mealy-carbonate soils with the *Leymus chinesis – Artemisia frigida – Stipa* plant community. The floodplain landscape is represented by alluvial meadow-gley (with the *Menyanthes - Carex* plant community) and sod-gley (with the *Carex duriuscula - Agrostis plant* community) soils.

The steppe landscape of the lakes Nukhe-Nur I and Nukhe-Nur II is developed on chestnut mealy-carbonate soils with the *Leymus chinesis – Artemisia frigida – Achnatherum* plant community. The floodplain landscape is represented by alluvial meadow-gley soils with the *Menyanthes - Carex* plant community.

In the water of the lake Bolshoye Alginskoe, which has a sulphate composition, the content of Li, B, S, Cu, Zn, Ge, As, Rb, Sr, Mo, Cd, Sb, W, Mo is significantly higher, and Mn, Fe, Sn, Ba, La, Ce, Pr, Hf, Pb - lower than in the lakes Sagan-Nur, Nukhe-Nur I and Nukhe-Nur II.

A common feature for the soils of landscapes of mineral lakes is the predominance of Si, Ca, Al; for the vegetation - Na, N, K, Fe, P, Sr. In the soils of landscapes of sulphate lakes, the content of Fe, Li, Sr, Zn and Rb is higher, and Ba, La, Ce are lower than the content of these elements in the soils of landscapes of soda lakes. For the vegetation, a similar dependence was observed for Fe, Sr, Zn, Rb and Ba, Ce, respectively.

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SOLID-LIQUID PHASE EQUILIBRIUM FOR THE QUATERNARY SYSTEM (LiCl + NaCl + $CaCl_2$ + H_2O) AT T = 288.15 AND 308.15 K

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Lithium resource in China mainly comes from salt lakes, which are distributed in Qinghai, Tibet, Xinjiang, Inner Mongolia, Sichuan Provinces [1-3]. The brine of Qinghai largely consists of the complex six-component system ($Li^+ + Na^+ + K^+ + Ca^{2+} + Cl^- + SO_4^{2-} + B_4O_7 + H_2O$) [4,5]. Solubilities of the quaternary system (LiCl + NaCl + $CaCl_2$ + H_2O) at 288.15 and 308.15 K have not reported in the literature. The solubilities and the physicochemical properties (densities, refractive indices) in the liquid–solid phase system (LiCl + NaCl + $CaCl_2$ + H_2O) at 288.15 and 308.15 K were determined. In the phase diagrams at 288.15 and 308.15 K in Figure 1, there are all in four crystallizing regions corresponding to lithium chloride monohydrate ($LiCl·H_2O$), sodium chloride, calcium chloride hexahydrate ($CaCl_2·6H_2O$ 288.15 K) or calcium chloride hydrate ($CaCl_2·4H_2O$ 303.15 K) and double salt ($CaCl_2·LiCl·5H_2O$), five univariant curves, two invariant points ($LiCl·H_2O$ + NaCl + $CaCl_2·LiCl·5H_2O$) and (NaCl + $CaCl_2·6H_2O$ + $CaCl_2·LiCl·5H_2O$) at 288.15 K and ($LiCl·H_2O$ + NaCl + $CaCl_2·LiCl·5H_2O$) and (NaCl + $CaCl_2·4H_2O$ + $CaCl_2·LiCl·5H_2O$) at 308.15 K. A comparison of the phase diagrams for the quaternary system at 288.15 and 308.15 K shows that the crystallized area of $LiCl·H_2O$ is increased with the increasing of temperature. While that of $CaCl_2·6H_2O$ or $CaCl_2·4H_2O$ is decreased obviously.

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THERMODYNAMIC REPRESENTATION OF THE PROPERTIES AND PHASE EQUILIBRIA FOR THE Li^+ CONTAINED BRINE OF CHLORIDE-TYPE SALT LAKE

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Chaerhan salt lake is the base of potash fertilizer production in China. Large amount of bittern were discharged after the production of potash which contains mainly magnesium chloride and seldom but high valued lithium chloride. However extracting lithium is difficult since the high radio of Mg/Li. Thus, in order to establish advanced technique to recover lithium, it is necessary to know the whole feature of the solid-liquid phase equilibrium and brine physical-chemical properties for the $MgCl_2$ - LiCl - H_2O ternary system.

In this work, a comprehensive thermodynamic model based on symmetric eNRTL model[1] was employed for $MgCl_2$-LiCl-H_2O system. The parameters τij denoted the interaction effect of electrolyte - water and electrolyte -electrolyte were calculated through one temperature-dependent model (Gibbs-Helmholta type expression), and were regressed from experimental thermodynamic data including mean ionic activity coefficient, osmotic coefficient, vapor pressure, enthalpy and heat capacity. The expression of ion's thermodynamic data (Gibbs energy of formation $\Delta_f G_k^0$, enthalpy of formation $\Delta_f H_k^0$ and heat capacity C_p) was extended to fit low temperature until -84℃. The solids thermodynamic data ($\Delta_f G_k^0$, $\Delta_f H_k^0$, C_p) of single salts and their hydrates were re-determined by regressing binary solubility data, and of double salts were regressed by ternary solubility data.

For $MgCl_2$-LiCl-H_2O system from eutectic temperature -84℃ up to boiling temperature under normal pressure, the 10 regions of one solid saturated, 14 curves of two solids co-saturated and 7 invariant points of three salts co-saturated were predicted which involve the total solid species of 8 hydrates ($MgCl_2 \cdot 12H_2O$, $MgCl_2 \cdot 8H_2O$, $MgCl_2 \cdot 6H_2O$, $MgCl_2 \cdot 4H_2O$, $LiCl \cdot 5H_2O$, $LiCl \cdot 3H_2O$, $LiCl \cdot 2H_2O$, $LiCl \cdot H_2O$), one double salts ($MgCl_2 \cdot LiCl \cdot 7H_2O$) and one ice.

The results indicate the model provides accurate representation and reliable predictions for the solid-liquid phase equilibrium in the ternary system. In addition, the results show the lithium carnallite exists within the whole temperature region, and $MgCl_2 \cdot 4H_2O$ could also be formed at low temperature in high concentration of LiCl.

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THERMODYNAMIC REPRESENTATION OF THE PROPERTIES AND PHASE EQUILIBRIA FOR THE BRINE OF CALCIUM CHLORIDE SUBTYPE SALT LAKE

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Calcium chloride subtype salt lakes such as Qarham salt lake in China, Afdera salt lake in Ethiopia, normally locate in the arid region. With the evaporation， the carbonate, sulfate, sodium chloride and sylvine were separated out successively, and the main contains of the final brine are magnesium chloride and calcium chloride. In $MgCl_2$-$CaCl_2$-H_2O ternary system, it is known that 10 solid species includes 7 hydrates ($MgCl_2·12H_2O$, $MgCl_2·8H_2O$, $MgCl_2·6H_2O$, $MgCl_2·4H_2O$, $CaCl_2·6H_2O$, $CaCl_2·4H_2O$, $CaCl_2·2H_2O$), 2 double salts ($2MgCl_2·CaCl_2·12H_2O$, $MgCl_2·2CaCl_2·6H_2O$) and one ice. Knowing the conditions of these solid species forming and existence are important to understand the characteristics of those salt lakes.

In this work, a comprehensive thermodynamic model based on symmetric eNRTL theory [1] is employed for $MgCl_2$-$CaCl_2$-H_2O system. The parameters τij denoted the interaction effect of electrolyte -water and electrolyte - electrolyte were calculated through one temperature-dependent model, and were regressed from experimental thermodynamic data including mean ionic activity coefficient, osmotic coefficient, vapor pressure, enthalpy and heat capacity [2]. The solids thermodynamic data ($\Delta_f G_k^0$,$\Delta_f H_k^0$,C_P) of single salts and their hydrates were re-determined by regressing binary solubility data, and of double salts were regressed by ternary solubility data.

Thus, the 10 curved surfaces of one solid saturated, 14 curves of two solid co-saturated, and 7 invariable points of three solids co-saturated were predicted under the normal pressures and within the temperature from -56 ℃ to 120 ℃. The predictive results agree well with the experiment data, and the model is expected to cover more ions simultaneously.

Key words: Salt-lake Brine, phase diagram, electrolyte NRTL Model, $MgCl_2$-$CaCl_2$-H_2O system

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DIFFERENCE OF GEOCHEMICAL CHARACTER OF M56 SUBSECTION FROM THE MAJIAGOU FORMATION IN THE SALT BASIN FROM THE EAST ERDOS BASIN

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The northern Shanxi salt basin is located in the east of the Ordos Basin. The Majiagou Ordovician formation contains thick salt sediments. Among it a potash mineralization layer can be found and a thin potash layer that reaches industrial grade in the sixth subsection of the fifth section, which indicates a good potash prospect. Drilling well and seismic interpretation data indicate that the north of the Shanxi salt basin shows the paleo-tectonic framework of “two sags and one rise”, including the east and west salt depressions and the middle rise. The east and west salt sags can be divided into five secondary salt sags. The thickness of the strata and the thickness ratio of the salt layer versus the strata indicates that the ratio of salt to the strata is very low, reflecting strong desalination. This implies the seawater entered the salt basin from the two western salt sags. The geochemistry and petrology analysis reveal that the difference in the condition of the forming potash is apparent in the salt sags. The west salt sag shows the sea water invaded leading to the characteristics of a deep water destination. Though the thin potash layer appears in the east 1 sag, the character of the water destination reveals that it is not good for potash preservation. The saline trend in the seawater in the two eastern salt sags is obvious; the character of the geochemical and sedimentary environment is similar to typical potash basins all over the world. The sylvine exists in the intercrystal with a round shape, and as the inclusion of salt mineral within the dissolution crystal boundary. A series of preservation characteristics reflect the dry salt lake stage. Though terrigenous fresh water was added, clay exists on the outside of particles, which has led to some sylvine particles being preserved, forming the potash mineralization phenomenon. The evidence from sedimentation, geochemistry and petrology reveal the good prospects for potash deposition.

PHASE EQUILIBRIA OF THE TERNARY SYSTEMS ($MgCl_2 + Mg_2B_6O_{11} + H_2O$) AND ($MgSO_4 + Mg_2B_6O_{11} + H_2O$) AT 288.15 K AND 0.1 MPa

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Salt lakes with high concentrations of magnesium and boron resources are widely distributed in the western of China, especially in Qinghai-Tibet Plateau [1]. The composition of the brine belongs mostly to the complex seven-component system (Li^+, Na^+, K^+, Mg^{2+}//Cl^-, SO_4^{2-}, borate – H_2O) [2]. As we all know, the phase equilibria and phase diagrams are essential for exploiting the brine resources and describing the geochemical behavior of brine and mineral system [3]. Therefore, the studies on the thermodynamic phase equilibrium containing magnesium and boron could provide the scientific guidance and theoretical foundation to separate and purify the boron and magnesium effectively from the mixture. These two ternary systems ($MgCl_2 + Mg_2B_6O_{11} + H_2O$) and ($MgSO_4 + Mg_2B_6O_{11} + H_2O$) are subsystems of the complex seven-component system, and they are not reported in the literature. The phase equilibria for the ternary systems ($MgCl_2 + Mg_2B_6O_{11} + H_2O$) and ($MgSO_4 + Mg_2B_6O_{11} + H_2O$) at 288.15 K and 0.1 MPa were investigated using the isothermal dissolution equilibrium method. On the basis of experimental data on the solubilities and the physicochemical properties including density, refractive index and pH of the two ternary systems, the phase diagrams and the diagrams of physicochemical properties versus composition of magnesium chloride or magnesium sulfate in the liquid solution were plotted. It can be found that there are all in one invariant point, two univariant curves, and two crystallizing zones in these two ternary systems. Both systems belong to a simple eutectic type, and neither double salts nor solid solution were found. The physicochemical properties of the equilibrium solutions change regularly with the increasing of magnesium chloride or magnesium sulfate concentration in the equilibrium solution, and reach the extreme values at the invariant points. According to the empirical equation of the density and refractive index in electrolyte solutions, the calculated results of density and refractive index in both ternary systems are in good agreement with those of experimental values.

Key words: phase equilibria, solubility, inderite, bischofite, epsomite.

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GEOCHEMICAL FEATURES OF ENDORHEIC SALINE LAKES OF KULUNDA STEPPE (WESTERN SIBERIA, RUSSIA)

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The aim of this study was to examine and interpret the chemical composition of 22 saline lakes located in steppe area of Western Siberia. Mineral reserves of soda minerals (Petukhovo lakes), glauberite salts (Kulunda, Kuchuk) and sodium chloride salts in water of lakes were determined. All studied lakes can be categorized by TDS values as brackish (1-30 g/L), saline (30-40 g/L) and hypersaline (up to 40 g/L) with 30 g/L in average for the region. There is no trend between TDS and location of the lakes on the Kulunda plain; highly mineralized lakes are identified on the north as much as on the south part of the region. Values of pH vary from 7.2 to 9.9 and correlate with $HCO_3^-+CO_3^{2-}$ concentration in lakes water (correlation coefficient is 9.9). The majority of the lake surface waters are characterized by oxic-anoxic redox conditions (Eh varies from -400 to 270). The bottom sediments are usually anoxic with presence of H_2S and CH_4 gases. Sampled groundwater of the region are mainly oxidized with the exception of well near to Kulunda lake where Eh has strong negative value (-102 mV). Based on the chemical data and pH values, all lakes in this area can be divided in to 3 main groups: clear soda lakes with $HCO_3+CO_3^{2-}$>50 %, chloride lakes with high soda amount (Cl>50 %, $HCO_3+CO_3^{2-}$ up to 30 %) and pure chloride lakes with Cl-ion dominance. Water Type 1 (HCO_3^-Na) soda lakes (with HCO_3+CO_3>50 %) is characterized by the highest pH values in all studied lakes on this territory. The pH of the water varies from 8.9 to 9.9, which determines the attribution of these waters to the soda type. Wide range in TDS values is a distinctive feature of soda lakes; TDS varies from 1 g/L to 100 g/L, the average value of TDS is 30 g/L. At the same time, the percentage of carbonates (CO_3^{2-} + HCO_3^-) in waters rarely reaches 50 eq. %; on average, its value is 25 eq. %. Moreover, Na^+ always prevails (on average 85 %) in the cationic component of lake waters against the very low concentrations of calcium and magnesium (2 and 11 eq. %, respectively). Water type 2 (Cl-Na with HCO_3 up to 30 eq. %) chloride lakes with high soda amount (Cl>50 %, $HCO_3+CO_3^{2-}$ up to 30 %). This type of lakes is very similar to the second Type of water, but the amount of carbonates varies from 10 to 30 eq. %. However, as can be seen, even a small amount of soda in water can provide high pH values, which in this type can reach up to 9.7. The difference in ionic composition for last 2 types is only in CO_3^{2-}, SO_4^{2-}, Cl^- and Mg^{2+} accumulation. Water Type 3 (Cl-Na) chloride lakes with Cl-ions in dominance. Chloride lakes are the most widespread type (50 %) among all studied lakes. Value of TDS varies between 40 and 600 g/L, pH between 7.2 and 9.4. This is the most saline type of lakes and the least alkaline in Kulunda steppe. Sodium content prevails among cations (average - 74 eq. %); magnesium in waters of this type is somewhat larger than in soda - 26 eq. %. Isotopic data ($\delta^{18}O$ and δD) of lakes water is located below the line of meteoric water, and the slope of the trend line corresponds to the line of evaporation trend. Enrichment of water with heavy isotopes compared to precipitation at relatively wide variation is mainly determined by the degree of evaporation in the reservoir. It has been revealed that the composition of lake waters is determined by two differently directed processes: 1) the interaction of water with rocks in the catchment area and in the lake, which leads to the precipitation of soda in solution and many other authigenic minerals and 2) the degree of evaporation of water in the lakes, which leads to a depletion of carbonate amount in water simultaneously with chloride and sulfate salts enrichment. The geochemical type of the lake is formed depending on the dominance of this or that process. For the formation of the soda lake type, it is necessary that the scale of soda formation dominate other processes, including evaporation. This is possible if evaporation is relatively small or compensated by the additional surface or groundwater inflow into the lake.

SOLID-LIQUID PHASE EQUILIBRIA FOR THE AQUEOUS QUATERNARY SYSTEM (Na^+, Ca^{2+}//Cl^-, borate - H_2O) AT 288.15 K

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Calcium borates are widely used in terms of glasses industry, ceramics, flame retardant, nonlinear optical materials and agriculture for its special properties [1]. At present years, a large scale of oil-field brine and underground brine with high concentration of calcium and boron are widely distributed in the western of China [2]. In order to developing and utilizing these brine resources, some borate systems have been reported previously, but involving in calcium borate systems is scarce [3]. In this paper, the solubilities and physicochemical properties including refractive index, density, viscosity and pH in the quaternary system (Na^+, Ca^{2+}//Cl^-, borate - H_2O) at 288.15 K were determined experimentally with the method of isothermal dissolution equilibrium. According to the experimental data, the dry-salt diagram (Fig. 1), water-phase diagram and the diagram of physicochemical properties versus composition in the quaternary system were plotted, respectively. The experimental results showed that there is two invariant points named as F1 ($CaB_6O_{10}\cdot 5H_2O$ + NaCl + $Na_2B_4O_7\cdot 10H_2O$) and F2 ($CaCl_2\cdot 6H_2O$ + $CaB_6O_{10}\cdot 5H_2O$ + NaCl), five univariant curves and four crystallization regions corresponding to $CaCl_2\cdot 6H_2O$, $CaB_6O_{10}\cdot 5H_2O$, $Na_2B_4O_7\cdot 10H_2O$ and NaCl in the quaternary system at 288.15 K. The diagrams of physical and chemical properties including refractive index, density, viscosity and pH versus composition were changed regularly with the increasing of the boron concentration and singular values were achieved at the invariant points of the quaternary system at 288.15 K. Those results are useful for guiding oil-field brine development and utilization process.

Key words: Phase equilibrium, Calcium chloride, Calcium hexaborate, Sodium chloride, Borax.

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RESEARCH PROGRESS AND APPLICATION OF URANIUM-SERIES DATING METHOD ON SALINE LAKE OF TIBET PLATEAU

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Ever since it came into being, the saline lake deposits have contained information of environmental changes during each stage of its evolution. It's another most important carrier of extreme arid climate research. And geochronological study is very important for reconstructing the past climate change recorded in salt lake. At present, besides ^{14}C, OSL, ESR and paleomagnetism dating, uranium-series dating has been used widely in chronology research of salt lake deposit. As dating technology advances, uranium-series dating has gone through different stages: α spectrometry, TIMS and MC-ICP-MS, which have made some contribution to geochronological study of Quaternary and salt lakes on plateau. And almost all kinds of saline minerals, such as carbonate, halite and gypsum et al, can be used as uranium-series dating research materials. Compared to quick progress of mass spectrometry technology, there is also the possibility of micro dating in saline minerals. Caidamu Basin, in north edge of Tibetan plateau of China, is not merely producing abundant saline mineral resources, and keep high-accuracy information of palaeoclimate and the ancient environment. For study's needs, we try to apply saline samples to U-series dating and find some pretreatment processes and ways for saline samples. According to our and others research data, saline deposits in salt lakes, such as halite, gypsum, mirabilite etc, are suitable for U-series dating. Then U-serises dating is carried out for gypsum and mirabilite samples of mirabilite sections in Dalangtan saline lake area, western Caidamu Basin. The gypsum and mirabilite samples' ages are (117.8±3.8) ~ (189.7±10.0) ka BP and (118.0±5.0) ~ (195.1±10.0) ka BP, respectively. According to the contrast of other studies, these saline deposits' ages are credible, and pretreatment processes for gypsum and mirabilite are also effective. Through survey and comprehensive study, it is pointed out that Dalangtan region has undergone five climate stages during penultimate glaciation (MIS 6): relative warm & wet stage (>195.1 ka BP) — frigid and arid stage (195.1 ~ 169.9 ka BP) — relative warm & wet stage (about 169.9 ka BP) — frequently fluctuating stage (169.9 ka BP ~ 118 ka BP) — relative warm & wet stage (118 ka BP). After a comparative study with loess section and marine oxygen isotope studies, it show that, since middle and late Pleistocene, Dalangtan region not only was uplifted by activities of regional geology, but also response to globle climate change. But the researches of uranium-series dating on saline minerals are still limited. So in the future, more and more dating researches on saline minerals will exert positive effects on application of uranium-series dating technology on saline lake.

THE GEOCHEMICAL CHARACTERISTICS AND MINERAL DEPOSITS OF TRAVERTINE OF TANGQUNGMAI IN TIBET, CHINA

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Tangqungmai salt lake is a modern liquid deposit of rich Li and B, which is located in Nima country in Tibet-Qinghai plateau. In the southern part of the lake, there are a large scale of travertine deposit and carbonate clay sediments, which also relatively rich in such as Li and B. According to theirs sedimentary characteristic and structure, the travertine can be divided into two types, which are laminated travertine in south hot springs valley and columnar travertine in southern lake. The laminated travertine is mainly formed in the laminar flow environment, and the columnar travertine is thought to be formed in the lake environment due to the growth of the vertical hollow channel. The pattern of rare earth element distribution of the ancient laminated travertine has been largely consistent, suggesting that the chemical composition of hot springs water formed travertine has not changed in since ancient times. The distribution of rare earth element of all travertine and carbonate clay in salt lake area are also basically consistent, indicating the uniqueness, consistency, and stability of the source of the ore-forming material of tangqungmai salt lake. Both travertine and carbonate clay have higher δ^{13}CV-PDB, the ^{13}C values of south hot springs travertine varying from 1 to 5.6 (average 3.35, n=30), the ^{13}C values of south lake travertine varying from 2.6 to 7.1 (average 5.65, n=35), and the ^{13}C values of carbonate clay varying from 4 to 7.9 (average 5.45, n=30). All of these evidence reveal that travertine in south hot springs valley, south lake area and carbonate clay have same carbon source and CO_2 formed travertine come from deep crust or upper mantle.

THERMODYNAMIC REPRESENTATION OF THE PROPERTIES AND PHASE EQUILIBRIA FOR THE BRINE OF MAGNESIUM SULFATE SUBTYPE SALT LAKES

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Magnesium sulfate subtype salt lakes are widely distributed in the world, such as Liping, East-west taijnar, Lop Nor, Yuncheng Salt Lake, etc. in China and Karen Salt Lake in Egypt. The composition of magnesium sulfate and magnesium chloride causes a large impact on the characteristics of salt lake, and on the processes of valuable recovering. For Mg-Cl-SO_4-H_2O ternary system, it was known 9 solid species ($MgCl_2 \cdot 12H_2O$, $MgCl_2 \cdot 8H_2O$, $MgCl_2 \cdot 6H_2O$, $MgCl_2 \cdot 4H_2O$, $MgSO_4 \cdot H_2O$, $MgSO_4 \cdot 4H_2O$, $MgSO_4 \cdot 7H_2O$, $MgSO_4 \cdot 12H_2O$ and ice) exist. There is no double salts, but the complex metastable phenomenon occur in the system which caused by the special structure of $MgSO_4$-H_2O solution. Although there are a large amount literatures refer to $MgCl_2$ -$MgSO_4$- H_2O ternary system, the whole feature of the solid-liquid equilibrium and brine physical-chemical properties from eutectic temperature to boiling temperature under normal pressure are still desired.

In this work, a comprehensive thermodynamic model based on symmetric eNRTL theory [1] was employed for $MgCl_2$-$MgSO_4$-H_2O system. Theparameters τ_{ij} denoted the interactive effect of electrolyte –water were calculated through one temperature-dependent model, and were regressed from experimental thermodynamic data of binary systems which include mean ionic activity coefficient, osmotic coefficient, vapor pressure, enthalpy and heat capacity. And the interactive parameter of electrolyte – electrolyte τ_{ij} were regressed by ternary solubility data on the whole temperatures region. The solids thermodynamic data (Gibbs energy of formation $\Delta_f G_k^0$, enthalpy of formation $\Delta_f H_k^0$ andheat capacity C_p) of single salts and their hydrates were re-determined by regressing binary solubility data.

Depending on the model and above parameters, 8 regions of one solid saturated, 13 curves for two solids co-saturated, and 9 invariable points for three solids co-saturated were predicted from -33℃ to 100℃ under the normal pressure. The results indicate the model provides accurate representation and reliable predictions for the solid-liquid phase equilibrium in the ternary system. In addition, one metastable region was confirmed to exist from 0℃ to 60℃ where the $MgCl_2$ content is concentrated. The stable solid should be $MgSO_4.H_2O$, however, the solids formed usually $MgSO_4 \cdot 4H_2O$ or $MgSO_4 \cdot 5H_2O$.

Key words: $MgCl_2$-$MgSO_4$-H_2O, phase diagram, electrolyte NRTL Model.

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COMPARATIVE STUDY ON THE ADSORPTION AND SEPARATION OF LITHIUM AND MAGNESIUMIONS FROM AQUEOUS SOLUTIONS BY NANOCARBONS AND ZEOLITES

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Lithium is a representative of clean energy storage-related materials, of which the salt lake brine is one of primary sources. Due to its very promising applications in the environmentally friendly efficient technology, the global demand for lithium increases in recent years. However, high ratios of Mg^{2+}/Li^{+} in many cases make separating Li^{+} difficult because of their similar ionic properties. Although efforts have been devoted to the development of techniques (e.g. solvent extraction, membrane process) with the attempted to selectively separate the lithium ions from salt lake brines, few are efficient with concerning to the environmental and economical aspects. Nanocarbons have excellent properties such as high specific surface area, chemical and mechanical stability, and tunable nanoporosity. Recently, progress on nanocarbon techniques shed some light on the effective and fast separation of ions from aqueous solutions. In this work, we used nanoporous carbons as solid adsorbents for the adsorption and separation of lithium and magnesiumions from aqueous solutions. The results were compared with that of zeolite adsorbents. In order to demonstrate beneficial prospects for effective lithium separation from salt lake brines, the nanoporous structures of the adsorbents were thoroughly characterized with nitrogen adsorption at 77 K, field emission scanning electron microscopy and transmission electron microscopy. The results obtained indicate that it is possible to employ a better nanostructure of carbon for the adsorption and separation of lithium ions from salt lake brines.

THE MAN-MADE PLUTONIUM RADIOISOTOPES IN THE SALT LAKES OF THE CRIMEAN PENINSULA

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Many salt lake ecosystems are on the territory of the Crimean peninsula. They are characterized by a wide range of salinity and divided into several groups according to location. A lot of them have high salinity, which is supported mainly due to the water balance: the water input and flow rate of fresh water. During the summer, a main factor of water balance regulation is intensive water evaporation. So, many chemical elements can collect in high concentrations, including man-made radioactive isotopes. At the same time a plenty of the salt lakes of the Crimea are used by man for recreation and treatment, as well as for industrial purposes. The salt lakes contain large reserves of salts and their mud and brine are widely used for medicinal purposes. The lakes are sources of biological resources. Therefore it is important to assess the radioecological state of lake ecosystems and their individual components. In modern conditions one of the significant components of the radiation technogenic factor is the plutonium alpha-radionuclides (^{238,239,240}Pu). They show the high radiotoxicity, the long half-lives and they are among the main dose-forming artificial radionuclides in the Crimea region now. Moreover, in aquatic ecosystems the plutonium behaves like a pedotrophic element which is accumulated mainly by the bottom sediment.

For the first time investigation of the radioactive alpha-emitting radionuclides $^{239+240}$Pu and ^{238}Pu activity concentration in the bottom sediment of the Crimean salt lakes was carried out. It was found that the specific activity of the bottom sediments against the plutonium radionuclides in the surface layer (0-5 cm) varied widely between regional geographical groups of lakes as well as within groups. The values of the specific activities of the bottom sediments in relation to $^{239+240}$Pu differed by more than an order of magnitude. The values ranged from 11 to 443 mBq$^{239+240}$Pu/kg and from 2 to 81 mBq^{238}Pu/kg. The ^{238}Pu activity was presented by 1986. The highest levels of contamination by $^{239+240}$Pu and ^{238}Pu of surface bottom sediment in the lakes Dzharylgach and Kyzyl-Yar were observed. The lowest values of contamination by $^{239+240}$Pu and ^{238}Pu in Kirleutskoe and Kiyatskoe lakes were identified and were equal 48 and 24 mBq$^{239+240}$Pu/kg and 19 and <1 mBq^{238}Pu/kg, respectively.

The average sedimentation fluxes of the plutonium radioactive isotopes over the past two decades to the bottom sediment from the water column in the lake Dzharylgach were determined. They reached 1.515 for $^{239+240}$Pu and – 0.084 Bq/(m^2 year^1) for ^{238}Pu.

For the first time the characteristic ratio of the activities of ^{238}Pu/$^{239+240}$Pu in the bottom sediment were calculated and share of Chernobyl and global origin plutonium in the total plutonium radioisotope contamination of the lakes was found. The largest share of $^{239+240}$Pu and ^{238}Pu of Chernobyl origin (72 %) was observed in the lake Tobechikskoe. In the lakes Chokrakskoe, Kirleutskoe, Kiyatskoe, Bakalskoe, Kyzyl-Yar in the top layer of bottom sediment the plutonium contamination was formed almost entirely by radionuclides of global origin. The percentage of the plutonium radionuclides of Chernobyl origin did not exceed 4 %. In lakes Dzharylgach, Aktashskoe, Sasyk-Siwash the share of the Chernobyl origin plutonium was 8-16 %.

The plutonium radionuclides stocks in the 0-5-cm layer of bottom sediment in the salt lakes of Crimea were estimated. In the lakes Kyzyl-Yar, Dzharylgach, Kirleutskoe, Aktashskoe, Tobechikskoe their values varied from 2.14 to 25.84 for $^{239+240}$Pu and from 0.08 to 2.93 Bq/m^2 for ^{238}Pu.

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EXPERIMENTAL STUDY AND THEORETICAL PREDICTION OF PHASE EQUILIBRIUM OF LITHIUM–CONTAINING SYSTEM

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As we know, there are many salt lakes rich in lithium in China, and they will be the major source of lithium resource exploitation in future. The unique carbonate-type salt lake brine in Qinghai-Tibet Plateau of China has many characteristics, such as more beneficial components, higher grade and larger reserves, which is of great significance to make up the shortages of lithium, potassium, boron, iodine and strontium resource. However, there have been few scientific studies on the phase equilibrium of salt-water system for this type brine, which to some extent, restricting the development and utilization of these mineral resources. Research on the phase equilibrium of lithium–containing system could not only help to reveal the metallogenic regularity and evolutionary trends of salt lake brine, but also provide the basic data for the development and utilization of its lithium resource. This paper showed the stable phase equilibrium experimental results of the ternary system Li^+, Na^+/CO_3^{2-}-H_2O at 298.15K. Based on these obtained solubility data, the single salt Pitzer model parameters and the mixing parameters of Li_2CO_3 were fitted by establishing a functional relationship, combining with the existing solubility data of other ternary systems from the related references such as the Li^+, K^+/CO_3^{2-}-H_2O, Li^+/Cl^-, CO_3^{2-}-H_2O, Li^+/SO_4^{2-}, CO_3^{2-}-H_2O. After the species have been parameterized, the Pitzer models were established for the solubility theoretical prediction of the quaternary system Li^+, Na^+/SO_4^{2-},CO_3^{2-}-H_2O and its ternary subsystem Li^+, Na^+/CO_3^{2-}-H_2O at 298.15K. It could be seen from the phase diagram as shown in the figure that the predicted solubility data were according well with the experiment data. And the research results of the mineral solubility and phase equilibrium prediction on the quaternary system Li^+, K^+/SO_4^{2-}, CO_3^{2-}-H_2O at 298.15K were also showed in this paper. Some single salt parameters for Pitzer model such as Li_2SO_4•H_2O, K_2CO_3•3/2H_2O, K_2SO_4 and other mixing parameters could be found from literature except the salt Li_2CO_3 and the thermodynamic data. The single salt parameter of Li_2CO_3 and the mixing parameters Ψ(Li, SO_4, CO_3) and Ψ(Li, K, CO_3) were obtained by fitting the related solubility data of ternary systems. And then the Pitzer models with the parameterized species were established for predicting the solubility data of Li^+, K^+/SO_4^{2-}, CO_3^{2-}-H_2O.

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RAMAN SPECTROSCOPIC STUDIES ON THE CHARACTERISTICS OF ASSOCIATION EQUILIBRIUM OF Mg_2^+ AND SO_4^{2-}

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Magnesium Sulfate solution is an important electrolyte solution which is widely used in many fields, such as chemical industry, biology, metallurgy and so on. The characteristics and the association equilibrium of Mg_2^+ and SO_4^{2-} have been the focus of attention, which has important application values. In this paper, the characteristic of ion association structure of SO_4^{2-} of 0.5mol/L, 1.0mol/L, 1.5mol/L, 2.0mol/L $MgSO_4$ solution at the temperature of 5℃, 10℃, 20℃, 30℃, 40℃, 50℃, 60℃, 70℃, 80℃, 90℃ were studied by Raman Spectroscopy combined with Gauss-lorentz peak fitting program. Furthermore, the ion association equilibrium constant of $MgSO_4$ solutions were calculated. The spectra experiments results showed that there were four ion association structures of SO_4^{2-} as the free SO_4^{2-} ion, monodentate, bidentate and complicated contact ion pairs (CIPs). With the increasing of the concentration of $MgSO_4$ solution at the same temperature, the peak area and peak intensity of the ν1- SO_4^{2-} characteristic peaks increased. For the same concentration of $MgSO_4$ solution, with the increasing of temperature, the peak area and peak intensity of the ν1- SO_4^{2-} characteristic peaks decreased and blue shift phenomenon occurred in the peak position. For all the $MgSO_4$ solutions, the free SO_4^{2-} ion was the main structure, then the bidentate CIP, the other two structures appeared or disappeared with the change of concentration. There were almost no bidentate and complicated CIPs detected in dilute $MgSO_4$ solutions. During the process of the temperature increasing for high concentration of 1.5mol/L and 2.0mol/L $MgSO_4$ solution, the content of free SO_4^{2-} ions decreased, the chance of bidentate CIPs increased, but the content of bidentate and complicated CIPs didn't change much. Likewise, the ion association equilibrium constant of $MgSO_4$ solution increased which showed that the ion association equilibrium moved to the right with the temperature increasing for 1.5mol/L and 2.0mol/L $MgSO_4$ solution, thus more CIPs generated. But the ion association equilibrium constants of 0.5mol/L and 1.0mol/L $MgSO_4$ solution changed irregularly.

ELECTROCHEMICALLY SELECTIVE EXTRACTION OF LITHIUM FROM SEAWATER AND BRINE

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Lithium is one of the most important elements in various fields including energy storage, medicine manufacturing and the glass industry. The demands for lithium are constantly increasing [1]. The solar evaporation process is the major method for lithium production from lake water, but this process is not only inefficient and time-consuming but also causes a few environmental problems [2]. Here, an electrochemical lithium recovery method based on a λ-MnO_2/carbon materials hybrid supercapacitor system was proposed. The lithium ions and counter anions are effectively captured at each electrode with low energy consumption in a salt solution containing various cationic species. The spinel manganate lithium (LMO) was obtained by sol-gel method. The prepared LMO was pasted on screen printing carbon electrode (SPCE), forming LMO/SPCE composite electrode. In order to form a specific embeddable cavity for lithium ions, the lithium ions were extracted from LMO/SPCE by applied a constant voltage. The lithium extracted MO/SPCE electrode was employed as working electrode in several solutions: 1M LiCl solution, 1M NaCl solution, 1M $MgCl_2$ solution and pretreated real brine provided by Chaerhan salt lake.Qinghai.China. During the cycle voltammetry measurement obvious selectivity of MO/SPCE electrode to lithium ions was observed, which was supported by the considerably higher peak currents in lithium contained solution than those flat curves in NaCl and $MgCl_2$ solutions. Farther, the diffusion coefficient of lithium in LiCl solution and real brine were compared, under same Li+ concentration. The peak current of CV test in real brine is slightly less than that in pure LiCl solution. The diffusion coefficient was calculated by Bard Equation (Bard and Faulkner, 2001) [3]: IP=2.69×105n3/2SD01/2V1/2C0 (1) IP indicates peak current with unit of mA; n indicates numbers of transferred electron; S indicates surface area with unit of cm^2; D0 indicates diffusion coefficient with unit of cm2/s; V indicates scan rate with unit of V/s; C0 indicates concentration of electrolyte with unit of mol/cm^3. Diffusion coefficient of lithium ions in real brine is obvious slower than that in pure LiCl solution. The reason may explain by blocking effect and interactions, which should be studied further. A flow process for electrochemical lithium extraction from brine was proposed based on the studied method. The optimized operating parameters are studying with the aim of high selectivity and long-term stability.

Key words: Electric Filed, Selective Extraction of Lithium, Seawater and Brine.

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THOUGHTS ON SALT SCIENCE

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Saline lakes are an important type of lake, viz. one where water-bodies contain a relatively high concentration of dissolved salts. According to recent advances in the study of saline lake geology, biology and other fields, I suggest that the lower limit of salinity for saline lakes sensu stricto be defined as >3.5 %, while that for saline lakes sensu lato≥0.30 % or in excess of 3 $g \cdot l^{-1}$ (Williams, 1996). Saline lakes can contain important raw materials for industry, agriculture, and medicine, e.g. halite, mirabilite, lithium, magnesium, boron, gypsum calcium chloride, tungsten, cesium, rubidium, strontium, hydromagnesite and zeolite. Considerable amounts of biological resources, such as halophilic algae, Artemia, Spirulina, of economic and scientific value, occur in saline lakes. Moreover, saline lakes are important for tourism. The heat-storing features of lake brine solar evaporation ponds have also been used in electricity. Finally, saline lakes are sensitive indicators of the past and important for reconstructing paleoclimatic, paleoenvironmental and tectonic events. Salt lake systems are the products of combined interactions of multifactor, including various source material and extreme climates. They are the treasure house of various salt minerals, halophilic and salt-tolerant biological resources. Salt lake sediments records rich information about the evolution of nature, including the past and modern of earth interior, atmosphere, hydrosphere, cryosphere, and even the universe, for example, salts have been found on Mars, Europa, and Enceladus, thus salt lake is the "window" and the recorder for understanding the interaction between multi spheres of our planets. Therefore, after long history of studies from single discipline (geology, chemistry, chemical engineering, biology, and engineering etc.) comprehensive studies are needed in interdisciplinary approach under the guidance of holism and the system theory, to reveal the mysteries of salt lake systems and to explore their big value.

THERMODYNAMIC REPRESENTATION OF THE STABLE PHASE EQUILIBRIA AND SALT-FORMING DYNAMIC FOR TYPICAL SALT-LAKE BRINE

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Chloride and sulfate brines are typical and high concentrated in the salt lakes of Qinghai China where the major cations include Na^+, Mg^{2+}, Ca^{2+}, K^+, Li^+, Ru^+, etc. Under the nature conditions, the phase equilibria and salt-forming dynamics are more complex. Furthermore, the valuable salts recovering processes depend on complex solid-liquid phase equilibria behaviors.

We present recent advances in thermodynamic representation of stable phase equilibria and salt-forming dynamics aimed to support geochemistry of saline lake, and industrial process simulation. The comprehensive thermodynamic model based on symmetric eNRTL theory [1] was employed and furtherly improved by accounting for the chemical contribution in some special system, such as LiCl-KCl-H_2O system. The expression of ion's thermodynamic data is extended to fit low temperature. The concentration dependency of the solution nonideality is accounted for with two binary interaction parameters for each of the water-electrolyte interaction pairs and the electrolyte-electrolyte interaction pairs. The temperature dependency of the binary interaction parameters is accounted for with a Gibbs-Helmholta type expression with three temperature coefficients representing excess Gibbs energy, excess enthalpy, and excess heat capacity contributions. The temperature and concentration dependency of the ion associative effect is accounted for with the Gibbs energy of formation for each species of ion association.

With the binary parameters regressed from thermodynamic data of aqueous single salt, and aqueous two salt ternary systems, the model provides accurate representation and reliable predictions for various thermodynamic properties. The complete phase diagrams for 20 ternary systems from low temperature of eutectic point (even less than -84℃) to boiling temperature under normal pressure have been predicted, which present the satisfied full view of single solid regions, two solids co-saturated curves and invariable points. The model is expected to cover more ions simultaneously and it should become an indispensable scientific tool in geochemistry and industrial processes analysis.

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SALINE LAKES IN EXTREME ENVIRONMENTS

DIVERSITY OF EXTREMOPHILIC BACTERIAL COMMUNITIES HOSTED BY TWO HIGH-ALTITUDE SALINE LAKES LOCATED IN THE PUNA DE ATACAMA PLATEAU, CHILE

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Laguna Santa Rosa (3770 m.a.s.l.) and Laguna Verde (4350 m.a.s.l.) are high-altitude saline lakes located in the Puna de Atacama plateau, a mountain desert in the Dry-Andes. The plateau is characterized by aridity, great daily temperature range and intense solar radiation. Volcanic features (e.g. warm springs) are also represented, contributing to the extremity of this environment. These habitats harbor extremophilic bacteria, however our knowledge about their phylogenetic and ecological diversity is sparse. A polyphasic approach was applied to reveal the hitherto unknown bacterial communities inhabiting these extreme saline lakes. Samples for microbiological investigations were taken in February, 2016, from sediment of Laguna Santa Rosa (18.1°C) and microbial mats growing in a warm (34.5°C) lagoon of Laguna Verde. Cultivation was carried out on two different types of media (PYG and R2A) and BG11 enrichment cultures were used to further analyse the diversity of phototrophs. The isolated bacterial strains were identified and tested for NaCl tolerance. Community DNA was isolated from each sample and the enrichment cultures, and investigated using 16S rRNA gene based molecular methods. In order to compare the general diversity, denaturing gradient gel electrophoresis was performed. Based on the UPGMA similarity dendrogram constructed from the molecular fingerprints of bacterial communities in the two examined lakes, samples were chosen for a more in depth analysis using next-generation amplicon sequencing technology (Ion Torrent). The estimated average cell counts were two orders of magnitude higher on the oligotrophic R2A medium compared to the PYG proving that bacterial communities of these saline lakes are well adapted to the oligotrophic environment. Altogether 113 strains were identified, and overall 95 % of the isolates required NaCl for growth. Members of the genera *Marinobacter*, *Caenispirillum*, *Jeotgalibacillus*, *Idiomarina*, *Halomonas*, *Paraliobacillus*, *Nitratireductor*, *Salinarimonas* and *Planococcus* were detected. Overlap between genera isolated from the two lakes was minimal. 16S rRNA gene based molecular methods revealed diverse but distinct bacterial communities in Laguna Santa Rosa sediments and Laguna Verde microbial mat samples. Community structure of phototrophs based on the similarity dendrogram of molecular fingerprints was different in the two lakes, however sequencing revealed the presence of *Oscillatoriales* in both environments.

POLYEXTREMOPHILIC ENZYMES FROM ARCHAEA AND BACTERIA: STRUCTURAL AND FUNCTIONAL FEATURES

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Enzymes from extremophilic organisms are often polyextremophilic. In other words, they exhibit resistance to more than one stress factor of extreme environment, such as high temperature, high salinity, marginal pH values or water-miscible organic solvents. Detailed analysis of many–years research revealed a relationship between polyextremophilicity and organization of 3D-structure of the enzymes. Combination of different forces provides stability and activity of the enzymes in the extreme environments. Structural features of new polyextremophilic archaeal and bacterial enzymes are discussed here.

The short-chain alcohol dehydrogenase from the archaeon *Thermococcus sibiricus* (TsAdh319) exhibited adaptation to different kinds of stress. The enzyme demonstrated robust thermostability (50 % of activity was observed after 6 h at 90°C and 20 h at 80°C at neutral pH), the temperature optimum of activity with different substrates was between 80-85°C. The enzyme was stable and active in 4M NaCl at 60ºC. The preincubation of TsAdh319 for four hours at 55°C in the presence of 50 % [v/v] DMSO, DMFA, methanol, acetonitrile, chloroform and n-hexane prior to the activity assay did not result in the decrease in the enzyme activity. Only guanidine hydrochloride being a charged agent was able to deactivate TsAdh319. Detailed structural analysis and a comparison of TsAdh319 with close structural homologs revealed an abnormally large number of charged residues on the surface of TsAdh319 tetramer. The percentage of charged residues was suggested to play a key role in the resistance of TsAdh319 to environmental stress.

Further, the correlation between enzyme thermostability and resistance to water-miscible organic solvents was examined using structural and functional characteristics of new thermostable transaminases, which were able to keep stability in 50 % DMSO, DMFA, acetonitrile and methanol. Transaminase from archaeon *Geoglobus acetivorans* (GeoTA) demonstrated an optimal temperature of reaction with L-leucine and 2-oxoglutarate around 80°C. The preincubation of the enzyme at 70°C resulted in 50 % loss of activity after 5 h. Optimal temperature of reaction with L-leucine and 2-oxoglutarate catalyzed by transaminase from *Thermobaculum terrenum* (TterTA) was found to be 75°C and the preincubation of TterTA at 70°C resulted in 16 % loss of activity after 24 h. Both GeoTA and TterTA showed robust resistance to denaturation in the presence of 50 % DMSO, DMFA, acetonitrile and methanol at 65ºC and retention of significant activity in standard assay with 15 % organic solvent added. At such concentrations of organic solvent the likelihood of direct contact of the solvent with the enzyme is increases and can result in severe distortion of the enzyme structure, rapid denaturation or inactivation. One explanation for this destruction is that the hydrophilic tendency of water-miscible organic solvents strips off water from the protein surface and competes with the non-covalent interactions of enzymes, especially at the elevated temperatures. The analysis 3D-structures of GeoTA and TterTA showed the small excess of charged amino acid residues on the surface of the molecules

compared to mesophilic homologs. The percentage of unpaired charged residues was small for TterTA and significant for GeoTA. The role of hydrophobic and charged residues distribution on the protein surface in terms of GeoTA and TterTA resistance to dehydrating condition in water-miscible organic solvent system at elevated temperature was examined.

This work was supported by RFBR, project № 16-34-60252 (in part of structural analysis of TsAdh319) and by the Russian Science Foundation, project 14-24-00172 (in part of structural and functional characterization of new transaminases).

SALT LAKES HYDROCHEMISTRY OF THE BAIKAL RIFT ZONE

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Studies of soda and salt lakes of the Baikal rift zone were started in 1996 by Professor Bair Namsaraev.

More than 600 soda-salt lakes ranging from a few hundred meters up to 400 km^2 were revealed in the Baikal rift zone, characterized by a great variety of chemical composition. These lakes belong to the Central Asia region famous for arid climate and considerable temperature changes throughout the year. The formation of lakes is favored by hummocky terrain with a lot of depressions and semi-arid climate that is conducive to evaporative concentration of surface waters. Lakes formation is greatly influenced by permafrost that increases the level of ground waters and accelerates the process of soil salinity and salt accumulation in the lakes.

For thirty years we have been conducting hydro-chemical and microbiological studies of salt lakes in the Baikal region, including Mongolia. Most of those lakes are small in size (0.2–5.2 km^2) and depth, have unstable water regime with strong seasonal fluctuations in the amount of precipitation and temperature. Hydro-chemical composition of lakes is associated with the geological and geomorphological structures, hydrological characteristics, activities of the biota in the water column and bottom sediments. In the period under investigation pH ranged from 8.6 to 10.6 and salinity – from 1.8 to 390 g/dm^3. Most widely represented was a group of lakes with salinity up to 30 g/dm^3. Shallow lakes with a small area of water surface periodically dry out, and then are naturally irrigated during periods of rain and snow melting.

Under favorable conditions, such as shallow water, sufficient lighting and water heating, fou ling or microbial mats are formed. Mats in most of the studied lakes were very thin, ephemeral. Only in some lakes a mat is a firm strictly structured formation, similar to halophilic mats of saline ecosystems. We found that the formation of a thick mat is promoted by the chemical composition of water. Mat structure changes depend on physical-chemical conditions of the lake. Mineral layers of aragonite, calcite, calcium phosphate were revealed in the mat.

OVERVIEW OF SALT LAKE STATIONS ON TIBETAN PLATEAU

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Long term salt lake observations are of great significance in resource exploitation and fundamental studies of salinology. This paper introduces the background, existing infrastructure, equipments, current research progress and prospects of three salt lake stations on Tibetan Plateau. These three salt lake stations have been established adjacent to the Li, B rich special lake Zabuye, Dangxiongcuo, and Bange respectively, Northern Tibetan Plateau. Up to now, these three stations have been equipped with instruments for hydrochemical analysis and for the meterologic and hydrographic automatic observation, together the experimental platform for brine evaporation studies has been established. Based on three salt lake stations, we have carried out continuous meterologic and hydrographic observations on selected salt lake system and the study of the dynamic change of salt lake type Li, B deposits, the extraction experiments of lake mineral resources, and many achievements have been made. In the future, we will compile the large volume of meterologic and hydrographic data observed, and try to built a useable database for public sharing.

GLAUBER' SALT PRECIPITATION RULES OF YABULAI SALT LAKE BRINE

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In order to seperate Glauber' Salt from recycled salt in Yabulai salt lake, the rules of glauber's salt precipitation in the simulation of the local climate conditions was studied with the help of equilibrium phase diagram of the quaternary system (Na^+, Mg^{2+}//Cl^-, SO_4^{2-}-H_2O). It was shown that temperature had a great influence on the precipitation rate of glauber's salt brine.Relative low temperature is advantageous to the precipitation of glauber's salt under the condition of constant temperature. At -10°C, when the rate of adding water was controlled at 7.82 %, concentration of SO_4^{2-} fall below 0.15mol/L in the liquid phase and glauber's salt precipitation rate could reach 82.61 %. It could satisfy the requirements of the salt lake. Simulating the salt lake local climate characteristics, we can find that concentration of SO_4^{2-} increased with the promotion of temperature. At -10°C, concentration of SO_4^{2-} reached 0.12mol/L, glauber's salt precipitation rate was 85.66 % in this case. Concentration of SO_4^{2-} in liquid phase was lower Compared with the condition of constant temperature at -10℃. Concentration of SO_4^{2-} in liquid phase reached 0.11mol/L at -10°C when the temperature changed from 5°C to -20°C and meet the demand of the salt lake once again.

HYDROCHEMICAL INVESTIGATIONS OF SODA-SALINE LAKES OF TRANSBAIKALIA IN WINTER PERIOD

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Soda-saline lakes, which are widespread in the Baikal region, form the sets of interconnected reservoirs. A characteristic feature of such unique aquatic ecosystems is the alkaline conditions and high concentration of salts. At present, soda-saline lakes are poorly studied, with the controversial opinions about their origin [1-2].

Hydrochemical characteristics of salt lakes of Buryatia were investigated in winter – they are lakes Nuhe-Nur, Alginskoe and Orongoyskoe, located in the steppe areas. These lakes are shallow ponds of a relatively small size. The values of mineralization of lakes Nuhe-Nur, Alginskoe and Orongoyskoe define them as salty, alkaline (salinity 1-35 g/dm^3 [1]).

PH values of water of lakes Nuhe-Nur and Orongoyskoe are alkaline, the water of the Alginskoe is slightly alkaline. The value of the oxygen content in lake Alga was lower than in other lakes, that might be explained by the fact that at the time of sampling this lake was completely frozen. The values of hardness in all lakes are different; the hardest is the water of lake Orongoyskoe.

According to the ion composition in all the lakes under investigation, sodium ions dominate among cations that is typical for highly mineralized waters. Unlike cations, dominant ions in all lakes differ from each other in anionic composition: Nuhe-Nur – bicarbonate-ion; Alginskoe – sulfate- ion; Orongoyskoe – chloride-ion. Unlike the others, in lake Orongoyskoe recorded was high concentration of calcium and magnesium that causes high values of stiffness.

The results of elemental analysis showed a significant concentration of silicon, boron and strontium in all the studied lakes. High concentration of phosphorus was detected in lakes Nuhe-Nur and Alginskoe. In comparison with other lakes, high concentration of uranium, tungsten, molybdenum, zirconium, and astatine was revealed in lake Nuhe-Nur; in lake Alginskoe - iron and silicon; in lake Orongoyskoe - lithium and strontium.

Based on the results of the analysis, the waters of the above-mentioned lakes were typified for the winter period; classification of salt lakes was based on the chemical composition of the brine. For lake Nuhe-Nur sodium bicarbonate water type is typical, for the Alginskoe – sulphate-sodium type, for the Orongoyskoe – sodium chloride type. The distinguishing feature of the selected types of waters is that the transition of the composition of water from one chemical type to another can be accomplished through the interaction with the matters of the environment. Metamorphosis in the forward direction leads to a gradual loss of less stable in solution components and a transition of the chemical types in the direction from bicarbonate to sulfate, then to chloride. Metamorphosis in the reverse direction leads to the change of chloride type waters by sulfate and bicarbonate ones. The development of the direct metamorphosis is promoted by the increase in climate aridity and growing mobility of calcium ion; the humid climate contributes to the reverse process that reduces the degree of mineralization and increases hydro-carbonate concentration of water.

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MICROBIOLOGY OF SALINE LAKES (SPECIAL SESSION DEDICATED TO THE MEMORY OF PROFESSOR BAIR NAMSARAEV)

CONTRIBUTION OF PROF. B. B. NAMSARAEV IN BIOGEOCHEMESTRY AND MICROBIOLOGICAL RESEARCH OF HIGHTLY-MINERALIZED SODA LAKES OF SOUTH-EAST SIBERIA AND MONGOLIA

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Professor Bair Badmabazarovich Namsaraev is a well-known scientist ingeneral microbiology and biogeochemistry of aquatic ecosystems. He is successor of the ideas of the two academicians – G. A. Zavarzin and M. V. Ivanov, which were his colleagues for a long time. During work in Institute of Biochemistry and Physiology of Microorganisms RAS (Pushchino) and Institute of Microbiology RAS (Moscow) Bair Namsaraev made a significant contribution to the study of microbial processes in marine ecosystems: the hydrothermal habitats of the Pacific and the Kurile Islands, the salt marches of Cuba, as well as the bottom sediments of the Black, Baltic, Japanese, Caribbean and Kara Seas. In 1993 Bair Namsaraev headed a new direction of research in the Siberian Branch of the Russian Academy of Sciences – the study of structural and functional organization of microbial communities of aquatic and terrestrial ecosystems in the Central Asia. Bair Namsaraev and his colleagues carried out pioneering work on biogeochemistry and microbial diversity of mineralized waters of Buryatia, Trans-Baikal Territory and Mongolia. Leading specialists in various fields of knowledge also contributed in his research projects. Bair and his lab used a multifaceted methodological approach for a sufficiently complete microbiological characterization of bottom sediments of soda and salt lakes. In his works much attention was paid to the quantitative activity of the microbial processes involved in the decomposition of cellulose, reduction of sulfates and methanogenesis. He also investigated the biotechnological potential of microorganisms of extreme habitats and medicinal properties of mineral waters in the Siberian region. The works of Bair Namsaraev have great fundamental and practical importance. Bair Namsaraev published more than 400 scientific works, including several monographs. The proposed presentation will reflect the results of the most significant studies of B. Namsaraev.

MICROBIAL COMMUNITY OF THE BRACKISH LAKE BELOE (TRANSBAIKAL REGION)

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Brackish Lake Beloe located in Transbaikal Region (N $51^0 32' 40''$ E $107^0 02' 42''$). The surface area is 0.63 км^2 and the maximum depth is 2.1 м. The lake has low salinity water (3.1 g/L). Extreme physicochemical parameters include alkalinity (pH 9.4). Investigation of microbial taxonomic diversity and of the rates of microbial processes of production and decomposition of organic matter made it possible to establish considerable diversity and activity of the sulfur cycle microorganisms in the microbial community of Lake Beloe upper sediment layer. According to the results of pyrosequencing, of the 16S rRNA gene, bacteria involved in H_2 formation and oxidation were numerically predominant and highly diverse. The *Hydrogenophaga* spp. dominating in the community are aerobic or facultatively anaerobic chemoorgano- and chemolithoautotrophs using hydrogen oxidation as the source of energy. They play an important role in the transitory zones of mixing of subterranean and surface water.

OBLIGATE ALKALIPHILIC FUNGI INHABITING THE LITTORAL ZONE OF HYPERSALINE LAKES

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Text (not more than 4000 characters with spaces) Fungi are well-known primary aerobic decomposers in the wide range of environments. However, in extreme habitats such as hypersaline lakes all main roles in the nutrient cycle are traditionally attributed to prokaryotic organisms. The question arises whether fungi take part in decay in extreme ecosystems. A large amount of organic material accumulates on the shores of lakes; and furthermore, cyanobacterial blooms develop there. Fungi can be successful both in aerobic and microaerobic environments, which makes them the best candidates for decomposition in the littoral zone of hypersaline lakes. This becomes especially intriguing with regard to soda lakes, being among the most productive aquatic habitats. Until recently, it was believed that fungi do not occur in soda habitats due to the general preference to grow at neutral or slightly acidic pH. Nonetheless, recent studies have shown that alkalitolerant and alkaliphilic fungi are widespread in soda habitats. In our research group, we`ve developed the set of methods for selective recovery of alkalitolerant and alkaliphilic fungi. They include selective medium - alkaline agar (pH 10.2), improved isolation methods and growth experiments on the wide range of pH values. We`ve analyzed more than 150 samples of soda soils around soda lakes from Russia, Mongolia, Tanzania and Kenya with pH up to 11. Our research has shown that alkalitolerant fungi, which can cope with high pH levels but have the growth optimum at neutral pH, are widespread in different soils. Alkaliphilic fungi that prefer alkaline conditions are less common. Among them only few fungal species from Thielavia (*Chaetomiaceae*, *Sordariomycetes*, *Ascomycota*) and Sodiomyces (*Plectosphaerellaceae*, *Sordariomycetes*, *Ascomycota*) are obligate alkaliphiles that cannot grow at pH below 5.0-5.5. The latter one, Sodiomyces, is a new genus, which is most common in stable alkaline soils. It seems to be an ideal model for investigating the alkliphilic trait within fungi. Type species S. alkalinus was isolated from stable soda soils (pH 10.7) on the shores of soda lakes in Russia, Mongolia, and Tanzania. Later we described two additional obligate alkaliphilic species S. tronii and S. magadii from soils around the Lake Magadi in Kenya (the soda lake with pH up to 11). Thus we supposed Sodiomyces to indicate stable alkaline conditions. The last year`s research showed that it was not so clear. We found Sodiomyces magadii to inhabit hypersaline neutral soils (pH 7.5) on the edge of the chloride Lake Baskunchak (Russia). The explanation for such an unexpected habitat of this fungus can be in clarification of its ecological niche. Our isolates were recovered from the littoral zone of hypersaline lakes. We can speculate that Sodiomyces can thrive through alternating cycles of drought and flood. Unique sodiomyces` type of sexual reproduction confirms the following hypothesis: sexual spores develop in closed fruiting bodies to be released into the slime matrix, asexual spores are also covered with slime. These properties seem to be adaptive to aggressive environment and to distribution with water flow. The composition of enzymes and some other features confirm that Sodiomyces switched over from the plant diet characteristic for other Plectosphaerellaceae members. Some data including the presence of bacterial genes in Sodiomyces genome suggest that fungus can be somehow associated with bacteria. We hypothesize that fungi are good candidates for cyanobacterial blooms` decomposers, as cyanobacteria are the main producers both in chloride and soda lakes. Alkalinization of medium during photosynthesis can explain the presence of obligate alkaliphilic fungi in the generally neutral chloride Lake Baskunchak. Further studies of Sodiomyces ecology may confirm this hypothesis. This can help understanding of structure and evolution of extremophilic communities.

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A METAGENOMIC STUDY OF BENTHIC MICROBIAL COMMUNITIES OF SALINE LAKES OF THE NOVOSIBIRSK OBLAST

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Parts of the Kulunda and Baraba steppes located in the Novosibirsk oblast contain many brackish and saline lakes. These lakes are unstable and demonstrate significant oscillations in water levels on a timescale of year, season, and month, up to complete desiccation, and their microbial communities have various metabolic and behavioral adaptations to these environmental fluctuations.

There are studies of microbial communities of saline lakes from various parts of the world. For the lakes of the Kulunda and Baraba steppes (mostly from the Altai krai) we know physicochemical parameters, composition of organic matter, algae- and zoocenoses, as well as of chemolitoautotrophic bacteria, while little is known on the lakes of the Novosibirsk oblast.

The aim of this study was to investigate the fundamentals of biogeochemistry and microbiology of extreme environments using small saline drainless lakes of the Novosibirsk oblast.

As a model object we took the Solenoye Lake (Bagan district, Novosibirsk oblast). We studied the composition of the benthic microbial community using parallel amplicon sequencing of the V3 variable region of the 16S rRNA gene, as well as geochemical parameters (pH, Eh, cationic / anionic composition, gas components). We described and compared different layers of the bottom sediments and found relations between chemical composition and microbial content of the bottom sediments.

We found that this lake is characterized by (1) an annual visible microbial communities dominated by cyanobacteria; (2) thick bottom sediments dominated by *Actinobacteria* and/or *Proteobacteria*; (3) a peculiar set of geochemical parameters; (4) abundance of *Artemia*, a commercially valuable crustacean; (5) the lake is does not desiccate completely but is shallow enough for significant changes in water level, which allows one to track the dynamics of biological and geochemical characteristics and extrapolate the data to similar lakes of the Novosibirsk oblast.

On the whole, saline lakes of the Novosibirsk oblast are valuable for biotechnology as a source of microorganisms, their genes, enzymes, and metabolites, which should be studied in detail.

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MINERAL FORMATION IN THERMAL ALKALINE SPRINGS OF BAIKAL REGION

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The regions of geothermal water output to the earth surface are characterized by intensive development of microbial communities. At present, there is much evidence that microorganisms, and first of all archeas and bacteria, play a huge role in geological processes [1]. The study of sedimentary deposits of thermal springs has shown a great role in the processes of mineral formation of microorganisms, including cyanobacteria. We have studied the organomineral composition of microbial mats of the Baikal region hydrotherms. The phase composition of the minerals was carried out by X-ray diffraction analysis using a Bruker AXS D-8 Advance diffractometer (CuK_α radiation, graphite monochromator) and Hitachi TM 1000 scanning electron microscope with a TM 1000 EDS detector. It was found that the most common minerals precipitated in thermal springs are carbonate minerals (calcite, aragonite), silicate minerals (cristobalite, quartz, kyanite, albite, anorthite).

It is known, microorganisms play an important role in the cycle of silicon, as well as in the precipitation and dissolution of silicate minerals and amorphous composition. Microbial fouling and mats are considered to serve as nucleation centers for the formation of silicate minerals, and then the process of mineral formation occurs autocatalytic [2].

Siliceous formations of biogenic origin that are siliceous covers on filaments of cyanobacteria and valves of diatom algae are found within the microbial mats. Thus, in the Umhei and Seiyu hydrotherms, the waters of which come out in the northern part of the Barguzin basin and form a lake, albite $(Na,Ca)Al(Si,Al)_3O_8$, quartz, cristobalite (SiO_2) and anorthite $CaAl_2Si_2O_8$ are deposited.

The microbial precipitation of carbonates (travertins) has been studied rather well. Most travertines are believed formed as a result of the combined action of biogenic and abiogenic factors. Calcium carbonate is known to occurs in the form of calcite, which is often found in the sort of biominerals to be formed as a result of metabolic activity of organisms. Calcite deposits are found in the communities of the Alla and Garga springs. The main conditions for the formation of calcium carbonate are the active working of cyanobacteria, which in the course of their vital activity can increase the pH of the medium, and the supply of the required amount of the Ca^{2+} cation.

As studies have shown the carbonate and siliceous rocks are an inherent part of ancient sediments [3]. Their accumulation was due, to a large extent, to the biogenic factor.

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PHOTOTROPHIC BACTERIA IN MICROBIAL MATS OF MINERALIZED KIRAN LAKE (SIBERIA)

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The physicochemical properties, the pigment composition, species variety, and the vertical distribution of microorganisms in microbial mats of the soda Lake Kiran were investigated in September 2015. The Lake Kiran is located in Kyakhtinsky District of Buryatia, Russia (50°33'N; 106°85'E). At the sampling time the water temperature in the lake was 28-31°C, the pH value of the water was 9.2-9.3, the water was of the carbonate-sodium type with a total mineralization of about 35 g/l. Collected near the lake shoreline, samples 1-3 were cyanobacterial mats 1-5 mm thick. From the microbial mat of the sample 2 four new alkaliphilic purple sulfur bacteria of the families *Chromatiaceae* and *Ectothiorhodospiraceae* were cultured, and one filamentous anoxygenic phototrophic bacterium of phylum *Chloroflexi* was isolated. The analysis of the species diversity of the bacterial community of the samples 1-3 was performed using the method of new generation sequence of PCR fragments of the 16S rRNA gene. *Alkalihalophiles*, and halotolerant microorganisms dominated in the bacterial mats community. The microbial mat formation in the soda lake Kiran grounds on the organic biomass decomposition while the latter consists of the plankton cyanobacteria belonging to *Arthrospira* genus. *Cyanobacteria* were represented by twelve phylotypes with the three prevailing phylotypes being close to *Arthrospira platensis*, *Geitlerinema sp*. and *Spirulina major*. The largest species diversity of microorganisms was found in sample 1. In addition to cyanobacteria, a significant number of nonsulfur purple bacteria (NSPB) (34.3 % of the total number of phototrophic bacteria) and aerobic bacteriochlorophyll a-containing bacteria (3.6 %) were detected in sample 1 with almost no purple sulfur bacteria. NSPB were represented by the three phylotypes close to alkalophilic species *Rhodobaca bogoriensis*, *Rhodobaculum claviforme* and *Rubribacterium polymorphum*. Aerobic anoxigenic phototrophic bacteria were represented by five phylotypes, with the dominant phylotype close to *Geminicoccus roseus*. Purple sulfur bacteria were represented by ten phylotypes with 29 % of the total number of phototrophic bacteria in the community in the sample 3 and 20 % in the sample 2, while less than 1 % in the sample 1. Most of the sequences belong to the bacterium close to *Thiorhodovibrio* winogradskyi. The phototrophic representatives of the family Ectothiorhodospiraceae developed mainly in the sample 2. Filamentous anoxygenic phototrophic bacteria (FAPB) were represented by the two phylotypes. Most of the FAPB were found in the sample 2 - 0.5 % of the total number of phototrophic bacteria, whereas FAPB presented in trace amounts of the sample 1. The bacterium "Candidatus *Chloroloca asiatica*" is the closest bacterium to the prevailing phylotype. Green sulfur bacteria were not found. It can be assumed that not only planktonic cyanobacteria participate in the formation of the sapropel of Lake Kiran, but also the phototrophic microorganisms that compose the cyanobacterial mat. Previously, the role of benthic phototrophic microorganisms in the formation of therapeutic mud in salt ponds of the Crimea was established.

ECOLOGICAL CONDITIONS AND ACTIVITY OF MICROBIAL COMMUNITY IN MINERALIZED LAKES OF SOUTH-EASTERN TRANSBAIKALIA

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A large number of mineralized lakes are distributed in the South-Eastern Transbaikalia (Saltish and salt lakes of Zabaykalie: hydrochemistry, …, 2009). The hydrochemical composition of these lakes is determined by geological and geomorphological structures, hydrological characteristics, and by the functioning of the ecosystem biota. In many lakes are created conditions under which the activity and propagation of most eukaryotic organisms is impossible. Under such extreme conditions (high alkaline pH, high salinity) the dominant organisms in lakes are prokaryotes (oxigenic and anoxigenic phototrophs and chemotrophs). One of the lakes of the South-Eastern Transbaikalia, where environmental conditions are extreme or close to those, are the lakes Khilganta, Gorbunka, Khotochey and Borzinskoe. We investigated ecological conditions (temperature, pH, salinity, redox potential, hydrochemical composition of water) and the functional activity of the microbial community of these lakes.

The lakes are characterized by a high alkaline pH (from 9.51 in Lake Borzinskoe to 9.8 in Lake Khotochey) and high salinity (from 13.08 g/l in Lake Khilganta, to 470 g/l in Lake Borzinskoe) According to the chemical composition of the water, the lakes belong to the chloride-sodium (the Lakes Khilganta, Gorbunka and Borzinskoe) and the carbonate-sodium (Lake Khotochey) types. Anionic composition is dominated by chlorides (from 6,6 g/l in Lake Khotochey to 155,1 g/l in Lake Borzinskoe), a hydrocarbonate-carbonate complex (from 0,109 g/l in Lake Gorbunka to 6,456 g/l in Lake Khotochey), as well as sulphates (from 1,4 g/l in lake Khilganta to 32,6 g/l in Lake Borzinskoe). The cation composition is mainly represented by sodium and potassium (from 4,107 g/l in Lake Khilganta to 129,7 g/l in Lake Borzinskoe). The content of calcium and magnesium was minimal in Lake Borzinskoe (Ca^{2+}–40,08 mg/l and Mg^{2+}–12,16 mg/l), maximal – in Lake Khilganta (Ca^{2+}–62,9 mg/l and Mg^{2+}–509,8 mg/l) .

In the lakes Gorbunka, Khilganta and Khotochey environmental conditions were favorable for the formation of microbial mats. In Lake Bozinsky due to extremely high salinity of water microbial mats was absent. The rate of photosynthesis in microbial mats varied from 0,29 gC/m^2 in day (in Lake Khilganta) to 3,2 gC/m^2 in day (in Lake Khotochey). The anoxygenic photosynthesis rate was 0,067-0,93 gC/m^2 in day. The maximal rate was in Lake Khilganta, the minimal – in Lake Khotochey. The rate of dark assimilation of CO_2, which is an integral indicator of the activity of the microbial community, varied in microbial mats from 0,103 gC/m^2 in day (in Lake Khilganta) to 0,659 gC/m^2 in day (in Lake Khotochey).

In the bottom sediments the rate of dark assimilation was 0,86-56,28 mgC/dm^3 in day. The minimal microbial activity was detected in the bottom sediments of lake Borzinskoe, while the greatest activity was in Lake Khotochey.

Thus, environmental conditions determine the activity of the microbial community of the investigated mineralized lakes. Extremely high salinity in Lake Borzinskoe suppresses the vital activity of phototrophic organisms and the overall activity of the microbial community.

16S DNA ANALYSIS AS A METHOD OF INVESTIGATING PROKARYOTES DIVERSITY IN THE BENTHIC MAT OF SOLAR SALTFIELDS

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Samples of the benthic mats in three solar saltfields in North West Australia have been analysed over four years on three occasions. The primary aim was to evaluate 16S DNA as method for investigating the species diversity and richness of the benthic mat. The method has expanded the prokaryotic richness database for the sites. The ecosystem is much more diverse than expected with up to 200 OTUs identified for individual ponds. 16S DNA analysis has yet to prove itself as a management monitoring tool for commercial saltfields. The results are very dependent on the sampling regime and there is a significant time lapse between sampling and results. The method is becoming cheaper and more available with time so it is very probable that it will become more useful as a technique in the future.

MICROBIOLOGICAL AND PHYSICO-CHEMICAL CHARACTERISTICSOF SALINE SOILS OF FAULT ZONES OF THE BARGUZIN BASIN

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The aim of the work is to determine the physico-chemical parameters and the distribution of various physiological groups of bacteria-destructors of the organic matter of saline soils of the Kuchiger springs. A series of key areas were put in the contour of saline soils of the Kuchigersky tract: TLK-1-16, TLK-2-16, TLK-3-16, TLK-4-16. The TLK-2-16 site was laid in the immediate vicinity of the Dyrensky spring; on the terrain upland - TLK-1-16; on the marshy area with drying lakes - site TLK-3-16; on a high scarcely flooded area near the mouth of the river Ulyugn - TLK-4-16.

All studied soils have an alkaline reaction of the environment. The maximum values are noted in the salt crust (pH 8.6) and in the lower layers of solonchaks of the key areas of TLK-3-16 and TLK-4-16. Carbonates vary over a wide range: from 0.2 to 10.8 %.

The maximal values of maintenance of a humus are recorded in the surface and buried humus horizons. Its content varies from 2.83 to 1.89 %. In sandy light-gray layers, the values of humus are reduced to 0.84 %.

Sharp differences in the profile distribution of easily soluble salts are observed in the solonchaks of TLK-3-16, forming in the lacustrine depression. The maximum salt concentration in the salt crust (27.4 %), humic (2.16 %) and buried humus horizons (1.3 and 0.83 %). Chlorides (62 %) and sulfates (36 %) prevail among aniones.

Among the studied groups of bacterium-destructors the most numerous were saprophytic bacteria. The maximum number of aerobic saprophytes up to 10^6-10^7 cells/g of soil was detected in the upper layers of the soil in the key section of the TLK 1-16. The minimum amount of aerobic saprophytes up to 10 cells/g of soil was recorded in the lower layers of soil in the section of TLK-3-16 and, also, their complete absence was recorded in soil sublayers in the section of TLK-2-16. The large number of anaerobic saprophytes were the share of the upper soil layers of the key sections of TLK 1-16, TLK 2-16, TLK 4-16 to 10^6 cells/g soil. Down along the soil profile, the number drops to 10^3 cells/g soil. The number of aerobic and anaerobic cellulolytic substances ranged from 10^4 to 10^5 cells/g of soil in the section of TLK 2-16, and from 10^5 to 10^6 cells/g in the areas of TLK 3-16 and TLK 1-16, respectively. The growth of sulfate-reducing bacteria was registered only in the key section of TLK-3-16 in layers from 0 to 36 cm. The number of sulfate-reducing bacteria varied from 10 to 1000 cells/g of soil, reaching a maximum in the surface layer of the soil. The conducted researches have shown that in alkaline soils alkaliphilic bacteria-destructors are widespread, and their geochemical activity affects on the chemical composition of these soils.

BACTERIAL PRODUCTION AND PROTOZOAN BACTERIVORY IN STRATIFIED, BRACKISH-WATER LAKE SHIRA (KHAKASIA, SIBERIA)

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The distribution of primary components of the microbial community (autotrophic pico- and nanoplankton, phototrophic bacteria, heterotrophic bacteria, microscopic fungi, heterotrophic flagellates, ciliates and heliozoa) in the water column of Lake Shira, a steppe brackish-water, stratified lake in Khakasia, Siberia (Russia), were assessed in midsummer. Bacterioplankton was the main component of the planktonic microbial community, accounting for 65.3 to 75.7 % of the total microbial biomass. The maximum concentration of heterotrophic bacteria were recorded in the monimolimnion of the lake. Autotrophic microorganisms contributed more significantly to the total microbial biomass in the pelagic zone (20.2–26.5 %) than in the littoral zone of the lake (8.7–14.9 %). First of all, it is caused by development of phototrophic sulphur bacteria at the oxic-anoxic boundary. The concentrations of most aerobic phototrophic and heterotrophic microorganisms were maximal in the upper mixolimnion. Heterotrophic flagellates dominated the protozoan populations. Ciliates were minor component of the planktonic microbial community of the lake. Heterotrophic flagellates were the most diverse group of planktonic eucaryotes in the lake, which represented by 36 species. Facultative and obligate anaerobic flagellates were revealed in the monimolimnion. There were four species of Heliozoa and only three of ciliates in the lake. Rates of oxygenic and anoxygenic photosynthesis, chemoautotrophic and heterotrophic bacterial production and protozoan bacterivory were measured in the pelagic zone of the stratified brackish-water lake with the purpose to determine the vertical distribution of these processes and to estimate their significance in the functioning of planktonic community of the lake. In midsummer, total daily primary productivity was about 1.3 g C m^{-2}, of which 72 % was produced by the phytoplankton, 24 % by the chemoautotrophic bacteria, and only 4 % by the phototrophic sulphur bacteria. Thus anoxygenic photosynthesis is a negligible source of organic matter in the lake. The production of heterotrophic bacteria averaged 1.5 g C m^{-2} d^{-1} and exceeded the total photosynthesis of phytoplankton and photosynthetic bacteria by a factor of 1.5. The estimated total primary production was too low to sustain the bacterial production. Probably the carbon cycle in the lake is dependent on the input of allochthonous organic matter. As a rule, the maximal rates of primary production and heterotrophic bacterial production were found in the chemocline or at the upper boundary of the chemocline. Heterotrophic flagellates dominated among the protozoan populations and were the major consumers of the bacterioplankton production in the lake. They showed maximal ingestion rates from 2.3 to 2.9 mg C m^{-3} h^{-1} at the upper boundary of the chemocline, where they consumed from 50 to 54 % of the production of heterotrophic bacteria. Data obtained indicate that in Lake Shira the oxic-anoxic interface is the site of the most intensive production and mineralization of organic matter.

GENERAL REGULARITIES OF ORGANIZATION IN THE VERTICAL STRUCTURE OF SALT LAKE ECOSYSTEMS: OBSERVATIONS, EXPERIMENTS, THEORY

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The report is dedicated to two new phenomena in the dynamics of aquatic ecosystems: A) a comprehensive experimental and theoretical study of one of the important properties of biological systems open with regard to matter — the effect of autostabilization consisting in the independence of the stationary level (average concentration) of the growth-limiting factor from its concentration in the input stream; B) a new essentially more correct method for describing interpopulation metabolic interactions using a response in the growth acceleration of the acceptor population as a reaction to perturbation of the size of donor population. A. On a large number of specific experimental laboratory examples it is proved that the effect of autostabilization is inherent in the processes of periodic and continuous cultivation of microorganisms, interacting populations of one trophic level, predator-prey interactions and some natural systems. In all cases, general conditions for the existence of the autostabilization phenomenon were determined using mathematical models. The general theorem of "quantization" of autostabilization factors verified experimentally was proved. The results of the study were applied to the explanation of the mechanisms of stratification in the brackish Lake Shira (Khakassia, Siberia), which showed in detail the presence of autostabilized components in the ecosystem from the photic to the anaerobic bottom layer. Theoretical calculations of the concentrations of autostabilized factors coincide with the field data. B. A new method is proposed to evaluate the interaction coefficients in microbial communities interacting due to physical-chemical environmental factors. This method differs from the classical one suggested by E.P. Odum. Redefinition of the interaction coefficients (IC) makes it possible to evaluate the experimental (actual) and theoretical values of the coefficients for the hypothetical interaction layout. The interaction layout is considered to be a set of factors, the values of their transformation ratios and the form of dependence of a population's specific growth rate on these factors. A comparison of theoretical and experimental values of interaction coefficients allows us to assess the adequacy of the hypothetical interaction scheme in microbial communities. The objective of the work is to test the suggested method on a natural algal-bacterial community of Shira Lake, which has been the object of detailed and concerted limnological studies and for which detailed data are available. The feedback coefficients of phyto- and bacterioplankton and the coefficients of influence of phytoplankton on bacterioplankton have been defined. Dominance of negative experimental IC values has been experimentally shown, which is indicative of the negative feedback in bacterio- and phytoplankton links of Shira Lake and of negative interpopulation (phytoplankton vs bacterioplankton) interactions. The considerable differences observed between the experimental and theoretical coefficients indicate the inadequacy of the assumed interaction layout of the community under study. Further investigations are needed to provide a precise sketch of the interactions. The possibility is being discussed of using these results as a new effective methodical and diagnostic technique for determining specific growth control factors for individual populations and mixed cultures, and also as a fundamentally new system for the classification and measurement of interactions in a mixed culture of microorganisms however complex in terms of metabolic relations.

THE PROTEOLYTIC ACTIVITY OF THE ALKALOPHILIC STRAIN *HALOMONAS MONGOLIENSIS* ISOLATED FROM THE SALINE LAKES OF THE BADAIN JARAN DESERT (INNER MONGOLIA, CHINA)

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Saline desert lakes Badain Jaran represent a unique ecosystem in which an extremely high pH (up to 11) is often combined with high salt concentrations (up to 500 g / l). To survive in such conditions, microorganisms should have a complex of adaptation mechanisms [Boltyanskaya, 2006]. Therefore, under these conditions, alkalophilic and halophilic bacteria are widely developed, which are of interest as producers of extracellular alkaline enzymes [Kanekar et al. 2002] Among the enzymes that they synthesize, an important role belongs to proteolytic enzymes. The aim of the study was to determine the extracellular proteolytic activity of the true alkalophil Halomonas mongoliensis isolated from the microbial mat of the saline Lake Badain Jaran.

In the course of our work, we determined the ability to secrete extracellular proteases active on various para-nitroanilide substrates by the method of Erlanger [Erlanger et al., 1961]. The dynamics of the accumulation of proteolytic activity during the growth of these cultures (24-288 hours of cultivation) was studied depending on the source of nitrogen (caseinate, peptone, tryptone). The data showed that activity is present only in two groups of aminopeptidases, where the highest activity was found on the substrate of L-leucyl-n-nitroanilide in a medium with a tryptone. The activity increases after 144 hours and is equal to 0.2 units, the activity peak was observed after 240 hours and amounted to 0.8 units. Based on the results of the conducted studies, it can be concluded that the proteolytic activity depends on the nature of the nitrogen source, its concentration and the time of cultivation of the strain.

The effect of temperature and pH on the activity and stability of extracellular peptidase hydrolyzing the substrate of L-leucyl-n-nitroanilide was studied. The data showed that the optimum pH is 8.5, and the enzyme is stable in an alkaline medium (pH 7-11). The temperature optimum of peptidase at 40°C, the temperature stability of the enzyme is from 10°C to 50°C.

Using a chromatograph DEAE Sephadex A-75, the enzyme was purified 1.32 times with a yield of 6.5 %. The molecular weight of the enzyme is 208900 Da.

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PROTEOLYTIC ACTIVITY OF HALOALKALOPHILIC BACTERIA OF THE GENUS OF *PROTEINIVORAX* FROM SODIUM LAKES TANATAR (RUSSIA)

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Applied interest in haloalkalophilic bacteria is associated, among other things, with the possibility of using them as a source of unique enzymes exhibiting catalytic activity under conditions of increased salinity and alkalinity [Gomes et al., 2004]. The objects of this study were extracellular peptidase complexes of haloalocalophilic anaerobic proteolytic bacteria of the genus *Proteinivorax* - *P. tanatarense* Z-910T [Kevbrin et al., 2013] and *P. Hydrogeniformans'*Z-710T, isolated earlier from the silt of the soda lakes of Tanatar (Altai Territory, Russia).

The aim of the study was to study the specificity of extracellular peptidases with respect to various para-nitroanilide substrates: trypsin-like, chymotrypsin-like, subtilisin-like, cysteine and substrates for aminopeptidases (BAPA, GlpFpNA, GlpAALpNA, GlpFApNA and L-pNa, F-pNa, respectively) by Erlanger [Erlanger et. al, 1961], as well as the determination of the effect of pH and temperature on the proteolytic activity of enzymes.

Peptidases of strain Z-910T were active against substrates specific for subtilisin-like and trypsin-like peptidases, as well as for aminopeptidases. The activity of peptidases with respect to these substances depended on the growth substrate introduced into the culture medium. Thus, the maximum activity on the subtilisin-like substrate GlpAALpNA in the strain Z-910T was achieved with growth on intact biomass of the cyanobacterium *Geitlerinema* sp. (One of the typical primary producers of Tanatar soda lakes) and was 1.6 units, whereas when cultivated with tryptone and caseinate, GlpAALpNA activity did not exceed 0.3 units. The peptidase activity of strain Z-910T according to L-pNa was 0.36 units when growing on medium with *Geitlerinema* sp. and 0.2 units with growth on media with a tryptone or caseinate. Activity on trypsin-like substrate BAPA was 0.9 units with growth on a tryptone or biomass of cyanobacteria and 0.7 units when growing on caseinate. Thus, the peptidase complex of the bacterium Z-910T showed maximum activity when cultivated on intact biomass of cyanobacterium, which at the enzymological level confirms the ability of the organism demonstrated earlier in growth experiments to utilize the "natural" protein component of the biomass [Boltyanskaya et al., 2016]. Peptidases of strain Z-710T grown on media with peptone and tryptone were active only in L-pNa (0.16 unit activity), differing in this way from the peptidases of strain Z-910T for substrate specificity.

The influence of temperature and pH on the proteolytic activity and stability of enzymes was studied using extracellular peptidases hydrolyzing the L-pNa substrate. It was shown that peptidases are active in the temperature range from 10 to 50°C with a maximum at 40 ° C for strain Z-910T and at 30°C for strain Z-710T. The temperature stability range of the enzyme strain Z-910T was 4-60°C, and strain Z-710T was 4-50°C. The data obtained are in full agreement with the growth characteristics of the crops. Peptidases from both cultures showed activity in the pH range of 6 to 9, the maximum being at pH 8. The stability of the enzymes was maintained at a pH of 6 to 9. These values were found to be slightly lower than the growth intervals and pH optimums.

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MICROBIAL DIVERSITY OF THE SODA-SALT LAKES LOCATED IN THE BADAIN JARAN DESERT

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The Badain Jaran desert is located in the western part of Inner Mongolia (China) and characterized by coexistence of numerous lakes and mega-dunes. The lakes of the Badain Jaran desert are located in the northwestern part of the Alashan upland and exhibit a wide range (from moderate to hyper) of salinity. Such ecosystems can harbor unique microbial communities adapted to extreme environmental conditions.

In this study, we assessed bacterial diversity and community composition in microbial mat, water and sludge samples derived from salt lakes of this region via high-throughput amplicon sequencing of 16S rRNA genes. Comparison of rarefaction analyses with the number of OTUs calculated by the Chao1 richness estimator revealed that approximately 70 to 95 % (3 % genetic distance) of the estimated richness was covered by the surveying effort. Thus, a substantial fraction of bacterial diversity within the individual samples was assessed.The dominant phyla and proteobacterial classes across all samples comprised *Alphaproteobacteria*, *Gammaproteobacteria*, *Bacteroidetes*, *Cyanobacteria*, and *Firmicutes*.High relative abundances of sequences affiliated to the cyanobacterial genus *Lyngbya* were determined formicrobial mat datasets. The salt samples harbored *Enhydrobacter* (relative abundance, approximately 3 %), which was not detected in microbial mat samples. So far, only one species belonging to this genus, *Enhydrobacteraerosaccus*, is known.

Correlation data analysis revealedthe dependence of abundance of some microbial groups on environmental parameters. Families *Ectothiorhodospiraceae, Rhodothermaceae, Halanaerobiaceae* and *Halobacteriaceae* exhibited a positive correlation of their abundance with salinity and carbonate concentrations. At genus level, *Halospira* and *Halobacteroides* relative abundances were positively correlated with the aforementioned parameters. Furthermore, some representatives of different genera were significantly affected by pH. Thus, salinity, carbonate concentration and pH influenced the structure of microbial communities in soda-salt lakes.

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PLANKTONIC MICROBIAL COMMUNITIES IN HELIOTHERMAL SALINE LAKES OF TRANSYLVANIA, ROMANIA (SOUTHEASTERN EUROPE)

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A rare feature of saline lakes is a special thermal stratification, called heliothermy, when solar heating results in an underwater temperature maximum. Three deep, heliothermal lakes were studied in Transylvania (Romania), which had different human impact: Lake Fără Fund in Ocna Sibiului is a natural conservation area, Lake Ursu in Sovata, the largest heliothermal salt lake in Europe, is used as a health spa during summer, and a highly polluted lake in Ocna Mureş. A steep stratification existed in all lakes in summer with a transition zone at around 2-4 m, which had the highest temperature (32-42 °C) and the characteristic increase of salinity (up to 260 mS cm-1). Pyrosequencing revealed the dominance of bacterial phyla *Bacteriodetes*, *Cyanobacteria*, *Proteobacteria*, *Firmicutes* (and additionally *Chlorobi* in Lake Ursu) in these heliothermal saline lakes. In all lakes, the euphotic zone was dominated with sequences from small cyanobacteria (e.g. *Synechococcus*) and/or chloroplasts, while in the case of Lake Fără Fund members of the genera *Halogeometricum* and *Salinibacter* (pink-colored archaeon and red-colored bacterium with a light-driven proton-pump), and in Lake Ursu genus *Prosthecochloris* (anaerobic green sulfur bacterium) were also the dominant members of the phototrophic community. Strictly anaerobic genera, such as the sulfate-reducer *Desulfonauticus*, were characteristic in the deeper zones of the lakes. Our results have shown that heliothermal saline lakes with remarkably different microbial communities may exist even within a geographically restricted area.

ANOXYGENIC PHOTOTROPHIC BACTERIA OF THE LAKE KRASNOVISHNEVOYE (BARABA STEPPE)

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The lake Krasnovishnevoye (Novosibirsk region, South Siberia, Russia) is situated in Baraba steppe, in the North Kulunda hydrological zone. It is a typical steppe shallow (depth less than 50 cm) drainless sodium chloride lake. The water and chemical regime is extremely unstable, that is typical for such lakes. The average meanings of mineralization in the lake comprise more than 300 $g.L^{-1}$. To the moment of sampling (August 2015), the area had been experiencing long rains that lead to the significant desalinization. As a result, the total mineralization comprised 180 $g.L^{-1}$, pH 7.8. The data on the abundance, species composition and the distribution patterns of anoxygenic phototrophic bacteria (APB) are known for the lakes of Kulunda steppe situated 300 km far from Baraba steppe (1). This work is the first attempt to characterize APB of a mineralized lake in Baraba steppe. For the detection of APB a number of enrichment cultures were obtained using the upper layer of the lake sediment as inoculum. The liquid medium simulated the mineral content of the lake, also sodium acetate and sodium thiosulfate were added (0.5 $g.L^{-1}$). The content of NaCl (10 – 200 $g.L^{-1}$) and pH values (6.8 – 9.0) varied. The enrichment cultures were incubated anaerobically in the light. Then the bacterial cultures were isolated and purified using the serial agar shake dilution method. The growth of APB was observed in the enrichment cultures on various mineralization with pH higher than 7.5. No growth of APB occurred with the lesser pH values. The purple sulfur bacteria of Ectothiorhodospiraceae family dominated in all the enrichment cultures. The non-sulfur purple bacteria of *Rhodobacteraceae* were also present. The purple sulfur bacteria of *Chromatiaceae* family have not been detected. The purple sulfur bacteria of *Ectothiorhodospiraceae* family were represented by two morphotypes. The first morphotype prevailed on the lower mineralization (up to 70 $g.L^{-1}$). It was phenotypically similar to *Ectothiorhodospira variabilis*. The second morphotype was observed in the enrichment cultures on the lower mineralization, but it dominated on the salinities of 100 – 200 $g.L^{-1}$. Phenotypically this morphotype was similar to the bacteria of *Halorhodospira* genus. The pure cultures of APB of both dominating morphotypes were isolated. The moderately haloalkaliphilic strain KrV03 obviously belonging to *Ect. variabilis* is represented by large polymorphous cells (0.8-1.5 x 1-3 μm) that contain gas vesicles and are motile in the young culture. The colonies and the liquid culture of this strain are red. The halophilic strain KrV01 ("*Halorhodospira* sp.") is represented by motile spirals or curved rods (0.4-0.6 x 1-2.5 μm), the colonies and liquid culture are crimson red. The results obtained show that apparently the lake Krasnovishnevoye shares the characteristics of the species composition of APB (the low diversity of species composition and the dominance of *Ectothiorhodospiraceae* representatives) with the lakes of Kulunda.

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MICROBIAL COMMUNITIES OF TWO STEPPE SODA LAKES OF SOUTH ZABAIKALIE

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Microbial diversity was investigated in two steppe soda lakes Verkhnee Beloe and Nizhnee Beloe located in Buryatia by high-throughput sequencing analysis. The lakes are shallow (maximum depth is 2-2.5 m) and located near (10 km apart). Lake Nizhnee Beloe is a permanent habitat for waterfowl, the shores of the lake are swamped.

Surface sediments were sampled in the coastal zone of Lake Nizhnee Beloe; sediment's column samples were collected from a depth of 2 m in Lake Verkhnee Beloe. Total dissolved salts (TDS) concentration in Lake Verkhnee Beloe water (VB1) was 12.4 g/l, pH 10.2, the temperature was 20.4°C in June, 2011; TDS in the water of Lake Nizhnee Beloe (NB1) in June, 2010 was 4.3 g/l, pH 9.8, the temperature was 30.4°C; in September, 2012 the physical and chemical parameters of lake Nizhnee Beloe water (NB2) were differed: TDS 12.0 g/l, pH 9.7, the temperature was 21.3°C.

Pyrosequencing revealed 11238, 11963 and 8655 sequencesof the 16S rRNA gene in the surface sediment from VB, NB1 and NB2 samples, respectively. *Proteobacteria* dominate (47.3, 47.52, 45.65 %) in microbial communities. *Bacteroidetes* (16.75, 10.33, 12.9 %) and *Firmicutes* (9.42, 16.72, 12.09 %) were subdominants. Phylum *Cyanobacteria/Chloroplast* consist of 10 % in sample NB2, and in other samples 3.87-4.69 %. *Actinobacteria* were 3-5.8 % in all samples. *Chloroflexi* was found only in NB2 sample and constituted 5.35 %. Classes *δ*- and *γ-Proteobacteria* were most represented in VB sample (39.75 % and 27.18 %) and NB1 samples (58 % and 20.3 %). *α*- and *δ*- *Proteobacteria* prevailed in NB2 sample (47.6 and 26.3 %). Percent detection of *β-Proteobacteria* in all samples was the smallest. Analyze of eco-physiological characteristic of these bacterial classes showed that characteristic for marine, brackish or alkaline ecosystems genera constitute 60–80 % (*δ-Proteobacteria*), 12–40 % (*γ-Proteobacteria*) and 15–39 % (*α-Proteobacteria*) in microbial communities. And in all classes specific for marine ecosystems genera were represented more than for hypersaline ecosystems. 3.3-21 % sequences represent alkaliphilic bacteria. Phylum *Firmicutes* was represented by *Clostridia*.

The greatest number of genus was detected in the sample NB2 – 205, 160 and 144 genera were revealed in samples VB and NB1, respectively. 83 genera were common for all three samples, 97 genera were common in samples NB1 and NB2, 103 common genera were revealed in VB and NB1 samples, 110 genera were represented both in VB and NB2. According to Venn diagram, 36.43 and 76 % were represented by unique genera in sediment microbial communities.

POLYSACCHARIDOLYTIC HALOARCHAEA: UNDERESTIMATED DIVERSITY AND EXCEPTIONAL SETS OF GENES, ENCODING SUGARS-PROCESSING ENZYMES

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Until recently, extremely halophilic euryarchaeota were considered mostly as aerobic heterotrophs utilizing simple organic compounds as growth substrates. Almost nothing is known on the ability of these prokaryotes to utilize high-molecular weight polysaccharides as cellulose, xylan or chitin. The analysis of currently available haloarchaeal genomes deciphered numerous genes encoding glycosidases (GHs) of various families, yet only a few haloarchaeal cellulases and chitinases were biochemically characterized. Moreover, all these proteins belong to haloarchaea, isolated and cultivated on simple substrates, thus their ability to grow on polysaccharides *in situ* or *in vitro* is unknown. In our work we have isolated several halo(natrono)archaeal strains from geographically distant hypersaline lakes, capable of growing in salt-saturated mineral media on insoluble polymers as a sole growth substrate. Some of them belonged to known taxa, while other represented novel phylogenetic lineages within the class *Halobacteria*. All isolates produced extracellular extremely salt tolerant cellulases or chitinases, either cell-free or cell-bound. Among all isolated strains, the genomes of representatives of different phylogenetic and/or physiological groups were sequenced and analyzed. Genome analysis revealed a vast number of various glycosidases (GHs), both, intracellular and extracellular, composed of one or several GH domains, possessing and lacking carbohydrate-binding modules. The most numerous were GH families 1 and 2 in all strains, 5 in cellulolytic strains and 18 in chitinolytic strains. Besides GHs, a small number of carbohydrate esterases (CEs) and polysaccharide lyases (PLs) genes were also found. The latter are almost absent in the archaeal genomes, sequenced to date. Altogether, obtained results demonstrate a presence of diverse population of haloarchaeal cellulo/chitinotrophs in hypersaline and their participatation in aerobic mineralization of recalcitrant organic polymers in salt-saturated environments.

IDENTIFICATION OF PEPTIDASES IN THE GENOME OF ALKALIPHILIC AND HALOTOLERANT BACTERIUM *PELAGIRHABDUS* SP. A 11 BY THE BIOINFORMATICS ANALYSIS

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Pelagirhabdus sp. A 11 is a facultatively anaerobic, alkaliphilic and halotolerant bacterium isolated from salt and soda lake in Badain Jaran Desert (Inner Mongolia, China).

Peptidase activity in strain *Pelagirhabdus* sp. A 11 on various substrates was studied. It is shown that the cultures possess highly subtilisin - like, aminopeptidase activity. Peptidases are stable in a wide temperature range of 23 to 60^{o}C and a pH from 6.80 to 11.98. Peptidase activity varies depending on the substrate in the medium and cultivation time.

Genome sequencing of *Pelagirhabdus* sp. A 11 was performed on Illumina HiSeq in the BioSpark (Moscow).

Total of 1067 contigs yielded a genome sequence 2,959,587 bp long. The complete genome sequence contained 2668 CDS, 12 rRNAs, 61 tRNAs, 1 tmRNA.

The bioinformatics analysis of the genome showed that nucleotide sequences were related to 29 locuses coding peptidase. It was shown that the detected peptidase genes are responsible for the synthesis of the aminopeptidase enzyme, they are signal biomolecules for the initiation and initiation of certain mechanisms in the living prokaryotic cell and can participate in sporulation.

The homology of the genes of found peptidases with known enzymes ranged from 38 to 99 %.

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BIODIVERSITY, NOVELTY AND ANTIMICROBIAL ACTIVITY OF CULTURABLE ACTINOBACTERIA ISOLATED FROM JIULIANCHENG NUR IN HEBEI PROVINCE, CHINA

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Due to the widely spread of the drug-resistance bacteria, new antibiotics are urgently needed. Actinomycetes are one of the most important antibiotics-producing pharmaceutical resources. Studies have shown that the possibility of discovery for new antibiotics from actinomycetes inhabited in special environments was higher. Saline lakes are special water-bodies with a relatively high concentration of dissolved salts. Previous studies have shown the actinomycetes from saline lakes are rich in diversity & novelty and a wide range of biological activities, hence, actinomycetes from saline lakes is a potentially pharmaceutical resource for drugs discovery. To explore the diversity and novelty and study the antimicrobial activity of culturable actinobacteria. Soil samples from dried lake basin were collected in Jiuliancheng Nur, affiliated in eastern Inner Mongolia subregion, north-central region of Chinese saline lakes. Actinobacteria were isolated by using dilution plating technique with 15 media. Purified isolates were analyzed by comparison of 16S rRNA gene sequences to study biodiversity. Crude extracts from the fermented broth were obtained using ethyl acetate and from mycelia by acetone. Disk diffusion was used in antibacterial or antifungal assay and positive strains were further screened for PKS I, PKS II and NRPS antibiotics biosynthetic genes by PCR. A total of 251 actinobacterial strains, isolated from 11 soil samples, belonged to 31 genera affiliated with 15 families in 10 orders and *Streptomyces* and *Nocardiopsis* are dominant genera. Fifty seven strains were halotolerant or halophilic isolates, including 22 *Nocardiopsis* isolates and 15 *Nesterenkonia* isolates. Based on the polyphasic taxonomic approaches and phylogenetic analysis by 16S rRNA gene sequences, a halotolerant actinobacterium strain J12GA03T from rhizosphere soil of Suaeda salsa was proved to be a novel species of the genus *Hoyosella*, for which the name *Hoyosella rhizosphaerae* sp. nov. was proposed. The type strain was J12GA03T (=DSM 101985T=CGMCC 1.15478T). Meanwhile, strain J11Y309T from soil, was also proved to be a novel species of a new genus in the family *Glycomycetaceae*, for which the name *Salilacibacter albus* gen. nov., sp. nov. was proposed with *Salilacibacter albus* sp. nov. as the type species. The type strain of *Salilacibacter albus* is J11Y309T (=DSM 46875T=CGMCC 4.7242T=LMG 29297T). Out of 96 fermented strains, 56 exhibited positive activity in antibacterial or antifungal assay, and the total positive rate reached 58.3 %. Out of 56 positive strains, 47 carried at least 1 antibiotic biosynthetic gene and 17 strains carried all the 3 genes. Jiuliancheng Nur shows a rich biodiversity of culturable medicinal actinobacteria, and it is a valuable source for novel antibiotics discovery. The chemical studies on antimicrobial substances from positive actinobacterial strains were still under way.

DIVERSITY OF MICROBIAL COMMUNITIES IN ZONES WITH A CONTRAST MINERALIZATION OF PORE WATERS ON LAKE BAIKAL

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Lake Baikal is a unique freshwater reservoir in sediments which as well as marine sediments detected different geological structures, including a mud volcano, methane and oil seeps, a low-temperature vent, and areas near-surface gas hydrates (GHs) (Khlystov et al., 2007; Granin et al., 2010). In sediments of these areas in composition of discharge fluids detected the wide range of chemical compounds which can serve as electron acceptors and a source of carbon for different steps destruction of organic compounds.

In 6 sites with different composition of discharge fluids and mineralization of pore waters using massive parallel sequencing (Roche 454 platform) investigated diversity of microbial communities and assessed association of phyla and phylotypes Bacteria and Archaea with the presence of certain ions.

Chemical composition of pore water deep sediments the reference site was similar to Baikal water (Grachev et al., 2004). Among Bacteria dominated representatives of phyla *Verrucomicrobia*, *Bacteroidetes*, *Actinobacteria* and *γ-Proteobacteria*. Among Archaea dominated sequences of *Thaumarchaeota* and *Euryarchaeota* (group MBG-D).

Total mineralization of pore water deep sediments of oil seep Gorevoy Utes reached 250 mg/l. The chemical composition of pore waters another oil seep (Tolsty) was not substantially different from that of the reference site. In these sites concentrations of Fetot diss, calcium and sodium ions were high when in the reference site. The taxonomic composition of microbial communities sites of oil seeps was different. In deep sediments of Gorevoy Utes among bacteria dominated representatives *Actinobacteria* and *β-Proteobacteria*, archaeal community is presented sequences from phyla *Thaumarchaeota* and *Euryarchaeota*. In the samples from Tolsty communities of are more various with domination of bacteria phyla *Actinobacteria*, *β-, γ-Proteobacteria* and archaea phyla *Euryarchaeota*, *Crenarchaeota*, *Thaumarchaeota*, *Bathyarchaeota*. Here representatives of the new ANME group - ANME-2d are detected (Ding et al., 2015).

The situ a mud volcano Malenky is characterized by high intensity of fluid flow and high mineralization of pore waters, which increased with a depth and reached 845 mg/l. With increase a mineralization also increases sulfate ions (to 363 mg/l), also magnesium, and calcium ions. Contents sulfate ions in pore waters this situ reached the concentration course of active processes of AOM, but since 2005 in all periods of a research we haven't found the ANME groups, which perform sulphate-dependent AOM. However, in this area as well as in sediments of Tolsty were detected representatives ANME-2d, which number reached 22 % in archaeal community.

High concentration sulfate ions (62 mg/l) and the rates of sulfate reduction (Pimenov et., 2014) are characteristic for pore water of deep sediments a methane seep Posolsk Bank. This area is characterized by existence of a convective fluid flows, where in the GH-containing sediment layers, the concentrations of all analyzed ions were on average two to three times higher. In microbial communities this situ among bacteria dominated representatives of phyla *Acidobacteria*, *Cloroflexi*. *Representatives* of the candidate phyla *Saccharibacteria*, *Atribacteria*, *Aminicenantes*, *Latescibacteria* were detected. Among Archaea dominated representatives of *Thaumarchaeota*, *Bathyarchaeota* and *Thermoplasmata* (*Euryarchaeota*).

Pore waters of site a low-temperature vent in Frolikha Bay had high temperature flows, mineralization of pore water (355 mg/l), sulfate (16.8 mg/l) and acetate ions (54 mg/l). In the 16S rRNA gene libraries of Bacteria dominated members of phyla *Actinobacteria*, *Bacteroidetes*, *Proteobacteria*,

among Archaea – representatives of *Thaumarchaeota*, *Euryarchaeota* (orders *Methanosarcinales* and *Methanomicrobiales*). About 28 % of the sequences of archaea have been referred to the ANME-2d group.

Thus, showed that observed diversity of Bacteria and the Archaea in different types of geological structures depends on type of discharge fluids and its intensity differs on structure of the dominate taxons and their ratio in microbial communities.

The results of this work will be used for creation of the Hardware-Software Infrastructure of Processing of Big Data for archiving, monitoring, analysis and visualization.

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EFFECT OF ENVIRONMENTAL FACTORS ON DIFFERENTIATION OF MICROBIAL COMMUNITIES DURING DAY AND NIGHT: STUDY OF MEROMICTIC LAKE DORONINSKOE, TRANSBAIKALIA, RUSSIA

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Meromictic soda lakes are unique extreme ecosystems. These reservoirs are excellent models in limnological studies, because they are characterized by a stable stratification of physical, chemical and biological parameters (Overman et al., 1991), as well as the simplicity and poorness of biodiversity (Zavarzin, 2011). Soda Lake Doroninskoe is one of the three known meromictic reservoirs of Siberia. The extreme continental climate of Transbaikalia in the permafrost (N 51º25', E 112º28'), alkaline pH values (9.72) and relatively high salinity of water and sediments (32.3–35.0 g/L) create special conditions for the microorganism functioning. The low level of chemocline illumination (0.001 %) and the rare type of soda water formed under the conditions of evaporative concentration in the zone of sedimentary deposits distinguish Lake Doroninskoe from the known meromictic reservoirs of the world (Overmann, 1997, Wani et al., 2006) and make the studies of the microbial communities of the lake of current concern. The main purpose of this study was to establish the effect of environmental factors on the differentiation of microbial communities in the water column of Lake Doroninskoe under natural conditions of illumination and its absence. Water samples from various depths of the lake were collected in September 2013 at day and night time. Hydrochemical and hydrophysical conditions were measured in situ, water was filtered in the field to study the microbial communities by metagenomic analysis of the V3–V4 variable region of 16S rDNA. By the principal component analysis it was established that the light variables (illumination intensity and absorption) enhanced the clustering of the main ecological parameters. Thus, a positive correlation has been established between different light variables and sulfur forms (oxidized and reduced), Eh/O2 and mineralization/water depth. The results confirm the earlier conclusions that sulfur cycle is the leading one in Lake Doroninskoe and favors the dominance of anoxigenic phototrophic microorganisms (Gorlenko et al., 2010; Matyugina and Bel'kova, 2015). Metagenomic analysis of 16S rDNA amplicons established high diversity of the microbial communities in the water column of the lake both day and night. Statistically significant differences between day and night microbial communities were revealed. Analysis of alpha diversity showed a higher diversity in the water column during the day, than at night. The abundance of species on different depths during day and night was significantly differed. It was higher during daytime than at night, and reverse trends were observed on the different depths: during daytime the chemocline diversity was higher and decreased to the bottom, and at night – on the contrary. The study of the peculiarities of the taxonomic composition of microbial communities during day and night showed that *Proteobacteria* were dominant. *Firmicutes*, *Bacteroidetes*, *Spirochaetes* were a small proportion in communities. RDA made it possible to establish reliable differences between microbial communities formed in day and night at all depths in the Lake

Doroninskoe. The dominant phylotypes of *Pseudomonas*, *Enterobacteriaceae*, *Bacteroidetes* correlated with the composition of microbial communities at night, and *Achromobacter*, *Bacteria*, *Firmicutes*, *Nitriliruptor*, *Microbacteriaceae* – at day. Statistically, a reliable correlation of dominant phylotypes with environmental factors that affect the differentiation of the night and day microbial communities was revealed. According to the results obtained with the correlation analysis, the composition of microbial communities at different depths correlated reliably with such environmental variables as oxygen and the absorption in the red spectral range. In general, these data underscore the important role of environmental factors in the formation of richness and diversity of microbial communities.

PHYLOGENETIC STRUCTURE AND DIVERSITY OF PROTISTAN COMMUNITIES IN SALINE AND BRACKISH WATER BODIES OF THE SOUTH URALS (RUSSIA)

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Modern methods of high-throughput sequencing (NGS) are widely used for characterization of protists biodiversity in fresh and marine waters. The obtained data change our knowledges about natural microbial communities. At present only protistian communities from marine biotopes have been studied with NGS, whereas only couple of continental saline water bodies has been studied. The aim of this research was characterization of structure and biodiversity of protistian communities in saline and brackish water bodies of the South Urals (Russia) with 18S metagenomic sequencing. Plankton and benthic water samples from saline and brackish lakes were filtered through membranes with diameter of pores 0.45 μm. Salt-Iletsk lakes (Razval, Dunino, Novoe, Tuzluchnoe, Maloe Gorodskoe, Bolshoe Gorodskoe) in Orenburg region, Elton Lake in Volgograd region and Kulat Lake in Chelyabinsk region were investigated. Total genomic DNA was extracted from the samples by phenol–chloroform method. 18S DNA libraries were prepared according to Illumina workflow with universal primers targeting the V4 region of the SSU rRNA gene of Eukarya (forward TAReuk454FWD1 and reverse TAReukRev3). The libraries were sequenced in MiSeq (Illumina) using 2 × 300 bp paired-end v3 reagent kit. Bioinformatic analysis was conducted using USEARCH v8.0.1623_win32 (Edgar R.S., 2010) and included merging of pair-wise reads (minimal overlap 30 bp), quality filtering (Q20) and amplicon size selection (300 bp minimal size). Subsequent treatment and visualization was carried out with VAMPS (vamps.mbl.edu). The most numerous protists in saline and brackish continental lakes are represented by taxa from the supergroups Archaeplastida, Stramenopiles, Rhizaria and Opisthokonta. Dominant species and genera were specific for every sample, but their amount decreased along to mineralization. Communities of protists from lakes with the same salinity are more similar, but despite this fact proportion of specific species is higher (71.5–83.6%) than proportion of shared species (16.4– 28.5%). Principal component analysis (PCoA) of the taxonomic structure showed grouping of the studied eukaryotic communities according to similar salinity and regional vicinity of the water bodies. As a conclusion, the composition of eukaryotic communities in the Russian continental saline and brackish water bodies has been revealed for the first time by high-throughput sequencing. The taxonomic structure and species number depended on mineralization level in inverse ratio. Many new sequences showing low similarity with those from database GENBANK have been revealed. Some new taxa of protists isolated in pure cultures were characterized by their morphology, ultrastructure, genetics, saline tolerance and life cycle.

The research was performed in the Center of Shared Scientific Equipment «Persistence of microorganisms» of ICIS UB RAS and was supported by RFBR (17-04-02079, 15-29-02749, 15-29-02518).

BACTERIAL DIVERSITY IN SALT LAKE KHILGANTA, TRANSBAIKALIA, RUSSIA

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The main aim of the present study is to investigate the composition and phylogenetic diversity of community's microbial mat and bottom sediments in salt Lake Khilganta (Transbaikalia, Russia).

The temperature and pH of the water in the sampling locations were 22-27°C and 9.5, respectively. The lake water for macrocomponental composition relates to HCO_3^-, CO_3^{2-}. The total mineralization of 1.37-2.45 g/l.

In the community of microbial mat and bottom sediments in the Lake Khilganta sequencing 16SrRNA received from 20194 to 25091 nucleotide sequences. The largest share in the community of microbial mats lake were representatives phyla *Proteobacteria, Bacteroidetes, Firmicutes, Actinobacteria.* In the community of bottom sediments are generally dominated by representatives of phyla *Proteobacteria, Firmicutes, Bacteroidetes*. The following representatives can be referred to the minor phyla: *Cyanobacteria, Chloroflexi, Deinococcus-Thermus*.

A total of 119 OTUs were found in mat samples and 112 OTUs were detected in bottom sediments. The most abundant bacterial OTU was classified at genus level as *Halomonas* both belonging to the halophilic family *Halomonadaceae*. This is OTU accounted for more than 19 % of average abundance in bottom sediments of Lake Khilganta. In the sample of microbial mat more than 37 % OTU belonging to the *Chitinophagceae* family.

In this study for the first time described in detail by sequencing the taxonomic composition and proportion of the major groups of microorganisms in samples of salt Lake Khilganta.

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COMPARATIVE ANALYSIS OF METAGENOMIC DATA ON PROKARYOTIC DIVERSITY IN THE INLAND BRACKISH AND SALINE WATER BODIES IN THE SOUTHEASTERN EUROPEAN PART OF RUSSIA

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The metagenomic approach permits to expand significantly knowledge on microbial diversity of different environments and allows to get information about both cultivable microorganisms and ones, which cultivation is unavailable. In recent years culture-independent methods have noticeably improved our understanding of the saline lakes microbiology and led to discovery of new prokaryotic taxa of high-level taxonomic categories. The inland brackish and saline water bodies are widely spread all over the world especially in arid and semiarid zones and have different ionic proportions. It is interesting to compare their microbial biodiversity depending on geographical location, salinity level, salt composition etc. The objective of our study was to compare metagenomic data on prokaryotic diversity in the inland brackish and saline water bodies in the southeastern European part of Russia. Salt-Iletsk lakes (Razval, Dunino, Novoe, Tuzluchnoe, Maloe Gorodskoe, Bolshoe Gorodskoe) in Orenburg region, Elton Lake and rivers Malaya Samoroda and Bolshaya Samoroda in Volgograd region, and Gorko-Solenoe, Mironovskoe and Kulat Lake in Chelyabinsk region were investigated. Plankton samples from saline and brackish lakes were filtered through membranes. Total genomic DNA was extracted from the samples by phenol–chloroform method. 16S DNA libraries were prepared according to Illumina workflow with primers targeting the V3 and V4 regions of the SSU rRNA gene, forward S-D-Bact-0341-b-S-17 and reverse S-D-Bact-0785-a-A-21 (Klindworth A. et al., 2013). The libraries were sequenced in MiSeq (Illumina) using 2 × 300 bp paired-end v3 reagent kit. Data analysis was conducted using USEARCH v8.0.1623_win32 (Edgar R.S., 2010) and included merging of paired reads (minimal overlap 30 bp), quality filtering (Q20) and amplicon size selection (300 bp minimal size). Subsequent treatment and visualization was carried out with VAMPS (). Taxonomic composition of the prokaryotes at the high taxonomic levels was determined by salinity, whereas considerable individual differences observed at the low levels. Hierarchical clustering demonstrated three clusters of compared samples formed according to their salinity: 10-49, 85-150 and 170-330 g/L. Inside these three clusters similar samples from closely spaced sites placed together. The dominant complexes of prokaryotes were estimated. In hypersaline Salt-Iletsk lakes with salinity above 250 g/L the archaea *Halonotius* sp., nanohaloarchaea and bacteria *Salinibacter* sp. were the most abundant. Whereas in Elton Lake archaeal genera *Halorubrum* and *Halohasta* were predominant. In Kulat Lake (170 g/L) genera *Halomonas*, *Psychroflexus* and unclassified *Haloferacaceae* were most abundant. The dominant prokaryotic complexes in the lakes with salinity 85-150 g/L included common families *Microbacteriaceae*, *Ectothiorhodospiraceae* and supplement taxa, such as genus *Roseovarius* in Tuzluchnoe Lake and unclassified *Haloferacaceae* in Novoe Lake. In the Malaya Samoroda River *Spiribacter* sp., *Marinobacter* sp., and *Puniceicoccus* sp. were predominant. In the lakes with salinity 10-49 g/L phylum *Cyanobacteria* (Bolshoe Gorodskoe Lake), genus "*Pelagibacter*", unclassified *Firmicutes* (Gorko-Solenoe Lake), *Rhodoluna* sp., and unclassified *Gammaproteobacteria* (Mironovskoe Lake) were predominant. In the Bolshaya Samoroda River family *Rhodobacteraceae* and genera *Flavobacterium* and *Thalassolituus* were the most abundant. Taxonomic richness and diversity of prokaryotes, similarity of OTUs lists were analyzed. Also principal coordinate analysis was carried out. Thus, the observed differences in prokaryotic composition of the lakes were related to their salinity level as well as ionic proportions and geographic location.

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SPATIOTEMPORAL PATTERNS AND ADAPTATION MECHANISMS OF PLANKTONIC MICROBIAL COMMUNITIES INHABITING ALKALINE SODA PANS OF THE CARPATHIAN BASIN

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According to current knowledge, astatic soda pans of the Pannonian steppes are the most western representatives of this type of habitat in Eurasia. They are unique environments due to their environmental characteristics (high turbidity, alkaline pH, salinity, special ionic composition, high amount of polyhumic organic carbon) and the inhabiting local biota. Our recent study revealed that the prokaryotic communities of these lakes are distinct in composition from those in other alkaline lakes (e.g. archaeal taxa have a surprisingly low relative abundance). Special metabolic and physiological adaptation mechanisms were detected associated with the extreme conditions present in these aquatic habitats. Most of the soda lakes of the world are hardly approachable; therefore studies were not yet carried out investigating the seasonal dynamics of planktonic bacterial communities and the environmental factors which have the main impact on their structure. In our study, two lakes representing distinct ecological types (the turbid-type Zab-szék pan and the coloured-type Sós-ér pan in the Kiskunság National Park, Hungary) were sampled monthly for more than a year. Besides field measurements and the application of microscopic techniques, a next-generation sequencing approach based on the variability of the bacterial 16S rRNA V3-V4 region was used to reveal the characteristic genera inhabiting these lakes, and major shifts in the planktonic bacterial community structures. Results showed taxonomically complex and seasonally changing microbial communities in a response to environmental effects. Despite the different physical characteristics, several common taxa were detected as major components in the two studied lakes. Some taxa were abundant throughout the year, while for others a seasonal pattern was observed in their relative abundance. Algal-bloom associated taxa were characteristic during winter with the representatives of *Flavobacteria*, *Cytophaga*, *Rhodobacterales* and *Verrucomicrobia*, while in the summer actinobacterial lineages (e.g. acIII, *Nitriliruptor*) dominated in the community. OTU-based statistical approaches showed that algal blooms, desiccation and massive predation have the most remarkable effect on the composition of these bacterial communities.

ORGANIC OSMOLYTES IN ADAPTATION OF ALKALIPHILIC AND ALKALITOLERANT FUNGI TO THE AMBIENT PH

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Alkaliphilia in fungi, as a phenomenon, is known for only about 20 years. Alkaliphilic fungi have pronounced growth maximum in the alkaline conditions and do not grow at pH lower than 5, while alkalitolerant fungi demonstrate similar growth rate over a wide pH range from 4.0-4.5 to 11.0 (Grum-Grzhimaylo et. al., 2013). The important role in adaptation to different stresses belongs to organic osmolytes, that are considered to be cytoprotectors, which defense as macromolecules, nor the cell membranes (Yancey, 2005). We have suggested that organic osmolytes play the important role on alkaliphilia and that mechanisms of adaptation are different in alkaliphilic and alkalitolerant fungi. Therefore the objective of the present research was the comparative study of the soluble carbohydrate composition of three alkaliphilic fungi (*Sodiomyces tronii*, *S. magadii*, *S. alkalinus*) and two alkalitolerant fungi (*Astrostalagmus luteoalbus*, *Chordomyces antarcticum*), belonging to the same family - *Plectosphaerellaceae* (*Ascomycota*). Fungi were grown on wort agar with various pH, created by 0.2M citrate (pH 4.5-5.9), 0.2M phosphate (pH 7.0) or 0.2M carbonate-bicarbonate (pH 9-10) buffers for 7-10 days. After extraction and purification cytosol carbohydrates were analyzed using GLC with inner standard. Specific feature of *S. magadii, S. alkalinus*, grown under optimal conditions at pH 10.2, was the predominance of the three sugars - mannitol, trehalose and arabitol. Decrease of the medium pH to 9.2 and 7 resulted in a decrease of arabitol to a trace amounts and an increase in the proportion of trehalose. In *S. tronii* under optimal conditions pH 9.2 the main carbohydrates are trehalose and glucose. Raising the pH to 10.2 results in the accumulation of mannitol and arabitol by decreasing glucose, while lowering the pH leads to an increase in the proportion of trehalose. At all studied pH values the main carbohydrates of both alkalitolerant fungi were mannitol and arabitol, while trehalose amount was minor. Proportion of arabitol increased during growth in alkaline conditions, while in neutral and acidic conditions mannitol was predominant. The obtained data show that mechanisms of protection of alkaliphilic and alkalitolerant fungi are different. In alkaliphiles trehalose was predominant, its amounts increasing with the decrease of pH values, indicating its important role in alkaliphilia and in adaptation to the decreasing pH. In alkalitolerant species trehalose, presumably, doesn't play important role in adaptation, its amounts being minor and barely changing in response to varying ambientl pH. The fact that arabitol is present in alkaliphilic fungi only at high alkaline conditions and that its proportion increases in alkalitolerant fungi with the increase of the medium pH, indicates its important role in the adaptation to the alkaline conditions.

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PHYLOGENETIC DIVERSITY OF ACTINOBACTERIA IN SALINE ENVIRONMENTS OF MONGOLIA

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Saline environments of Mongolia consist of saline soils and saline lakes. They can mainly be found in the western, eastern and southern parts of the country. Recently saline environments of Mongolia have attracted researchers by their unique microbial diversity and their biotechnological potential. Several new genera and species of bacteria have been found indicating the probability of novel metabolites biosynthesis. Actinobacteria of extreme environments such as saline ones are known as the prolific producers of bioactive compounds. But there are very few investigations on actinobacteria of Mongolian saline environments. Therefore, the objectives of the present research were to isolate and describe the phylogenetic diversity of culturable actinobacteria in saline soils, muds and neighbourhood soils of saline lakes situated at the western and eastern parts of Mongolia and to evaluate their antimicrobial and proteolytic activities. Different approaches to isolation and media with and without NaCl were used. As a result, 128 strains in total were isolated. Based on 16S rRNA genes sequencing isolates of saline soils, salts and muds were assigned to 2 genera of the family *Nocardiaceae*, 3 genera of *Micrococcaceae*, 2 genera of *Cellulomonadaceae*, 2 genera of *Microbacteriaceae*, 1 genus of *Promicromonosporaceae*, 2 genera of *Micromonosporaceae*, 1 genus of *Pseudonocardiaceae*, 1 genus of *Streptomycetaceae*, 1 genus of *Streptosporangiaceae* and 1 genus of *Nocardiopsaceae*. In soils of grassland and desert steppe in the neighbourhoods of saline lakes actinobacteria of the genera *Arthrobacter*, *Cellulomonas*, *Marisediminicola*, *Microbacterium*, *Micromonospora*, *Nocardia*, *Oerskovia*, *Rhodococcus* and *Streptomyces* were found. Results of phylogenetic positions, antimicrobial and proteolytic activities of actinobacteria isolated will be presented. The data received showed that actinobacteria of saline environments of Mongolia had significant phylogenetic diversity and biotechnological potential.

CYANOBACTERIA OF SODA-SALINE AND FRESH LAKES OF TRANSBAIKAL REGION (REPUBLIC OF BURYATIA, RUSSIA)

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A comprehensive study of the diversity and functional activity of cyanobacteria of fresh and soda-saline lakes in the Transbaikal region was carried out by using microscopic, chemical, microbiological and molecular-biological methods. According to the water salt content, the lakes were classified as fresh, brackish and brine. Most of the investigated lakes were classified as chloride-sodium and hydrocarbonate-sodium types. The pH values of the water were in the alkaline. According to the content of chlorophyll *a* lakes were classified as mesotropic and eutotrophic types. In total, 48 species of cyanobacteria were found in the explored reservoirs: 22 species were found in fresh lakes and 26 in soda-saline. The list of cyanobacteria of Transbaikal region was supplemented with 10 previously unknown species.

8 monocultures of cyanobacteria were isolated from the studied lakes. They were characterized as neutrophilic and halotolerant, with an optimum of development at pH 8.5-9.5 and salinity up to 50 g/l. The research of uncultivated lake's diversity, carried out by metagenomic analysis, showed a significant diversity of bacteria and cyanobacteria in examined samples.

The toxicity assessment was carried out in two lakes (Dikoe and Kotokelskoye), situated near the lake Baikal. The water samples of the lake Dikoe were characrerized as normal or low toxicity class. Biologically active substances evolved from microorganisms and algae while alive did not influence the higher plants in most cases. Microbial mats of lake Kotokelskoye undermined the growth of the higher plants and were labeled as highly toxical.

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MICROBIAL DIVERSITY AND PIGMENT ACCUMULATION OF HALOPHILIC ARCHAEA *HALOFERAX* UNDER OPEN CULTURE CONDITIONS

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Halophilic archaea is the major group of the microorganisms existing in hypersaline environment. The high salt environment enable the archaea cells accumulating various compounds during their metabolic process to protect the cells from adverse external conditions. Most of these compounds possess bioactive properties and thus have great application value in food coloring and pharmaceuticals, environmental protection and aquaculture. *Haloferax* is a halophilic microorganism belonging to the family *Halobacteriaceae*. They are typically recognizable by their 'dished crisp' shape. The membranes of *Haloferax* are made of the ether linked membrane lipids found solely in archaea and also contain a high level of carotenoids including lycopene, which gives them their distinctive red color. Some researches *Haloferax* mainly focus on wastewater treatment and poly (3-hydroxybutyrate) production, while few were conducted in pigment accumulation and composition of this archaeal cells. Fermentation is used broadly in producing a specific chemical product in condition of the bulk growth of microorganisms in a growth medium. However, the corrosion the metal fermentation facilities caused by high salt concentration in culture medium limited the large-scale culture of halophilic archaea. *Haloferax* grow faster at 150-200 g/L salinity without much reducing the growth rate, while the growth of non-halophiles should be limited at such high salinity. Therefore the requirements for sterile condition reduced greatly at higher salinity. This paper investigated the growth and pigment accumulation of *Haloferax* at different salinities under open culture conditions, the microbial diversity was studied with polymerase chain reaction-denaturing gradient gel electrophoresis method, aiming to provide practical data on the pigment production of *Haloferax* in large-scale. The result showed hypersaline conditions inhibit the growth of other microorganisms, and it does not affect the pigment accumulation of *Haloferax*. It proved that the pigment can obtain through the large-scale culture of *Haloferax* under open culture conditions. Further research need to be conducted to investigate the optimal culture conditions for increasing pigment production. Moreover, the pigment component is planned.

PRIMARY PRODUCTION IN OXIC/ANOXIC INTERFACES OF DEEP-SEA HYPERSALINE LAKES: CONTRIBUTION OF MICROBIAL DARK CO_2 FIXATION IN THE EASTERN MEDITERRAN AN SEA

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Gradients of physical and chemical factors constitute major forces shaping ecosystems at activity 'hot spots' on the ocean floor, such as hydrothermal vents, cold seepages and mud volcanoes and hypersaline lakes, though the relationships between community composition, activities and environmental parameters remain largely elusive. The Mediterranean Accretionary Ridge, formed along the rifted margins of Northern Africa and the subducting margins of Southern Europe, contains one of the world's highest abundance of unique geological features called deep-sea anoxic hypersaline lakes (DHALs). Since the discovery of first Mediterranean DHAL *Tyro* in 1983, six other salt-related structures have been unveiled in this area in the last decades, namely *l'Atalante*, *Bannock*, *Discovery*, *Medee* and *Urania* and the existence of many other DHALs has been speculated. Indeed, during last years the group at IAMC-CNR found three new brine submarine lakes, named *Kryos*, *Thetis* (both found in 2008) and *Hephaestus*(found in 2013). The hydrologic and geological settings of these fascinating formations likely share the same genesis, i.e. they originated from dissolution of Messinian evaporitic salt deposits that underlie most of the Mediterranean basin. The astonishing amount of evaporites (this subsurface layer can be of up to 1,000-2,000 meters tick) was formed when the Mediterranean Sea was desiccated during the cyclic salinity crisis of Messinian period - between 5,600,000 and 5,300,000 years ago. Dense brines with salinities exceeding 300 g/L, created by dissolution of evaporites by over-pressured fluids, coming from the underlying sedimentary sequences, are expulsed on the surface of seabed and, due to favorable bottom topography, trapped in nearest and closed depressions forming a very stable salinity-induced water bodies at the seabed. The recent breakthrough discovery on the Martian surface of hydrated minerals, interpreted as deriving from the desiccation of pre-existing large water bodies and eventual presence of hydrogen in salty oceans beneath the icy shield in Jupiter's *Europa* and Saturn's *Enceladus* moons, has provoke a rekindling of interest in study of functioning of ecosystems, originated from ancient evaporites on Earth. Besides understanding the particular physiology of "ancient" halophilic communities, a most intriguing question is how these ecosystems sustain dense populations and flourish in submarine hypersaline lakes without support of light-driven phototrophic primary producers.

To get an answer on this question, the overlying water column and the brine-seawater (oxic/anoxic) interface of five deep-sea anoxic hypersaline brine lakes were characterized physico- and geochemically, microbiologically, in terms of their microbial community compositions, functional gene distributions and [^{14}C]-bicarbonate assimilation activities. We found that representatives of Marine Group I of phylum *Thaumarchaeota* are the predominant members of the meso- and bathypelagic microbial communities of Mediterranean Sea, and most likely play a pivotal role in dark deep-sea autotrophic carbon assimilation. These deep water values were among the highest ones reported worldwide at similar depths, probably as a consequence of the high temperature (13-14°C also at abyssal depths) of the deep Mediterranean Sea. The rates of dark ocean primary production were noteworthy, covering up to 55 % of measured total carbon demand of deep-sea prokaryotic communities. The correlation of the depth-profile of CO_2 fixation activity with the distribution of thaumarchaeal *amo*A gene copies suggests that ammonium oxidation is the main energy-generation process sustaining dark ocean autotrophy. In contrast, the high abundance of reduced sulfur compounds represents the predominant energy source for chemolitoautotrophic members of *Gamma-* and *Epsilonproteobacteria*, thriving in oxic/anoxic interface of DHALs. These autotrophic microbes are thus the basis of the food webs populating the DHAL ecosystems. The rates of light-independent assimilation

of dissolved inorganic carbon at the surface of DHALs are astonishing. For example, the hypersaline lake Medee, having the surface of 100 km^2, daily is fixing almost 2,000 kg of CO_2, which is equivalent to the amount of carbon dioxide produced by burning of ca. 3,300 liters of gasoline.Such a pronounced CO_2 utilization by prokaryotes inhabiting the dark deep marine habitats suggests a reevaluation of the Mediterranean Sea as a sink of carbon dioxide.Further efforts to understand in detail the chemoautotrophic communities thriving in the oxic/anoxic interface of Mediterranean DHALs, involving the activity measurements, culture isolation/enrichment strategies and environmental genomics are in progress.

ARCHAEA AND BACTERIA DIVERSITY ALONG AN INCREASING SALT GRADIENT IN ALKALINE LAKES

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Alkaline lakes are extreme aquatic systems, which are characterized by high pH values (9–11), predominance of sodium as kation, and a wide range of salt content (from brackish to hypersaline). Soda lakes have a unique chemistry because of the presence of large amounts of carbonate/bicarbonate concentration in the form of Na_2CO_3 and $NaHCO_3$ combined with a high concentration of other salts, especially sodium chloride. The effect of salinity on prokaryotic community diversity in alkaline lakes was investigated by using high-throughput 16S rRNA gene pyrosequencing. The upper sediment layer samples from four lakes spanning a salinity range of 1.2 % (Lake Verkhneye Beloye) to 47 % (Lake Borzinskoye) and pH 9.7-10.1were analyzed. Overall, 47 prokaryotic phyla were detected (42 bacterial and 5 archaeal), and the dominant prokaryotic phyla accounted for more than 95 % of the reads consisting of *Deinococcus-Thermus*, *Chloroflexi*, *Bacteroidetes*, *Actinobacteria*, *Firmicutes*, *Proteobacteria*, and *Euryarchaeota*. A total of 1794 OTUs were found at 47 % salinity whereas 3037 OTUs were detected in Lake Khilganta (3.6 % salinity), and 3160 OTUs in Lake Gorbunka at 5,8 % salinity. Along the salinity gradient, archaeal community gradually replaced bacterial community. Thus, archaeal community accounted for 0.7 % in Lake Verkhneye Beloye while 35.0 % in Lake Borzinskoye. *Euryarchaeota* accounted for more than 30 % of the abundance in lakes Khilganta and Borzinskoye. The two most abundant OTUs were classified at genus level as *Halorubrum* and *Halohasta*, respectively, both belonging to the archaeal halophilic family *Halobacteriaceae*. Together, these two OTUs accounted for more than 21 % of average abundance in Lake Borzinskoye. OTUs affiliated to phylum *Nanohaloarchaeota* and *Woesearchaeota* were noted in sediments samples at 5.8 and 47 % salinity. The archaeal phylum *Thaumarchaeota* and *Miscellaneous Crenarchaeotic* Group were defined only in the microbial community of the Lake Gorbunka (0.2 and 0.9 % of the archaeal diversity, respectively). The most abundant bacterial OTU was affiliated to the haloalkaliphilic gammaproteobacteria *Halomonas* (up to 15 % of average abundance). Haloalkaliphilic purple nonsulfur bacteria *Rhodobaca* (6 % of average abundance) were abundant in Lake Verkhneye Beloye and haloalkaliphilic actinobacterium *Nitriliruptor* dominates in Lake Gorbunka at 5.8 % salinity.

This study demonstrates that salinity appears to be the key environmental factor in structuring the prokaryotic communities of haloalkaline environments.

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SALT LAKE ECOLOGY AND BIOLOGY, FOOD WEBS AND BIOGEOCHEMICAL CYCLING

FLUCTUATIONS IN PHYSICOCHEMICAL CHARACTERISTICS OF URMIA LAKE WATER BETWEEN 2016 AND 2017

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Urmia Lake, the second largest hyper-saline lake in the world, has experienced a significant drop in water level during the last two decades. Several factors including climate change, anthropogenic changes such as dam construction and over exploitation of water in the Urmia Lake basin especially unsustainable expansion of agriculture are considered as the main causes for shrinking of the Lake. Water composition of the lake has changed greatly as a result of gradual sedimentation of salts and other minerals during this period. Present study is designed to examine the water quality of the Lake Urmia from April 2016 until March 2017. Water samples were collected from six sampling stations of the lake (samples U1 to U4 from north wing and samples U5 and U6 from south wing of the causeway). Anions (Chloride and Sulphate) and cations (Na^+, K^+, Ca^{++} and Mg^{++}) were determined by Ion Chromatography. HCO_3^- was analyzed by titration; using bromocresol green as indicator, and total alkalinity and salinity were measured using photometer and refractometer, respectively. According to the analyses, Na^+, K^+, Mg^{++}, Ca^{++} are the main cations while Cl^-, SO_4^{2-}, total alkalinity and HCO_3^- are the dominant anions. The lowest sodium concentration in all samples was detected in the month of November while the highest amount was detected in U5 and U6 in February. The lowest and highest amount of potassium in all samples were found in the months May and February, respectively. Highest concentrations of calcium were detected in U2 and U3 stations in the months of July and November. However, the least concentration of calcium in all samples was attributed to February. Magnesium ion in all stations sharply increased since April and reached to the maximum quantity in December with the exception of U6. Moreover, U5 and U6 had less calcium in January, February and March than others. Maximum and minimum amount of chloride were found in U1, U2 and U4 samples in March and April, respectively. U5 and U6 demonstrated highest concentration of chloride in June, while the least amount was seen in January. Sulfate ion in all samples showed the highest amount in October while the lowest amount was detected in April with the exception of U5 and U6 where the least concentration was observed in February. The minimum and maximum amount of bicarbonate in U1 to U4 were respectively attributed to months of April and October. However, U5 and U6 showed the most and least concentrations in September and February. Water samples from U1 to U4 had the lowest total alkalinity in April while U5 and U6 had the lowest in February. The highest amount of bicarbonate in samples U1 to U4 was observed in October, while in U5 and U6 were detected in November and September, respectively. U5 and U6 showed the least salinity in March. However, there was a fluctuation in salinity of other samples. Our data showed that Urmia Lake water quality has dramatically changed and as it is seen, all parameters have considerably increased.

Key words: Lake Urmia, physicochemical parameters, Water quality.

ABUNDANCE AND THE ECOLOGICAL ROLE OF EUCYPRIS MAREOTICA (CRUSTACEA, OSTRACODA) IN THE CRIMEAN HYPERSALINE LAKES

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Species of *Ostracoda* may rich high abundance and play important role in the different aquatic ecosystems. Their functional role in the ecosystems of hypersaline waters is poorly studied yet. There are about 50 hypersaline lakes and lagoons in Crimea. Eucypris mareotica is only *Ostracoda* species in them. Sampling in 2007–2017 shows that it may rich high abundance – up to 650,000 ind/m^3 in plankton and 150,000,000 ind/m^2 in filamentous green algae mats. In 2012–2017, the authors conducted study on feeding of this species in hypersaline Lake Chersonesus. Gut content analysis was applied. Microalgae are main food of E. mareotica; their composition was analyzed. Small animals are also essential component in ostracod ration. *Cletocamptus retrogressus* (*Harpacticoida*) is a most common component in ostracod guts among animals. Representers of other animals groups (*Nematoda*, *Calanoida*, *Cladocera* and others) were also found in guts as well as fragments of filamentous green algae *Cladophora*. Additional experiments were done to answer: Does E. mareotica consume cysts and nauplii of Artemia? *E. mareotica* intensively consumes nauplii but not cysts. Field data show that high abundance of E. mareotica prevents development of Artemia population in the lake. *E. mareotica* demonstrates wide diet plasticity that supports its success in the hypersaline variable habitats. It plays a very important role in food web complexity and community dynamics of the hypersaline lake ecosystems.

VERTICAL DISTRIBUTION AND TROPHIC ROLE OF CRYPTOPHYTA FLAGELLATES OF MEROMICTIC LAKES SHIRA AND SHUNET (KHAKASSIA, RUSSIA)

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Many of the stratified lakes are characterized by the presence of large populations of cryptomonads in their chemocline zones. These populations are adapted to low light intensity and high sulfide concentration; they have a mixotrophic ability and form the so-called "deep chlorophyll maxima". In the meromictic Lake Shunet (54°25′7″N, 90°13′41″E) there is a constant deep maximum of chlorophyll formed by a population of phytophagellates (cryptophyte algae) of the genus *Cryptomonas* (*Cryptomonadida*). The localization of the maximum density peak in the population of cryptomonads in all seasons coincides with the location in the chemocline zone of a narrow (5-10 cm) range of mass growth of purple photosynthetic bacteria. One of the hypotheses proposed to explain the mechanisms and causes of maintaining maximum cryptomonad population in low light conditions and proximity to the sulfide zone of the lake is the availability and accessibility of nutrients in the chemocline. Another hypothesis suggests that a high number of cryptomonads in the area of intensive development of bacterioplankton is maintained at the expense of the ability of these phytophagellates to mixotrophy. We were collected of considerable data that testifying of obligate mixotrophy of phytoflagellates in Lake Shunet. In particular, experiments demonstrate that without a light, as well as without the presence of an organic food, phytoflagellates population is unable to growth. The greatest number of the phytoflagellates population in the lake Shunet achieved in the chemocline zone (up to 15,000 cells/ml). Phytoflagellates are in the mixolimnion also, albeit in much lower concentrations (up to 250 cells/ml). When sampling with a syringe sampler (with a step of 2.5 cm) is shown that zone of the maximum number of phytoflagellates has the complex structure and consists of two peaks. This form of spatial distribution may demonstrate the fact of division of the population into mostly phototrophic and mostly heterotrophic subpopulation because below then border of the purple photosynthetic bacteria grown zone light intensity are plummeting, but the purple bacteria can be directly consumed by cryptophyta flagellates. The population of cryptophyta algae in Lake Shira (54°30′38″N 90°12′09″E) is also characterized by a vertical distribution, close to that in Lake Shunet, but considerably inferior in numbers. The maximum abundance of cryptophyte algae is observed in May at depths of 11-12 m, and reaches 600 cells/ml. In the summer months, the number of phytophagellates is significantly reduced and is not more than 100 cells/ml at depths of 8-14 m. During the autumn-winter period, the community of cryptophyte algae does not form a clearly expressed peak and is distributed throughout the mixolimnion, amounting to no more than 80 cells/ml at its maximum values. However, the mean concentrations over the entire water column of the lake in winter are quite high (up to 50 cells/ml), which is comparable to the number of cryptophyte algae during the spring maximum and significantly exceeds the summer values of abundance. During the disruption of the stable stratification of Lake Shira (2015-2016), the number of cryptophyta algae increased sharply (up to 5000 cells/ml at maximum values), which can be explained both by changes in the food regime and by a relative decrease in its consumption by planktonic crustaceans.

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GENETIC STUDIES OF INVERTEBRATE DIVERSITY IN THE GREAT SALT LAKE ECOSYSTEM

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Great Salt Lake (GSL), in northern Utah, is a fascinating example of an extreme environment, with salinities in some regions exceeding 20 %. The Great Salt Lake ecosystem is one of the western hemisphere's principle bird habitats and the lake supports a population estimated at 7.5 million individuals distributed among 257 species. While brine shrimp and brine flies are thought to be the principle food source for the birds, it is likely that they are utilizing other invertebrates as well. This study uses mitochondrial cytochrome c oxidase I DNA barcodes to examine the diversity of invertebrates associated with the GSL ecosystem. DNA barcoding is the international standard for species identification based on genetic comparisons and provides an estimate of species diversity and distribution. Invertebrates were collected from the shoreline and adjacent vegetation and the samples sorted based on gross morphology. DNA barcodes were determined for selected individuals by polymerase chain reaction and sequencing. The sampling revealed arachnids, insects, and crustaceans and within each group individuals were identified to the genus and species level where possible. Values for intraspecific sequence variation among individuals were examined and compared to variation between congeneric species. The barcoding data also permit assessment of the degree of morphological variation found within some species. The CO I sequences from several GSL taxa do not find exact matches in the barcoding databases, suggesting that this ecosystem supports a surprising diversity of invertebrates. These results represent one of the few assessments of invertebrate biological diversity from an extreme environment and may have implications for how to best manage a natural resource under increasing pressure from human activities.

ASSESSMENT OF PHYTOPLANKTON COMMUNITY STRUCTURE OF LAKE BALKHASH USING A FLOWCAM IMAGING FLOW CYTOMETER

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Lake Balkhash, located in the southeastern Kazakhstan, is a unique endorheic lake consisting of freshwater in the western part and saltwater in the eastern part. The lake covers the vast territory of 16, 400 km^2 situated both in unpopulated reserve areas and densely populated industrial regions such as city Balkhash. The varying degree of anthropogenic impact and salt content variation create a large spatial heterogeneity gradient along the lake generating ecological niches with diverse biological communities. The aim of the present study was to assess phytoplankton community structure along the environmental gradient using a FlowCam imaging cytometer. This is the first time the method of flow imaging cytometry is applied to characterization of lakes in Kazakhstan. Water samples were collected from surface layer during May to September in 2015 from 13 sampling stations covering spatially heterogenic sites with varying degree of salinity and anthropogenic load. Water parameters (e.g. water temperature, pH, conductivity, salinity, dissolved oxygen (DO)), content of biogenic elements (nitrites, nitrates, ammonium, phosphates) and heavy metals were measured for each sampling site. Phytoplankton composition and abundance were assessed using an imaging flow cytometer FlowCam (Imaging Fluid Technologies, Yarmouth ME, USA). Live samples of 10 ml volume were processed in laser triggering mode using combinations of 10x objective with 100 µl flow cell and 20x objective with 50 µl flow cell. Image libraries corresponding to different phytoplankton morphological classes were created and used for automatic classification operation performed by VisualSpreadSheet software (Fluid Imaging Technologies, USA). Unclassified and/or misclassified species were manually sorted into the correct classes and up to 40 parameters, including abundance, size and shape data, were exported for each class. Relationships between phytoplankton community and environmental parameters were examined using ordination methods included in statistical software Canoco 5 (Ter Braak & Šmilauer, 2012). Phytoplankton communities of Lake Balkhash were classified into the following major groups: nanoplankton (2-20 µm size), colonial cyanobacteria, colonial picocyanobacteria, filamentous cyanobacteria, dinoflagellates, photosynthetic euglenids, large and small centric diatoms, large and small pennate diatoms, green algae (*Oocystis* spp., *Coenococcus* spp., *Sphaerocystis* spp. and *Pandorina* spp.). Concentration of phytoplankton cells was ranging from 97 to 1072 cells/mL from site to site with the mean concentration of 354 cells/ml for the lake. Nanoplankton dominated nearly all sites contributing from 29 % to 95 % to the total phytoplankton abundance, followed by colonial cyanobacteria such as *Merismopedia* and *Snowella* spp. constituting between 4 % - 32 % proportion. In spite of the relatively low number of dominating phytoplankton groups, a significantly high variability in the presence and proportion of different groups was observed among the sampled environmental sites. We conclude that Lake Balkhash represents a heterogeneous environmental gradient with diverse phytoplankton communities that can be successfully assessed by FlowCam imaging flow cytometer. While FlowCam cytometer does not enable precise taxonomic identification of phytoplankton, it provides high statistical power along with reasonable image quality and software classification capabilities necessary for capturing variation in phytoplankton community structure in heterogeneous environmental sites.

PRODUCTION AND PRELIMINARY CHARACTERIZATION OF A RECOMBINANT CYTOCHROME C FROM *THIOALKALIVIBRIO PARADOXUS*

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Soda lakes are unique habitats with high pH (up to 10-10.5) and salinity levels. Genus *Thioalkalivibrio* is the most wide-spread representative in the group of sulphur-oxidizing bacteria (SOB) in the soda lakes. Some species of bacterial genus *Thioalkalivibrio* are capable of growing on a medium containing thiocyanate (NaSCN) as the only source of the energy, nitrogen and sulphur. Thiocyanate dehydrogenase (TcDH) was obtained from a periplasmic fraction of *Thioalkalivibrio paradoxus*. This enzyme catalyses the first step of the thiocyanate oxidation with formation of cyanate and free sulphur accompanied by an electron transport from thiocyanate to the cytochrome c. Cytochrome c from the horse heart (C550) was used as an electron acceptor for the measurement of TcDH activity in vitro. Fractions, obtained during TcDH purification were analysed by MALDI-TOF. Potential physiological electron acceptor for TcDH - cytochrome c (WP_006748979.1) (C552) was identified. To test this hypothesis the C552 gene was expressed in E. coli cells. The DNA fragment encoding the amino acid sequence of the mature protein (without predicted signal peptide – 26 aa) was amplified from the genomic DNA by PCR methods and was cloned into vector pET-22b(+) (Novagen). The pET-22b(+) vector includes the pelB leader sequence that directs the secretion of the newly synthesized polypeptide chain into the periplasm. It is necessary for proper posttranslational processing. C552 amino acid sequence contains histidine clusters on the N- and C- ends of the molecule. This feature of the protein primary structure was used further for its purification by means of affinity chromatography. *E. coli* strain BL21(DE3) (Novagen) co-transformed with plasmid pEC86 was used for protein production. pEC86 contains gene cluster *ccmABCDEFGH* responsible for the production of properly matured c-type cytochromes under normal aerobic conditions. Protein expression was induced with IPTG and assessed on SDS–page followed by heme-staining to confirm the presence of the protein-bound heme. The recombinant protein was successfully secreted into the periplasm. Protein purification was performed by affinity chromatography on Ni-agarose followed by gel filtration step. Mass-spectrometric analysis of the purified recombinant protein was used to confirm correct posttranslational processing (covalent heme attachment). Spectral and redox properties of the target protein were characterized. Recombinant C552 acts as electron acceptor in the thiocyanate oxidizing reaction catalysed by TcDH. Developed expression system and purification technique allowed obtaining necessary amount of izotopically labelled protein for structural and dynamic NMR research using minimal cultivation medium. Preliminary analysis of the heteronuclear 1H/15N-NMR high-resolution spectra of 15N-labeled protein showed that recombinant C552 possessed dense globular fold with a heme bound. The samples were homogeneous and contaminant-free (less than 5 %).

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ON THE ECOLOGY AND PHYSIOLOGY OF FACULTATIVE ALKALIPHILIC ASCOMYCETE *EMERICELLOPSIS ALKALINE*

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Traditionally fungi are divided into aquatic (including marine) and terrestrial species. However, there are some species that inhabit both water and terrestrial environments. These are inhabitants of the littoral zone of lakes. The edge of the lake basins is a specific habitat for fungi due to periodic flooding, fluctuations of water activity, salt concentrations, temperature, and lack of oxygen. Fluctuations in stress factors are particularly pronounced in the case of hypersaline alkaline lakes. Nevertheless our studies have shown an unexpectedly high abundance of ascomycete fungal species in the littoral zones of hypersaline alkaline lakes. The edge of the lake basins is rich in organic matter, such as remains of water plants, fish, invertebrates, algae, cyanobacterial mats. Fungi can be an important biodestructors at these conditions.

Investigating the fungi in the littoral zones of the hypersaline lakes in Astrakhan, Siberia, Trans-Baikal regions (Russia), the Aral lake (Kazakhstan), Eastern Mongolia, we detected an abundance of alkaliphilic isolates representing new species of fungi - *Emericellopsis alkalina* Bilanenko & Georgieva. The genus *Emericellopsis* has a wide ecological amplitude and worldwide distribution. There are two distinct marine (M) and terrestrial (T) clades within *Emericellopsis*. Our 22 isolates of *E. alkalina* demonstrated an extreme alkaliphilic phenotype and exclusively linked to the M clade. They grew well at pH from 4.0 to 11.2 with a slight optimum at 7–11. Both growth patterns and molecular data suggest that *E. alkalina* group originated from the marine isolates of the M clade, linking evolutionary development in the marine habitat with that of the soda soils. Recently physiological, biochemical features of these isolates were investigated.

Strains of *E. alkalina* were detected only in the littoral zone of the saline lakes, unlike some other alkaiphilic and alkalitolerant fungi that can be found on thalli of the lichens, at the surface of limestone rocks and architectural buildings, in neutral or even acidic soils. The growth experiments on plates with various nutrient media showed their ability to active growth both on synthetic and organic media.

Biologically active compounds produced by *Emericellopsis* spp. have been known for a long time, some of them are used in medical practice. Most strains of *E. alkalina* were characterized by low antibacterial and high/medium antifungal activities. *S*train A118 was of great interest due to strong antifungal effect against *Candida albicans* and *Aspergillus niger*. The most active fraction was purified by RT HPLC, which led to its separation into 11 individual compounds. Comparison of the molecular weights of the isolated individual compounds with the database for peptides indicates the homology of some of themwith antimicrobial peptides.

Biochemical studies have shown that *E. alkalina* have a unique composition of cytosolic soluble sugars. At optimal conditions (pH 10.2) it contained a large proportion of soluble sugars (14 % of dry

weight), predominantly erythritol, arabitol and mannitol, not trehalose and glucose, as obligate alkaliphilic fungus *Sodiomyces tronii* and not mannitol, as other studied ascomycetes. At neutral and acidic conditions (pH 7.0, 4.5) overall sugar content increased (at 45 %), predominantly by increasing of erythritol. We suggest that abundant accumulation of erythritol upon the acidic shock can signify its involvement in the pH stress response.

Thus, the study of facultative alkaliphilic fungus *E. alkalina* revealed its wide fitnessand adaptability to various conditions. These features distinguish it from obligate alkaliphilic species of *Sodiomyces*, which cannot grow at pH below 4–5. Fungi from similar extreme environments apparently use different adaptive mechanisms and require further study of their ecological roles at the edge of the lake basins.

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MOSAIC STRUCTURE OF FUNGAL COMMUNITY IN THE KISLO-SLADKOE LAKE DETACHING FROM THE KANDALAKSHA BAY OF WHITE SEA

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Some northern oceanic and marine coastal zones are intensely rising because of glacioisostatic movement. The White Sea's coastal line is a prominent example of this natural phenomenon. The shoreline of the western part of the White Sea is flat and indented; hence the consequence of the coastal rising is the separation of the water bodies such as bays, armlets, small lakes with coastal straits. These lakes gradually loose the connection with their parent sea and transform into different types of coastal basins depending on the depth. The lakes separating from the White Sea combines both marine and continental features and represent a unique environmental niche. These basins in a varying degree are still connecting with the sea, while also having fresh inflow from the shore. Therefore, the main feature of the lakes is strong vertical stratification supported by a dynamic between fresh and salt water influx. As a result, the detaching lakes contain exclusive selection of inhabitants including freshwater and marine living organisms. The shore-lines of the lakes are equally interesting biotopes than the water reservoirs. Horizontal near shore currents distribute inflowing marine and fresh water along the shores. Therefore, coastal soil and littoral ground are composed by different zones with various conditions for habitation, specifically humidity, salinity and pH values. Mosaic coastal vegetation of the lakes highlights the soil patchiness. Consequently, these transitional ecosystems represent extreme habitats and unmatched objects for observing the general regularities in the formation of anaerobic conditions, the diversity of biogeochemical processes that take place in water and sediments, and the interaction and alternation of freshwater and marine living organisms. Many scientists of various disciplines explore hydrology, flora and fauna of the water bodies at different stages of isolation from the White Sea. We failed to find studies available on the fungal biodiversity in the separating lakes. In this study we presented results of primary research of the fungal biodiversity in the Kislo-Sladkoe Lake detaching from the Kandalaksha Bay of the White Sea. This Lake is one of the most investigated sites among other models of separating water reservoirs located in this region. It is situated near the Pertsov White Sea Biological Station (WSBS, 66°34' N, 33°08' E) of the Lomonosov Moscow State University and represented a beginning stage of peatland formation because of its maximum depth is 4.5 m. Over the past years, the Lake has been examined with a diversity of many directions approaches, such as hydrology, chemistry, physics, zoology, phycology, botany and microbiology. We began to study fungi therein in the year 2009. To make the present work more complete, we combined our new data with selected data from our previous studies of microfungi in the Kislo-Sladkoe Lake. Presumably, soil from the coast is more inhabitable for fungi, than bottom sediments; therefore we predominately focused at the investigation of the Lake's shore-line, whereas fungi in the bottom sediments were described marginally. The fungi were isolated from the peat, soil and sediment samples taken from the coast, littoral and bottom of the Lake in 2009-2010. Our isolation method recovered culturable basidiomycetous, ascomycetous and zygomycetous microfungi, which were identified using morphological and cultural features as well as DNA sequence data (ITS rDNA region, along with LSU rDNA). We characterized the composition, abundance and spatial distribution of species in fungal communities from different parts of the Lake in connection with its freshening and a contact with the sea.

The work was supported by the research grant RFBF No. 15-29-02553 and RSF grant No. 14-50-00029 (the cultivation and collection of the fungi, Grum-Grzhimaylo; identification of fungi, Bilanenko). The work on collecting samples of peatlands was supported by the Program of Government jobs, parts 2 no. 01 10 (№ AAAA-A16-116021660088-9).

BIODIVERSITY OF ZOOPLANKTON IN EUROPEAN SODA PANS

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Soda pans represent unique ecosystems in Central Europe (with high protection priority within the European Union), not only by being the only saline inland waters in this region, but also because their ionic composition is unique on the European scale. They are temporary waters, where zooplankton thrive in the absence of fish. Due to their enormous zooplankton biomass, soda pans represent ideal stopover sites for several waterbird species during annual migration. My research focuses on the effect of salinity on biodiversity and ecosystem functioning in soda pans, the connectivity provided by wind dispersal among these temporary waters, and the trophic interactions between aquatic communities and waterbirds. Understanding these links within and beyond the physical boundaries of such habitats is crucial for their long-term conservation.

USING BARCODING FOR AN INITIAL ASSESSMENT OF DIVERSITY WITHIN TWO UBIQUITOUS, UNDESCRIBED TERRESTRIAL INVERTEBRATE GROUPS FROM AUSTRALIAN SALT LAKES

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Crickets and Desid spiders are found in abundance on most Australian episodic salt lakes, although it would appear that none have been described yet. Samples of these have been sequenced from a range of localities to gain some perspective of their diversity. These "first-pass" results will be presented and discussed.

SPECTRAL METHODS FOR STUDYING OF GREEN SULFUR BACTERIA FROM FIVE WATER BODIES SEPARATED FROM THE WHITE SEA

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Water basins that isolated from the White Sea in the region of the Kandalaksha Bay are unique natural objects with specific hydrological and physico-chemical conditions strongly affecting their ecosystems. As a result of a recent years study on the Karelia shore of the White Sea more than ten relict lakes in different stages of separation from the sea have been discovered. Five of them are located close to the Nikolai Pertsov White Sea Biological Station of Moscow State University. Typical small separating basins in the Kandalaksha Gulf have almost fresh water in the mixolimnion due to rainwater, springs or runoff from bogs, and monimolimnion with salinity close to marine water in the White Sea. The intermediate layer, a chemocline, contains water with salinity increasing with depth. The formation of large population of anoxygenic bacteria around the redox zone was described. Green sulphur bacteria (*Chlorobiaceae*) are single-celled microorganisms, obligatory anaerobic photoautotrophic bacteria. They inhabit only water bodies of different types: pelagic zone of lakes and lagoons, lower layers of bacterial mats, tidal sediments in hot springs. As a result, there are limitations to their physiological features, the bacteria can be found only in a narrow layer, in opposite gradients of light and sulfide. In the lakes and lagoons of the Kandalaksha Bay, this layer usually has a thickness of 0.2-0.5 m and is located at a depth of 2 to 4 meters. Green sulphur bacteria may reach high biomass densities. In this work water samples from five water basins separated from the White Sea in the Kandalaksha Bay area (lakes Trekhtzvetnoe, Elovoe, N. Ershovskoe, Kislo-Sladkoye and Lagoon on the Cape Zeleny) were studied. Water samples were taken using a submersible pump from different layers and then physico-chemical characteristics were registered. Fluorescence and absorbance spectra were registered in laboratory conditions using fluorometer Solar CM2203 and spectrophotometers Unico and Solar. Acetone and methanol extracts were prepared for bacteriochlorophylls (BChl) concentrations measurements by spectrophotometric method. Identification of the main bands in the absorption and fluorescence spectra showed that the main photosynthetic organisms in the chemocline are green sulfur bacteria containing BChls *c*, *d*, *e*. Absorbance spectra of the water samples with green sulfur bacteria contained absorption band of BChls *d* and *e* (longwave band at 710-725 nm) and carotenoids (400-500 nm). In the fluorescence spectra of water samples with green sulfur bacteria the peaks at wavelength λ = 740-770 nm correspond to the emission of BChls *d* and *e*, and *a* band at and 815 nm is caused by emission from BChl *a*. Anoxygenic phototrophic microorganisms including green sulfur bacteria, green-colored (containing BChl *d* in pigment compound) and brown-colored (containing BChl *e*), have the special ecological niche in such reservoirs. Separate determination of these microorganisms by spectral methods is complicated because of the similarity of spectral characteristics of their pigments. In this work two methods to separate the contributions of different groups of bacteria were proposed. The first method is associated with the deconvolution of the fluorescence spectrum of bacterial cells in the 740-770 nm range into two Gaussians, which are characteristic of fluorescence BChl *d* (770 nm) and BChl *e* (740 nm). The second method involves the calculation of the area under the short-wavelength peaks in the absorption spectra of acetone and methanol extracts of green sulfur bacteria (470 and 430 nm). These methods were tested on pure cultures of brown- and green-pigmented sulfur bacteria and there mixtures in various proportions. Using one of those two methods one can estimate distribution of the concentration of various groups of green sulfur bacteria in the ponds. Assesses of BChls concentration in the cells of green sulfur bacteria also provides in the work.

SALT STRATIFIES LAKES NATURALLY SEPARATED FROM THE WHITE SEA SHORE: HYDROLOGICAL STRUCTURE AND MULTIPLE COLORED LAYERS IN THE CHEMOCLINE

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On the shore of the White Sea many coastal saline stratified lakes were formed due to the postglacial uplift resulted in separation of some bays from the sea. Generally these lakes are small (1-4 ha), shallow (max depth 2-10 meters) with a bottom depression where a stagnant salt zone is formed. Their salinity depends on the extent of lake isolation. A typical vertical structure of the lake consists of five layers. 1) The zone of wind mixing about 1 m deep. It is almost fresh in the lakes lacking sea water intrusions, or salt in the lagoons with regular tides. 2) Pycnocline with the sharp salinity gradient. In most continental meromictic lakes pycnocline serves also as a chemocline (the interface between the aerobic and anaerobic zones), but in the studied lakes the redox boundary is situated lower than pycnocline. 3) Salty water saturated with oxygen, often supersaturated up to 200-300 %. In summer it is often the warmest due to the heat accumulation like in a solar salt pond. This layer is larger in the lagoons with regular tides, than in isolated lakes. 4) Chemocline (redox zone) characterized by low illuminance, high nutrients concentration, and presence of H_2S. Brightly colored layers usually are here; often two or three differently colored in same lake. In the upper horizon where the conditions are still microaerobic, or anaerobic with minor concentration of hydrogen sulphide, mixotrophic microorganisms are located (marine cryptophyte flagellates *Rhodomonas* sp. colors water in bright red, freshwater *Cryptomonas* sp. in pinkish, or *Euglenozoa* in greenish). Below the boundary of aerobic and anaerobic environment a dense community of anoxigenic phototrophic bacteria is usually formed, with the leading role of green sulfur bacteria. Green-colored strains color the layer is dense green, and brownish-colored strains - in brown. The layers with mixotrophs and anoxigenic phototrophs can exist in the same lake close to each other, we assume trophic relations between them. Number and biomass of the microorganisms in the redox zone are one or two orders of magnitude higher than those in the other layers. 5) Below the chemocline aphotic anaerobic zone with a high content of hydrogen sulfide, methane, organic substances and biogenic elements is situated. Colored layers in five lakes at the different stages of the separation from the sea were investigated using spectrophotometry, spectrofluorimetry and photobiology (measurements of primary photochemistry of PSII activity). Surface stratum, pycnocline and bottom anaerobic layer are poor of plankton. Thin layer with the algae containing Chl *a* in the lower part of the middle salt water in different lakes is inhabited by different dominant species such as dinoflagellate *Gymnodinium*, small non-identified protococcal algae, small flagellated alga belonging to *Chlorophyta* preliminary identified it as cf. *Micromonas*, green algae *Scenedesmus* and *Carteria*. The maximum density of the phototrophs appears in the chemocline. In spite of the contact with H_2S, photosynthetic apparatus of algae associated with the chemocline is characterized by high values of the maximum quantum yield of primary photochemistry, activity of electron transport, photosynthetic performance of photosystem II, fraction of the active centers and low values of heat dissipation. The specific electron fluxes per reaction center of photosynthesis were higher in green algae in chemocline zone due to the inactivation of some active centers and high dissipation of the inactive reaction centers. Cryptophytes were characterized by higher fraction of active centers and lower dissipation of the inactive reaction centers.

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EXPERIMENTAL STUDY OF INCREASING THE BIOPRODUCTIVITY OF SALT LAKES BY INTRODUCTION OF *ARTEMIA NAUPLII*

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The purpose of this work was to study the possibility of increasing the bioproductivity of salt lakes by introducing *Artemia nauplii* into the lake with the local natural Artemia population. According to the long-term monitoring of Artemia lakes [1], in Siberian populations with a salinity of more than 150 g / l due to low live birth, there is a decrease in the biomass of the crustaceans in the period of 2 and 3 generations. The introduction of nauplii during this period will contribute to increasing of the shrimps density and the natural productivity of the lakes. For experiments we have chosen Ulzhay Lake (Omsk region) as suitable for carrying out an experiment to increase bioproductivity through the introduction of *Artemia nauplii*. A comprehensive survey of Lake Ulzhay, including the study of abiotic (temperature, oxygen, composition of ions) and biotic (zooplankton, benthos, reserves of cysts) factors was carried out according to generally accepted methods. The area of lake is 864 hectares, the average depth is 0.5-0.7 m. The lake is drainless. During the period of research (July-August 2015) the salinity of the water in lake was 125 g/l. During the period of examination, the zooplankton of Ulzhay Lake was represented both by mature females and by younger stages of Artemia shrimps. The total number of shrimps was - 10 thousand shrimps/m^3. For the experiment, an incubation unit with a capacity of 100 kg of raw cysts (or 50 kg in dry) per day was created. We used a vessel, namely a 16 m^3 frame pool, incubation salt solution (30 to 45 g/l), aeration and illumination. In 1 experiment (beginning at 8:00 a.m.) 50 kg of dried Artemia cysts were placed in saline solution; in 2 experiment (beginning at 8:00 p.m.) - 30 kg of dry cysts. The incubation lasted for 24 hours in the first experiment and 36 hours in the second. In the second experiment, the duration was increased because of the low air temperature. 10 hours after the beginning of the experiment, every hour the main indicators were recorded: the hatching percentage of cysts, temperature, the amount of dissolved oxygen. The hatching of nauplii in both cases reached 60 %, in the first case after 24 hours, in the second - after 32 hours. After incubation *Artemia nauplii* was released from the incubator to the specially prepared in the littoral zone of Ulzhai Lake from polyethylene film enclosure (15x15 m) and then directly into the water area of the lake. On the enclosed territory the survival of the nauplii was observed, namely the adaptation of *Artemia* to the natural conditions of the environment and to a high level of salinity. To analyze the survival of crustaceans, we used the ratio of live and dead animals. The death of nauplii in the amount of 24 % in the first experiment and 13 % in the second was observed during incubation, probably as a result of lack of oxygen. Some of the nauplii died during their descent into the enclosure (23 % in 1 experiment and 12 % in 2), probably as a result of mechanical damage and possibly also as a result of salt shock. In the first experiment, when the ambient temperature was elevated (24°C), the percentage of survivors was smaller and amounted to about 47 %. In the experiment with a lowered temperature (19°C) the percentage of surviving individuals was 59 %. At the stage of metanauplii on the fifth day of their maintenance in the enclosure the crustaceans were released into the lake. The results of the experiments showed that by improving the incubation conditions, it is possible to achieve the yield of live nauplii up to 60 % or more. The calculation showed that from the incubated 80 kg of dry cysts we will get 950 kg of cysts in dry weight in 40-50 days. Thus, when 1 kg of dry cysts is applied, the production will increase 12 times. It is more than the expected result.

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^{210}Po IN SALT LAKES OF THE CRIMEA

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Originated in radioactive series ^{238}U, ^{210}Po is 100% alpha emitter with the particle energy 5.305 MeV and the half-life of 138.4 days. As well known, ^{210}Po is the dominant contributor to natural radiation doses to marine biota and man via seafood consumption, and one of tracers of biogeochemical processes in marine environment. Atmosphere fallout is the main pathway of ^{210}Po input to the surface layer of seas and oceans. ^{210}Po falls into sediments first of all with suspended organic matter. There are many data about ^{210}Po behavior in marine ecosystems. But only few papers about this radionuclide study in salt lakes ecosystems are known. Before 2016 there were no data about ^{210}Po in the Crimea salt lakes. The first aim of this work was to investigate the effect of salinity, formed by natural processes in different salt lakes of the Crimea peninsula, on the ^{210}Po concentrations and their vertical distribution in sediments. Second task was to determine the levels of this radionuclide accumulation by *Artemia salina* in the natural habitats in salt lakes to assess the dose generated by the ^{210}Po alpha particles. Sediments were collected in different salt lakes of the Crimea in the period from May to September, 2016. The determination of ^{210}Po in samples was carried out with using of the radiochemical procedure of the RISOE National Laboratory. ^{208}Po was added as a yield tracer. Polonium was spontaneously plated onto silver disks. Alpha counting of ^{208}Po and ^{210}Po was done using a silicon surface-barrier detectors and alpha-spectrometer EG&G ORTEC. The mean values of the ^{210}Po concentrations in investigated sediments and the standard error (SE) of the mean are given in Bq·kg^{-1} dry weight (dw). The results for artemia were done in Bq·kg^{-1} wet weight (ww). The ability of the sediments and artemia from salt lakes of the Crimea peninsula to accumulate the natural radionuclide ^{210}Po was estimated. According to the levels of ^{210}Po concentrations in sediments, investigated salt lakes are divided into the Kerch, the Evpatoria and the western groups of the Crimea. The highest concentrations of ^{210}Po are characteristic of sediments of lakes located on the Kerch peninsula (the eastern part of the Crimean peninsula). The comparison ^{210}Po vertical distribution in sediments from the western group lakes (Sasyk-Sivash, Dzharylgach and Kyzyl-Yar) with the salinity 280, 115 and 3.5 ppm, respectively, revealed the dependency its concentrations on sediments depth and water salinity. The comparison of the ^{210}Po fluxes into the sediments of the Dzharylgach Lake and the bays of the Sevastopol marine area revealed their significant excess in salt lake. The first calculations of the dose derived to adult *A. salina* from ^{210}Po alpha-radiation showed high level of equivalent dose rates for this crustacean. This value is almost 2.5 times higher than for the Black Sea mass molluscs – mussels *Mytilus galloprovincialis* Lam. and 65 times lower than the IAEA permissible level for aquatic biota.

Key words: salt lakes, the Crimea, natural radionuclide ^{210}Po, bottom sediments, artemia.

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HALOPHILIC BACTERIA AND ARCHAEA AS PART OF THE ARTEMIA DIET

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Hypersaline environments, commonly defined as water bodies presenting salt concentrations more than twice that of seawater, can be found on all continents of our planet. Their physicochemical characteristics makes them "extreme" for the survival of many organisms and exclude whole taxonomic groups from such habitats. The brine shrimp Artemia is, in fact, one of the scarce macrozooplankton organisms able to successfully populate hypersaline ponds and lakes around the globe. On the microbial level though, besides phytoplankton, a great variety of microorganisms equally adapted to life at high salt concentrations are also known to thrive in these harsh habitats, those being the moderately and the extremely halophilic Bacteria and Archaea. Since Artemia is a continuous, non-selective filter feeder which can take up particles up to 50µm when adult, but less so for its larval stages, its dietary basis comprises different microorganisms and organic particles that are present in its surroundings. Green microalgae and diatoms are indeed thought to be its main food items. Nevertheless, the everlasting coexistence of the brine shrimp Artemia and halophilic Bacteria and Archaea under the unique characteristics of the hypersaline environments leads to the hypothesis that trophic interactions between these extremophiles may occur. Surprisingly, in spite of the growing scientific interest for these ecosystems dynamics, until the present day no study on hypersaline food webs have tackled this pressing matter. Gnotobiotic culture systems (animals cultured in axenic conditions or with a known microflora) present themselves as excellent tools to investigate such hypothesis. Hence, in the present research we aimed to use a standard small-scale gnotobiotic Artemia culture system to investigate for the first time Artemia nauplii's ability to survive and grow on diets consisting exclusively of halophilic Bacteria and Archaea biomass. Our study included three experiments, each corresponding to one halophilic strain tested, i.e. two halophilic Bacteria and one halophilic Archaea. Each experiment included the strain offered to Artemia as live or dead cells, a negative control (starvation) and a positive control (autoclaved marine bacterial strain with well described nutritional value towards Artemia), each of them offered at two salinities i.e. hypersaline salinity (100 g l-1) and seawater salinity (35 g l-1). The performance of Artemia in terms of daily survival and final individual length after five culture days was used as criterion to assess the effect of each diet on Artemia. Our results demonstrated that the addition of the tested halophilic Bacteria, either live or dead to the Artemia culture water, at both salinities, allowed for significantly superior nauplii survival than the corresponding negative control at the end of the experiment. Moreover, the mono-diets of live halophilic Bacteria cells diets also resulted in significantly higher nauplii individual length values when compared to the positive control diet. On its turn, the Archaea strain cells also allowed for superior nauplii survival than the negative control but only at the hypersaline salinity. This acquired knowledge is therefore a crucial contribution for a better understanding of the role of Bacteria and Archaea in the hypersaline food webs, proving for the first time that they can indeed be part of the diet of the brine shrimp at least during its first developmental stages. When studying Artemia nutrition in salt lakes it is therefore of primary importance to take these halophilic microorganisms into account, counterbalancing the focus on phytoplankton as has been the case so far. Our findings also shed light on the potential use of these microorganisms as complementary diets to maximize Artemia resources exploitation on man managed salt ponds.

SPATIAL HETEROGENEITY OF PHYTOPLANKTON COMPOSITION AND WATER QUALITY IN LAKE BALKHASH

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Lake Balkhash is a unique oligohaline-mesohaline water body situated in South-Eastern part of Kazakhstan, with its basin being located in China, Kazakhstan and Kyrgyzstan. This endorheic tectonic lake is separated by Saryesik Peninsula into two different areas connected through Uzynaral Strait – freshwater shallow Western part and Eastern part where salinity and depth is higher. Currently, Lake Balkhash is facing challenges caused by synergistic effects of climate change, water scarcity and industrial pollution. Northern part of the lake, where a large number of industrial enterprises including metallurgic plant is located, is the most susceptible area to human impact and heavy metal pollution of water and bottom sediments. Besides, growing shortage of fresh water in the lake as a result of irrigation and river runoff in China's area of main tributary, Ili River basin, may lead to ecological catastrophe similar to the dramatic case of Aral Sea. The aim of the present study is to assess spatiotemporal heterogeneity of phytoplankton biodiversity and abundance along gradients of physical-chemical parameters and heavy metal pollution of Lake Balkhash. Samples were collected between May and September in 2016 from 13 sampling locations – 4 sites in Western part, 4 sites in Eastern part, 3 sites in Northern area (Bertys Bay) and 2 sites in Uzynaral Strait. In May-September 2016 salinity values in Lake Balkhash varied between 0.33 and 3.6 ‰ with mean value of 1.37 ‰ in Western part, 2.53 ‰ in Eastern part of the lake, 1.49 ‰ in Bertys Bay and 1.68 ‰ in Uzynaral Strait. Analysis of heavy metals content has shown significant excess of concentrations of copper and zinc over maximum permissible concentrations in Bertys Bay where technogenic pollution from metallurgic plant is pronounced. It was found that contamination spreads heavier in the direction of Western part. In May-July 2016 the excess over maximum permissible concentrations for manganese content was detected in whole water area of the lake. In addition, high concentrations of nickel, iron and arsenic were revealed for certain sampling sites. Due to vast lakescape and diverse environmental gradients Lake Balkhash provide a large variety of aquatic habitats for diverse populations of phytoplankton species so that sampling sites are made as refugiums with specific phytoplankton community composition. However, microscopy analysis of samples have shown that the bulk of phytoplankton community of Lake Balkhash is constituted mainly by three taxonomic groups – *Cyanoprokaryota*, *Bacillariophyta* and *Chlorophyceae*, where the most abundant species are *Snowella lacustris*, *Merismopedia tenuissima*, *Merismopedia elegans*. These colonial cyanoprokaryotes along with *Gomphosphaeria aponina*, chlorophyte *Oocystis lacustris*, diatoms *Entomoneis alata* and *Cyclotella radiosa* represent the group of eurybionts found in phytoplankton on every site in 2016 from May to September. Chlorophytes (including *Oocystis*, *Didymocystis* and *Raphidocelis* species) play a critical part in plankton community composition in the Western part while dinoflagellates (*Peridinium, Peridiniopsis, Gymnodinium* species) and diatoms (notably *Chaetoceros* sp.) contribute significantly to phytoplankton abundance and biomass in the East. Composition of dominant species is different for the saline creek in the East of the lake where salinity reaches the highest value. There are filamentous chlorophyte *Binuclearia lauterbornii*, diatoms *Fragilaria* sp. and dinoflagellates *Protoperidinium* sp. and *Peridinium bipes*, with xanthophyte *Gloeobotrys limneticus*. Sites in Bertys Bay also differ in dominants from the major part of the lake due to their acute industrial and organic pollution. Thus, phytoplankton there consisted mainly by phytoflagellates, most notably *Tetraselmis* and *Plagioselmis* species.

^{90}Sr and ^{137}Cs AS THE RADIOTRACERS FOR DETERMINATION OF THE RATE OF BIOGEOCHEMICAL PROCESSES IN SALT LAKES OF THE CRIMEA

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In 2016 for the first time in the history of the salt lakes of the Crimea, as well as for the entire period after the nuclear weapons test and after the Chernobyl NPP accident, a radioecological study was conducted on the contamination of the ecosystems of the 10 salt lakes of the Crimea by ^{137}Cs и ^{90}Sr. The following salt lakes of the Crimea were investigated: the Krasnoye, the Kiyatskoye, the Kirleutstkoye lakes from Perekopskaya group, the Tarkhankut, the Jarylgach, the Bakalskoye lakes from Tarkhankutskaya group, the Sasyk-Sivash, the Kyzyl-Yar lakes from Evpatoriyskaya group, the Tobechik, the Chokrak, the Aktash lakes from Kerchenskaya group. It was established that the main ways of the entering of the post-accident ^{90}Sr and ^{137}Cs in the ecosystem of salt lakes of the Crimea was atmospheric transport in the first months after the Chernobyl NPP accident. From 1987 until 2014 the waterway was the main source of the inflow of dissolved forms of radionuclides, introduced with the waters of the Dnieper River through drainage system of the North-Crimean Canal (NCC). In the water of the studied groups of lakes there was a positive correlation between the salt content and the concentration of anthropogenic radionuclides ^{90}Sr and ^{137}Cs. To determine the rate of sedimentation in the salt lakes of the Crimea, we used the methods developed previously (Polikarpov, 2008, Mirzoyeva, 2013) for the using of ^{137}Cs and ^{90}Sr as the radiotracers for the geochronology of the bottom sediment cores from the studied water objects. The biogeochemical process ensuring the elimination of ^{90}Sr and ^{137}Cs from the water column into the bottom sediments of the salt lakes of the Crimea is less than 1 %, whereas according to our data, the biogeochemical processes, which are responsible for elimination of the ^{90}Sr and ^{137}Cs after the Chernobyl NPP accident from the ecosystems of Sevastopol bays account more than 40 %. The analysis of the obtained results showed that the main process ensuring the reduction of the concentrations of the post-accident ^{90}Sr and ^{137}Cs from the salt lake ecosystems is the physical decay of these radionuclides.

This work was supported by the Russian Foundation for Basic Research Grant No. 16-05-00134. Key words: salt lakes of the Crimea, accident at the Chernobyl nuclear power plant, 90Sr, 137Cs, radiotracers, biogeochemical processes.

STRUCTURE OF THE FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE FROM HALOALKALIPHILIC BACTERIUM *THIOALKALIVIBRIO PARADOXUS*

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Thioalkalivibrio paradoxus is haloalkalophilic chemolithoautotrophic sulfur-oxidizing bacteria living in soda lakes. The main source of energy for such bacteria is oxidative metabolism of sulfur compounds such as sulfide/polysulfides, thiosulfate, sulfur. The key enzyme in sulfur oxidation is heterodimeric Flavocytochrome *c* Sulfide Dehydrogenase (FCC) (EC 1.8.2.3), which consists of flavine-binding and cytochrome c subunits. Cytochrome *c* subunit consists of either single- or double domains. Only the structure of FCC with two-domain cytochrome c is known. Five copies of fcc genes were found in genome of *T. paradoxus*. Expression level of each gene depends on cultivation conditions. In this work we investigate FCC from *T. paradoxus* grown on thiocyanate as a sole source of energy and nitrogen. FCC was purified to apparent purity and homogeneity and crystallized. Structure of FCC was solved by X-ray analysis at 2.5 Å resolution. Asymmetric unit contains heterotetrameric complex of FCC and copper binding protein CopC. FCC from *T. paradoxus* very similar to all known FCC structures. Superposition of flavine binding subunit of FCC from *T. paradoxus, A. vinosum* and *T. tepidum* gives r.m.s.d. 0.8 Å. Single domain of cytochrome subunit binds one heme c with axial His/Met ligands and is very similar to the first domain of cytochrome c subunit of FCC from *A. vinosum* and *T. tepidum*. Analysis of the structure revealed some mechanisms of adaptation of FCC to the specific conditions of soda lakes. During structure refinement dimer of copper binding protein CopC was found in asymmetric unit. We suppose that complex of FCC and CopC is a part of large periplasmic complex involved in oxidation of thiocyanate.

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GREEN ALGAE FLOATING CLADOPHORA MATS IN THE SALINE LAKES AS AN ECOSYSTEM ARCHITECT: THE CRIMEAN CASE

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Cladophora spp., filamentous green algae, may reach high biomass and play a very important functional role in productivity and nutrient cycling in the different water bodies, including hypersaline ones. In hypersaline lakes and lagoons of Crimea, they may form floating mats driving architecture and dynamics of ecosystems. Authors have been studying those mats ant their impact on the environment since 2000. Those mats may have high biomass - up to more then 5 kg/m^2 and are very complicated systems including different epibiontic organisms (bacteria, microalgae, infusorians) and free living in them protists and animals. Animal and infusorian abundance may rich high values in them, as an example: *Cletocamptus retrogressus* (Copepoda, Harpacticoida) – up to 350,000,000 ind./m^2, *Eucypris mareotica* (Ostracoda) – up to 150,000,000 ind./m^2 and the larvae of Chironomidae (Insecta, Diptera) – up to 3,000 ind./m^2. *Cladophora* spp. provide habitat for epibionts (bacteria and microalgae, primarily diatoms), and sustains of the mutualistic alga-bacterium interactions. Excreting exo-alkaline phosphatases, *Cladopora* spp., epibiontic microalgae and bacteria accelerate phosphorus cycling, and this may increase their productivity. Cladophora floating mats may cover from 20 to 90 % of the surface of the lake area, thereby significantly affecting its important abiotic characteristics such as: evaporation of water from the surface of the lake, respectively regulating a water level and the salinity change. Mats also influence on a temperature regime, its spatial and temporal variability, on regimes of pH and Eh, oxygen concentration. High development of mat leads to a strong vertical stratification of different parameters with anoxic layers under them. Biogeochemical cycles are within the boundaries of the mats that determine its integrity. Phases with high development of the floating mats repeat in temporal dynamics of the saline lake ecosystems as one of their alternative stable states.

LONG-TERM CHANGES OF THE SALT LAKES ECOSYSTEM IN SOUTH EAST ZABAIKALIE

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Research of salt lakes allows to speak about a new, promising, intensively developing field of limnology which has a huge practical and basical scientific value. There is a group of lakes (Zun-Torey (N50°05.404; E115°48.303), Barun-Torey (N50°14.082, E115°40.061), Bain-Bulak (N50°22.333, E114°48.807), Tsagan-Nor (N50°11.592, E114°59.363), Bain-Tsagan (N50°20.000, E115°06.288)) on the territory of Torey closed basin, these lakes differ in their origin, morphometric characteristics, surrounding landscape's conditions, mineralization rate, hydrological conditions and other characteristics. Complex hydrobiological researches of these lakes have been conducted in 1983, 1986, 2011 and 2014 years and have had low water content and dry climate, 1999 and 2003 years are the periods of high moisture.

Under the circumstances of climate change in the territory of the Torey hollow, basin's area and drying rate depend on lake's inflow type and its morphometric features. That's why hydrological regime's change is a main factor of mineralization rate and chemical composition of waters of the ponds in Torey closed basin. Cations chemical composition of the lakes is mostly natrium, anions chemical composition are hydrocarbonate-chloride or chloride- hydrocarbonate. In some cases mineralization rate's increase causes regular growth of relative chlorides content in waters, in other lakes carbonate's faster growth is marked (Zamana, 2008). Dynamics of nitrogen, phosphor and organic matter's content corresponds with water regime changes. Thus, during high-water period phosphor content increases, during low-water period phosphor content decreases. With respect to nitrogen combinations the opposite situation is marked.

Ponds water mineralization rate affects on species diversity and hydrobionts association structure. In salt lakes with mineralization rate's growth up to 7g/l microorganisms number and biomass increase is marked, benthos cyanobacterial mats also develop. Growth of quantitative indicators of bacteria indicates the growth of microbiologial process in producing of organic matter (Namsaraev et al., 2009). During high-water period species diversity is marked for hydrobionts associations (phytoplankton, filamentous algae, hydrophyte, zooplankton, zoobenthos, fish). In the conditions of water level lowering and mineralization rate increasing hydrobionts association species diversity decreases. Thus, when mineralization rate increases up to 8g/l, hydrophytes, filamentous algae and fishes disappear. With mineralization rate of 7g/l only halophilic planktonic species may survive.

GENOMICS AND TRANSCRYPTOMICS OF HALOALKALIPHILIC SULFUR-OXIDIZING BACTERIUM *THIOALKALIVIBRIO NITRATIREDUCENS*

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Thioalkalivibrio nitratireducens is a facultatively anaerobic, haloalkaliphilic, obligately chemolithoautotrophic sulfur-oxidizing gamma-proteobacterium from soda lakes growing optimally in sodium carbonate containing media at pH 10-10.5 and 0.5-1.2 M of total Na^+. The anaerobic growth of the bacteria is possible with sulfide or thiosulfate as donors, and nitrate as the acceptor of electrons that is reduced to nitrite. Recently, we sequenced, assembled, and annotated the complete genome of *Tv. nitratireducens* (Genbank: CP003989.1) containing a 4MB single circular chromosome. Analysis of the genome suggests construction of dissimilatory metabolic pathways for *Tv. nitratireducens*, which include sulfur and nitrogen compounds. To assess the activities of the metabolic pathways, we carried out a comparative transcriptomic analysis of the bacteria grown either aerobically or anaerobically at nitrate-reducing conditions, focusing on the expression levels of enzymes involved in transformation of sulfur and nitrogen compounds in dissimilatory oxidation of substrates. Depending on the growth conditions, the transcriptomes covered 79-94 % of the annotated regions of the genomic DNA including 3898 individual genes, of which 480 - 750 protein encoding genes had enhanced levels of transcription. The transcriptomic analysis found that the cells grown without oxygen showed a significant decrease in the expression of genes encoding enzymes involved in reverse sulfidogenesis [adenylsulfate reductase (APR), sulfate adenyltransferase (SAT), and reversed dissimilatory sulfite reductase (rDSR)]. As this path of sulfide oxidation appeared downregulated under anaerobic conditions, the oxidation of thiosulfate likely proceeds through the Sox pathway. Genes of enzymes for nitrogen metabolism were less sensitive to the nature of electron acceptor. The anaerobiosis moderately increased transcription of genes encoding nitrate ABC transporter, nitrate/nitrite sensor protein, and nitrogen regulatory protein P-II, as well as components of periplasmic nitrate reductase and respiratory nitrate reductase. At the same time, transcription of the N_2O-reductase, components of nitric oxide reductase, and the octaheme c nitrite-reductase (TvNir) decreased.

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ON THE INFLUENCE OF SEASON AND SALINITY ON THE PHENOLOGY OF INVERTEBRATES IN AUSTRALIAN SALINE LAKES, WITH SPECIAL REFERENCE TO THOSE OF THE PAROO IN THE SEMIARID INLAND

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While the fauna of Australian salt lakes is now well known, seasonal phenological patterns of invertebrates are not. Four studies on saline lakes in southern Australia suggest the lakes fill in early winter and remain at salinities characteristic for each lake during winter-spring before elevating and drying in summer. The fauna is dominated by crustaceans with almost no insects and all component species are present most of the time and fluctuating randomly in numbers. By contrast temporary salinas in the remote inland fill episodically mainly in summer and then their salinity increases steadily as they dry without further rain. Their fauna is also dominated by crustaceans, but with a significant insect component and composition varies though the hydrological cycle. This study reports on an unusual winter fill in two Paroo lakes and two pools, in which the crustacean fauna is similar to that in summer but insects are delayed till late spring and are not as common as in summer fills. It seems therefore that while insects are more restricted by medium and high salinities than crustaceans, they are also more restricted by cooler temperatures than crustaceans.

TAXONOMIC COMPOSITION AND BIOMASS OF ZOOBENTHOS IN SALINE LAKE SHIRA: SHIFTS THAT HAPPENED IN 65 YEARS

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In summer 2016 we studied biomass and species composition of zoobenthos in the saline meromictic lake Shira that has large recreational significance for Khakasia and Krasnoyarsk regions. The dimension of the lake is 9.5 km x 6.5 km, and the average depth is 11.2 m (the maximum depth is 24 m). The water of this lake is sulfate-chloride-sodium-magnesium and the mineralization is in the range 14-18 g / l. Zoobenthos of the studied lake consisted of 15 species, among those chironomid larvae *Glyptotendipes barbipes*, *Chironomus nigrifrons* and *Chironomus halophilus*, and plankto-benthic amphipod *Gammarus lacustris* dominated. Biomass values averaged for the studied summer period (54 days) were 6.8 ± 3.11 g / m2 and 4.4 ± 1.01 g / m2, for Chironomidae и Gammaridae taxa, correspondingly. Additionally, we found significant difference in dominant species biomass and the total production of chironomids between the littoral and the pelagial parts of the lake. A comparison of the biomass values of the frequently encountered species of zoobenthos (6 species of Chironomidae and *G.lacustris*), averaged over the entire lake area, showed that the biomass of *G. barbipes* and *P. bicrenatum* was significantly higher for the littoral zone of the lake. In turn, the profundal of the lake was characterized by significantly higher values of the biomass of chironomids *C. halophilus*, *S. nigrifrons*, *P. ferrugineus* and amphipods *G. lacustris*. We compared our data with results of the only extensive study of zoobenthos in the lake that was carried out in the early fifties of XX-century. The amphipod *G. lacustris* dominated in zoobenthos in that time, like in the contemporary period. In contrast, chironomid species that dominate now were not found in benthic fauna 65 years ago. Meanwhile, biomass values of Chironomidae and *G. lacustris* decreased in several times compared to zoobenthos values in fifties of the previous century. The reason for this could be the desalination of the lake, started in the 30s-40s of the last century. In general, relatively few number of benthic species in Shira Lake agrees with a common notion that species richness decreases in inland waters with salinity > 15 ‰. Averaged biomass of the dominant taxa, Chironomidae family, corresponded to a range of values reported for other saline water bodies.

SUPPLEMENTATION OF HALOPHILIC ARCHAEA IMPROVES ARTEMIA BIOMASS PRODUCTION IN HYPERSALINE CULTURE CONDITIONS

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Halophilic Archaea inhabit in hypersaline environment as an important part of microbial community. The high salt concentration enable archaea cells accumulating bioactive compounds with unique structure and functions. Therefore, archaea are also considered microbial resources with a potential of commercial application. As non-selective filter feeder, Artemia plays an important role in the aquatic food chain in hypersaline environments although the natural environment of Artemia has a relatively simple food web due to its high salinity. It is well known that the growth of Artemia population is supported by a rich phytoplankton community. Recently the role of microbiota in the Artemia life cycle and importance in the hypersaline food chain has drawn much interest (Riddle et al., 2013; Quiroz et al., 2015; Rahmani et al., 2016). This study focused on Archaea, the special but less concerned microorganisms from the 3rd domain of life. Halophilic archaea co-exist with Artemia in hypersaline water column. Their cells are made of ether-linked membrane lipids instead of ester-lipid presented bacterial and eukaryotic cells. It is considered unsuitable food for aquatic animals as the ether lipids are difficult to be digested and are not able to provide essential fatty acid for supporting the growth and survival of animals (Van de Vossenberg et al., 1998). Our previous study using gnotobiotic experimental Artemia system have indicated that the red halophilic archaea strains isolated from crystallization pond of solar saltworks, *Haloarcula*, *Haloferax* and *Halorubrum* could be the sole diet for Artemia nauplii at wide range of salinities (e.g. 30-150 g/L). Meanwhile the halophilic archaea could improve the resistance of Artemia against *Vibrio anguillarum*, the pathogen frequently emerged in aquaculture. However, few study deals with archaea under man-controlled condition, e.g. aquaculture system. In this study, three archaea strains *Haloarcula*, *Haloferax* and *Halorubrum* were supplemented into Artemia culture, respectively, to investigate if archaea can outcompete of the halophilic bacteria and other microorganisms in culture column, and support the growth and reproduction of Artemia. The GSL Artemia cysts were hatched at salinity 30 g/L, 28°C for 24 h. Newly hatched *Artemia nauplii* were acclimated to salinity 100 g/L by gradually increasing salinity with 4 days. Artemia were then randomly transferred into 1 L cones containing 800 mL brine water (salinity 100 g/L) at density of 1 ind./mL. Three groups of Artemia were fed *Haloarcula*, *Haloferax* and *Halorubrum*, respectively at daily ration of 108 CFU/mL and artificial feed (Selco-rotifer, INVE). The carbon/nitrogen ratios in each group were manipulated by adding sucrose and ammonium chloride at C/N of 0, 5, 15, and 30. The amount of sucrose and ammonium chloride were calculate according to Avinemelch (1999). Culture without archaea supplementation was used as a control. The Artemia were cultured at 22-25°C, with continuous aeration. At the end of the experiment, the total Artemia biomass production, biofloc volume, water quality (i.e. ammonium, nitrite and nitrate concentration, etc.) and microbial diversity of biofloc will be determined. The results showed that archaea supplementation could improve Artemia biomass production, biofloc volume; the highest biomass production reached at C/N 15. Other parameters are under analyzed will be reported at conference.

BIOLOGICAL AND ECOLOGICAL FEATURES OF MEROMICTIC LAKES

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Meromictic lakes are chemically and/or thermally stratified for several years, and have several specific ecological features. Various factors, including salinity are able to support meromictic conditions. The chemocline – the habitat created between the mixolimnion (top layers that regularly mix) on top and monimolimnion (deep stagnant waters) below is characterised by the existence of complex bacterial communities, autotrophic and heterotrophic protists, and metazooplankton, commonly dominated by rotifers; high rates of oxygenic and anoxygenic photosynthesis and some biogeochemical processes. In these lakes the sulphur, carbon and nitrogen cycles are partially coupled. However, a large number of bacterial and archaeal taxa, especially in anoxic waters, are still unidentified. The different components of the chemocline communities represent the ingredients of microbial loop that probably links the production of organic matter in anoxic waters with the classical grazer food-web. However, in most of such lakes, the food-web is not quite quantified. The classical grazer food-web in meromictic lakes is often truncated, especially because fish and other predators are often absent. Meromixis has several effects on the grazer food web. First, the lack of mixing favours the loss of nutrients into the monimolimnion, which thus controls nutrient availability and the development of the phytoplankton. Because there is virtually no annual mixing in meromictic lakes, spring algal blooms can be less pronounced. The anoxic monimolimnion prevents zooplankton from vertical migrations that change the nature of food-web interactions. The relatively large size of the monimolimnion and prevailing anoxic conditions adversely affect the biota. With the development of anoxic monimolimnion, the size of the photic and aerobic zones decreases, benthic community is altered, habitat for zooplankton and fish is reduced. The zooplankton community in meromictic lakes varies in the species composition and abundance. Depending on salinity and chemical composition of the mixolimnion, the zooplankton may include certain typical cladocerans and copepods. If the salinity increases, the zooplankton can shift to Artemia dominated community, typical of hypersaline lakes. Concluding, complex trophic links; coupling of nutrients cycles and anoxic and oxic food-web components – these peculiar features make meromictic lakes natural laboratories to study the complexity of the food-webs and biological interactions.

FEATURES OF THE BENTHIC COMMUNITIES OF LOTHIC ECOSYSTEMS IN THE BASIN OF HYPERSALINE ELTON LAKE

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Hydroecosystems of the saline rivers, flowing into the basin of hypersaline Elton Lake (located 49º13'N 46º40'E in Volgograd region), are interesting due to their functional role for the arid zone of the south of the Russian Federation. This region is especially important, because it is the largest migration route of Eurasia, where highly productive reservoirs support huge accumulations of migratory birds and serve as their feeding ground, as well as a source of organic-mineral mud of high balneotherapeutic value. Thus, faunistic and biocoenotic researches of saline rivers are of particular importance. It is known that benthic organisms are a constant component of the overall diversity of hydroecosystems. We present data on interannual changes in the taxonomic, structural and quantitative characteristics of benthos in the rivers with a high mineralization gradient. There 91 taxa of benthic invertebrates were established, among which the following prevailed in different years: *Chironomus salinophilus*, *Ch. salinarius*, *Ch. aprilinus*, *Tanytarsus kharaensis*, *Microchironomus deribae*, *Glyptotendipes salinus* (Diptera: Chironomidae), *Culicoides* (*M.*) *riethi*, *Palpomyia schmidti* (Diptera: Ceratopogonidae) and *Paranais simplex* (Oligochaeta), *Ephydra* sp. (Ephydridae). The basis of the benthic fauna consists of halotolerant species, which have a different range of salinity resistance. The taxonomic composition and diversity of macrozoobenthos closely correlates with water mineralization in the range from 6 to 41 g/l and more; the complex of hydrological and hydrophysical factors controls the distribution and abundance of the species. The long-term changes (2006-2014) of the benthic communities structure in 7 saline rivers were found to be caused by a considerable variability of the environmental conditions in the benthos that produce difficultly explainable fluctuation peaks in the abundance of species under different scenarios of climatic, hydrological, hydrochemical and biotic factors. In different years the taxocenoses are characterized by maximum abundance and species diversity with the presence of specific and new species of chironomids and ceratopogonids (Zinchenko, et al., 2011; Szadziewski, Golovatyuk et al., 2016). Interannual values of the average abundance and biomass of these taxocenoses varied by 8-30 times. Under these conditions, the statistical relationship of the total number ((ln N) of benthic communities with the level of mineralization appears to be rather low ($r = -0.16$, $F = 4.7$, $p = 0.0315$). It was established that there is a statistically significant linear relationship between the values of the Shannon's diversity index and mineralization (correlation coefficient $r = -0.489$, Fisher's dispersion ratio $F = 57.08$, $p \cong 0$). High eutrophic saline rivers are a specific adaptive zone inhabited by species according to their osmoregulatory capabilities. The variety of biotic features of such cenoses (high production, short life cycle, selectivity of feeding of mass species, etc.) provides a habitat for euryhaline species in extreme conditions. Under the influence of global and regional natural and climatic fluctuations, the hydroecosystem of the lake functions in an unsteady condition with the presence of bifurcations and changes of structural and functional components, for which the evolutionarily established steady-state condition is uncharacteristic.

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PALEOLIMNOLOGY: ENVIRONMENTAL CHANGE RECORDED BY SALT LAKE SEDIMENTS

DIATOMS IN BOTTOM SEDIMENTS OF CLOSED-BASIN LAKES OF KHAKASIA

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Diatoms are a unique bioindicator of development of aquatic ecosystems. They are very sensitive to any minor changes, such as raising or lowering the pH, mineralization, average temperatures, sedimentation rate, etc. Besides diatoms shells are well preserved in sediments for millions years. That is why in palaeoclimate research fossil diatoms from the bottom sediments saline lakes can be excellent indicators of the past salinity and mineralization, a proxy for climate change in region. The purpose of this research was to analyzed diatoms from the bottom sediments in the two closed-basin lakes of Khakasia - Lake Shira (54°30′ N, 90°11′ E, pH 8.9-9.3, 15-19 ppt) and Lake Utichye-3 (54°31′ N, 90°28′ E, pH 7.6-8.3, 6 ppt). The 36 cm core from the Lake Shira was taken on May 2011 and the 21.5 cm core from the Lake Utichye-3 was taken on July 2012. The samples of the cores were processed using 30 % hydrogen peroxide and analyzed with a microscope to determine fossil diatoms assemblages. In addition samples of seasonal water and from the sedimentation traps were taken from the water column of the Lake Shira during 2012 and analyzed too. Analysis seasonal dynamics of diatoms assemblages in water samples and sedimentation traps showed that *Cyclotella choctawhatcheeana* Prasad (planktonic, halophilic and alkaliphilic) is the dominant diatom in the Lake Shira at present. In the samples of core diatoms were found twice – in the layers above the 1st and 2nd carbonate thicknesses. Above the 1st carbonate layer diatoms assemblages was similar to current species composition with dominant *C. choctawhatcheeana*. This suggest that condition of the Lake Shira remains invariable or slightly variable from 1946 [Popova, 1946]. Above the 2nd carbonate layer (approx. 1655-1627 years) the diatoms species were not similar to current diatoms assemblages. There were found *Aulacoseira italica* (Ehrenberg) Simonsen, *A. valida* (Grunow) Krammer 1991, *Staurosira construens* var. *venter* (Ehrenberg) P.B.Hamilton, *Nitzschia sigmoidea* (Nitzsch) W.Smith. These diatoms species are freshwater, Arctic, Alpine and temperate latitudes. This suggest that in the middle and the end of the 17th century Lake Shira was less salty and climate was colder than at present. Analysis samples of the core from the Lake Utichye-3 showed that spreading of the diatoms was irregular in thickness of the core. Diatoms were found almost at the all layers from the top part of the core (0-77 mm). At the bottom part they were found only in several layers (92-130 mm). In these layers the dominant specie was *C. meneghiniana* Kützing. In addition there were found fragments of the shells *Surirella* sp. and *Navicula* sp. Dominant *C. meneghiniana* was absent at the layer 165-170 mm. There were several species of *Fragilaria* sp. and the fragments of the shells *Navicula* sp. and *Cocconeis* sp. In the other layers diatoms was absent (13-17, 23-27, 44-55, 58-60, 70-74, 77-92, 112-115, 119-125, 130-165, 170-210 mm). Summarizing, we can say that condition in both lakes was different in the past than at present.

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OSL DATING OF LAKE-SHORELINE RIDGES OF BANKOG CO, TIBET, CHINA AND ITS GEOLOGICAL SIGINFICANCE

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OSL Dating of Lake-Shoreline Ridges of Bankog Co, Tibet, China and its Geological Siginficance There are most of lakes in Tibet Province, China. The majority of lakes and slmost all salt lakes and playas situate in the Northern Tibet Plateau called Qiangtang (Xitao Zhao, 2011). The Northern Tibet Plateau with flat landscape is also the centre of cold region, and its altitude is about 4500~5000m. Because the cold and dry environment and scarcely changes by people, the closed inland lakes are the excellent materials for researching paleoenvironment change. The variaiton of lake-level can response to climatic variation truly and sensitively. It is significant to study the environmental change of Tibet Plateau by the geological age and formation mechanism of high lake-level. The geological ages of lake-shoreline ridges were studied by Optically Stimulated Luminescence (OSL) dating in this paper. We can determine the time series of closed lake level change and recover the lake status records and reconsturct area precipitation and effective humidity on the base of geochronology of lake-shoreline ridges. Besides, we can research the relationship between the environmental changes of Bangor disturict and Qinghai-Tibet Plateau and global climate change.

HALITE CRUST MICRORELIEF RECONFIGURATION AND ELECTROMAGNETIC SCATTERING ANALYSIS IN LOP NUR

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Lop Nur was a massive lagoon that lay at the throat junction of the ancient Silk Road and adjusted the nearby microclimate environment. Presently, the remains of this structure consist of a deserted and dried-out halite crust that resembles a human ear in satellite images. However, because the microrelief of this halite crust records the history of environmental change, the objective of this paper is to interpret the halite microrelief patterns seen at Lop Nur. Thus, based on a refined three dimensional model reconstructed using close-range photogrammetry, we propose a series of two dimensional features aimed at characterizing ground roughness and polygonal halite crust uplifts to distinguish the different kinds of surface features seen at Lop Nur. The electromagnetic scattering characteristics are also analyzed by several simulations. On the basis of the results of our analysis, we speculate that some of the features at this site can be related to paleo-climate events.

IMPACT OF WATER LEVEL FLUCTUATIONS ON STRATIFICATION OF LAKE SHIRA (KHAKASIA, SOUTH SIBERIA): FROM MODERN OBSERVATIONS TO PALEO-RECONSTRUCTION

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The levels of closed saline lakes are highly sensitive to climate changes and first of all on moisture. Therefore, reconstruction the changes in lake level may help us better understand climate changes in the past. However, the quantitative reconstruction of a lake level from sediments is still a challenge because there are no distinct proxies of water level. It is well-known that lakes may change their mixing regimes from holomictic to meromictic in response to level increase, and vice versa. Therefore, reconstruction of mixing regimes from bottom sediments may help us better understand the level variations hence moisture of the local climate can be reconstructed. From bottom sediments of saline closed Lake Shira we estimated the switches between meromictic and holomictic conditions caused by climate-induced fluctuations of water level. The fossil pigments of phototrophic sulfur bacteria were considered as a proxy of anoxia in water column. The bottom sediments of the lake were well-laminated, with dark organic-rich layers alternating with light carbonate-rich ones. The first carbonate-rich layer was formed during observed decrease in lake level at the beginning of XX century. The age of the layers was determined from 137Cs and 210Pb profile (Kalugin et al., 2013). In addition, we counted the visible annual layers (varves) in recent sediments obtained with freeze-corer. The results confirmed that the distinct carbonate-rich interval of 13-17 cm was formed during 1900-1940-s when the lake level passed through minimal value in 1926. The low content of total organics, photosynthetic pigments and sulfides indicated that oxic conditions prevailed in bottom waters during low-level stage. Therefore, the lake was a holomictic at that time. In layers formed after 1945 the higher content of organics, sulfides and photosynthetic pigments indicated anoxia in bottom waters. In addition, highest content of okenone (carotenoid of purple sulfur bacteria) in layers of 1940-1950-s indicated most favorable conditions for these bacteria at that time period. Our latest observations on purple sulfur bacteria in Lake Shira confirmed that their biomass tends to increase in years of 2002-2007 when stable meromixis took place in the lake due to level increase. And vice versa: in the years of 2008-2016 the decrease in purple sulfur bacteria was correlated with constant level and weak meromixis. So we presume that stable meromixis developed at the periods when the lake level increased due to increase in annual atmospheric precipitation. In addition the vertical structure of the lake was calculated with one-dimensional mathematic model (Genova et al., 2010). The calculated profiles of salinity and density showed that Lake Shira turned from meromixis to holomixis when the level decreased by 7 m and vice versa. Consequently, we presume that the older sediment layers with high okenone content indicate the periods of sharp increases in Lake Shira level.

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POLARIMETRIC SAR FOR SUBSURFACE LACUSTRINE DEPOSITS DETECTION AND THE EVOLUTION OF LOP NUR

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Lake Lop Nur was a vast playa located at the east end of Tarim Basin, northwest of China,is best known for being shaped like a human ear, as first seen in the Landsat MSS image acquired in 1972. It was dried up prior to 1970. Using synthetic aperture radar (SAR) with its advantage of penetration capability and sensitivity to moist saline materials, the subsurface lacustrine deposits were revealed. SAR also delineated the partially buried shorelines and detailed a panorama of Lop Nur Lake that led to three important scientific findings. Based on the interpretation of the scattering mechanism of polarimetric and multiple frequency SAR data, field investigation, and sample analysis, it was found that the total area of the vanished Lop Nur Lake was more than 11602 km^2, which is much larger than earlier reports. The relatively young West Lake was superposed on top of the lacustrine deposits of East Lake, making the well known 'Ear' feature of Lop Nur, so the western part of the shoreline was buried and not visible on optical remote sensing images. Therefore, the Lop Nur Lake actually has near circular, closed shorelines. The drying-up process of East Lop Nur Lake went through mainly three phases according to the shorelines interpreted from multiple SAR data. The shrinking phases of Lop Nur Lake indicate the climate changes between wet and dry environmental conditions.

CORE SEDIMENTS INFERRED CLIMATE EVOLUTION SINCE 9.4 ka IN KELUKE LAKE, THE QAIDAM BASIN, CHINA

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Core sediments from Keluke Lake (also named Hurleg Lake), located in the transitional zone between arid central Asia and humid Asia, provide insights into the advance-retreat history of the summer monsoon and the Westerly. Grain size and $\delta^{13}C$ of authigenic carbonate from core sediments in the lake reveal paleoclimatic evolution since 9.4 ka (1 ka = 1000 cal a BP). The Keluke Lake area experienced dry-cold climate in the early Holocene (9.4-7.7 ka), wet-cold climate in the early stage of mid-Holocene (7.7-5.8 ka), relatively dry-warm climate in the late stage of mid-Holocene (5.8-2.5 ka) and, moderately wet and variable climate after 2.5 ka. This lake level evolution pattern is similar to the effective moisture history in arid central Asia, suggesting the Keluke Lake area is mainly controlled by the Westerly since 9.4 ka. We hypothesize that though the QTP had up-lifted to a relatively high elevation and prevented most of the Indian monsoon reaching the Qaidam Basin, an intense Indian summer monsoon still can penetrate the Tibetan Plateau and carry large amounts of water vapor to the Qaidam Basin until 30 ka, when Kunlun Mountain up-lifted to a higher elevation in the 30 ka neotectonic movement in the east Kunlun Mountain to prevent any Indian summer monsoon to get to the Qaidam Basin. Generally, the climate in this area showed a wet-cold and dry-warm variation model. In arid northwestern China, the effective moisture mainly depends on the evaporation. High evaporation in a warm climate leads to a low effective moisture and, consequently a dry-warm climate, and vice versa.

FOSSIL ORGANIC BIOMARKERS OF THE BOTTOM SEDIMENTS OF LAKE ERCHECK (EASTERN TURKEY)

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In this study bottom sediments of lake Erchek were investigated for its content of fossil alkenones, photopigments and diatom shells. The bottom sediments of lake Erchek have an undisturbed structure and therefore able to provide information about lake past. All three paleoindicators were found in amounts that allow analyzing their composition. The diatom shells deposited in bottom sediments have bad integrity and generally damaged due to the environmental condition unfavorable for diatom shells. Among the shells, the remains of those belonging to the species *Cyclotella* sp. predominate, and this state remains through the entire length of the core. This indicates that salinity and pH were more or less constant throughout the core formation time. Composition of fossil pigments is mainly represented by common chlorophylls and carotenoids of phototrophic community. Among others, the carotenoid okenon, a pigment specific for purple sulfur bacteria, was detected, indicating the presence of sulfide in lake water. The concentration of okenon in the bottom sediments changes through layers of bottom sediments, varying from total absence to abundance several times along the length of the core. This may indicate a change in hydrological regime of the lake in its entire history The composition and concentration of alkenes also vary along the core. They are mainly represented by C-37 and C-38 alkenones and small amounts of C-39 and C-40. Indices of unsaturation show that the lake experienced several changes in the mean annual water temperature. The last period of warming began at the beginning of the 20th century and continues to the present.

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SALT LAKE–LANDSCAPE INTERACTIONS, WATERSHED STUDIES

THE HOLOCENE GEOMORPHIC AND HYDROLOGICAL EVOLUTIONS OF THE GOLMUD RIVER CATCHMENT AND ITS METALLOGENIC SIGNIFICANCE FOR QARHAN SALT LAKE

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Qarhan Salt Lake is located in the eastern-central Qaidam Basin in the northeastern Qinghai-Tibetan Plateau. As a lake-depocenter since the Pleistocene, it is a particular palaeoclimatic archives owing to its huge thick and continuous lacustrine sediments sequences. However, previous studies indicated that the Holocene palaeoclimatic records are lacking in the top lacustrine sediments for Qarhan Salt Lake, which limites the understanding for the evolutions of the salt lake since late Quaternary. Based on the Optically Stimulated Luminescence (OSL) dating technology, in the current study, we dated ages of swamp deposits for Qarhan Salt Lake catchment and five terraces of Golmud River (The Golmud River is a feed river for the Qarhan Salt Lakes, it originates from glaciers of the Kunlun Mountains), aim to investigate the climatic and hydrologic evolutions from the point of view for aqueous geomorphologic changes of lake watershed since the Holocene. The results indicated that the ages of five fluvial terraces of Golmud River are 10.4ka, 9.6ka, 8.1ka, 7.3 ka and 4.7 ka, and the formation ages of swamp deposits are the range of 3.2 to 1.3ka. These strong hydrologic processes are basically consistent with the regional climatic records from the other studies on the Qinghai-Tibetan Plateau. Our results suggested the abundant water input during the early-middle Holocene have a great influence for the re-dissolve and concentrations for salt minerals in the playa region.

TERRESTRIAL ECOSYSTEMS ASSOCIATED WITH SALT LAKES IN TRANSBAIKALIA, EASTERN SIBERIA: ENVIRONMENTS, DIVERSITY, AND PROSPECTS FOR FURTHER BIOLOGICAL STUDIES

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Combination of the semiarid climate, local mineralized underground water intrusions, as well as salt enrichment due to deluvial waters uptaking in the drainless depressions, has conditioned the origin and existence of salt lakes in Transbaikalia. The salinization process is commonly confined to surroundings of salt lakes, but salty soils also exist at the dry bottoms of intermountain depressions. As a result of global climate warming and regional aridity increasing, expanding of salty areas might be expected. At areas around the salt lakes distinctly special ecosystems exist. Multidimensional studies of those ecosystems in Transbaikalia have been carried out. Salty soil properties, diversity of halophytic vegetation, flora, and mesofauna, as well as microbial communities, were in the focus of these studies.

The chemical composition of salts on the unevenly dried shores of the salt lakes is variable despite at the bottom sediments of the dried lakes the uniform soda-sulfate chemistry occurs. The high sodium content (96–99 %) is the common feature of the lakeside solonchaks. Under halophytic vegetation, the salt content is much lower than in the crusts and soils without plant cover. The solonchaks are characterized by a great variability in patterns of particle-size fractions, cation exchange capacity, and carbonates. The soil reaction is slightly alkaline or alkaline. Fulvate or humate–fulvate humus is typical for solonchaks, humus and nitrogen contents are low. The soils are slightly provided with nitrate nitrogen, while the supply of available phosphorus and exchangeable potassium greatly varies.

The check-list of vascular plants (380 species and subspecies related to 180 genera and 55 families) from salty habitats in Western Transbaikalia has been created. Three ecological groups have been distinguished, including halophytes (51 species), halo-tolerant glycophytes (152), and typical glycophytes (177 species). Halophytic plant communities around salt lakes in the region are related to classes *Thero-Salicornietea* and *Scorzonero-Juncetea*. The class *Thero-Salicornietea*, whose Transbaikalian portion is at the eastern edge of the class distribution in Russia was found to comprise 6 associations, united in 2 alliances and 1 order. Within the class *Scorzonero-Juncetea* 1 community and 2 associations related to 2 orders and 2 alliances have been preliminarily distinguished.

The mesofauna of landscapes around salt lakes is poorly studied. For example, only some patterns in the carabid fauna (Coleoptera) around salt lakes have been discovered. The richest fauna around Torey and Belye lakes (86 and 82 species respectively) have been revealed. Poorer carabid fauna around Alginskiye lakes has been occurred (51 species). Lakes of the latter group are known as strongly salted, so the extreme salinity is considered to be a limiting factor for diversity of carabid fauna. In the halophilous portion of the carabid fauna more contrast geographical diversity pattern comparing with the total carabid fauna was found. The most probable that slightly but not strongly salted habitats is more favorable for the most of halophilous carabids.

The diversity and functional activity of microbial communities are being studied. Especially, the novel findings were provided by the modern molecular biology techniques. Such phyla as *Proteobacteria* (20-50 %), *Bacteroidetes* (10–20 %), *Firmicutes* (5-20 %) typically compose communities of bottom sediments.Within thin mats and upper layers of bottom sediments under water salinity of up to 200 g/l, the intensity of producing as well as destructing processes maintains at the high level.

Importance of integral functional assessments as the main topic for further biological studies of terrestrial ecosystems associated with salt lakes should be emphasized.

THE PHYSIC-CHEMICAL CHARACTERISTICS AND THE NUMBER OF MICROORGANISMS PERMAFROST SOIL KATENS YERAVNINSKY BASIN OF TRANSBAIKALIA

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The aim of the work is to determine the physicochemical parameters and microbiological characteristics of permafrost soil toposequences of the Eravninskaya depression (ED) in the south of the Vitim plateau. The research was conducted at 2 key stations. Station 1-ED-13 "Stationary" is located in the central steppe part of the ED. Station 2-ED-13 polygon-transect (PT) "Krasnogorka" is located in the western part of the Eravninskaya depression, near the lake Big Eravnoe. The polygon-transect is represented by 5 key sections: the vertex 2-ED-13-3, the transit part of the slope of the southern exposition (2-ED-13-4) and the accumulative position of the southern slope 2-ED-13-5; the stream valley (2-ED-13-1) and the transit part of the slope of the northern orientation (2-ED-13-2).

Soils have a pH close to neutral. In the carbonate horizon, the pH increases to slightly alkaline. The only exception is the soil of the meadow plain at the foot of the slope of the southern exposure 2-ED-13-5, where in the upper layers pH does not drop below 7.3, and in carbonate layers increases to 8.5.

The air temperature during sampling in May and July in 2013 was $+12^0$ C and $+23^0$ C, respectively. The minimum depth of thawing in the studied soil toposequences in ED was found at station 2-ED-13-2, which was 15 cm at the end of May, and 40 cm in July. The temperature in the lower not pro-thawing soil layers was -0.2^0C -0.4^0C. The maximum depth of thawing of soils is noted in the soil toposequences of the southern exposition slope (from the top to the accumulative part of the terrace).

The maximum number of aerobic saprophytes in the upper soil layers on the northern slope of the Krasnogorka ridge of the 2-ED-13-1 section reached 10^7 cells/g of soil. The minimum amount of saprophytes (up to 10^5 cells/g of soil) was found in the section 2-ED-13-2, where alluvial light-humic soils are formed. The soil temperature varied in 2-ED-13-1 from the upper $+8.2^0$ C to the lower -0.2^0 C soil layers and in 2-ED-13-2 from $+7.8^0$ C to -0.4^0 C, respectively. Apparently, the low number of saprophytes here is associated with low temperatures and late thawing of the soil. The increase in the number of saprophytes occurs according to the transect: the top is the southern slope of the terrace and is associated with a large warming of the soils. The soil temperature was $+9.0^0$ C in 2-ED-13-3, $+9.2^0$ C in 2-ED-13-4, $+9.4^0$ C in 2-ED-13-5.

From the slope of the northern exposure to the contrasting south, there is an increase in the number of saprophytes with a "peak" quantity in 2-ED-13-5 – the accumulative part – the foot of the slope. The number of saprophytes at the key station 1-ED-13 "Stationary" was 10^7 cells/g of the soil, the soil temperature was $+9.7^0$C.

The obtained results show that the increase of the temperature in permafrost soil toposequences of the Eravninskaya depression favor the activity of microorganisms-destructors of organic matter.

BOTANIC DISTRIBUTION CHARACTERIZATION IN THE PLAYA OF QAIDAM BASIN, TIBETAN PLATEAU

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The botanic distributions in the playa of Qaidam Basin, in the northeastern part of the Tibetan Plateau are presented. The communities were dominated by plants with strong saline-alkaline tolerance, such as Tamarix, Lycium ruthenicum, Phragmites australis, and Apocynum venetum. The type of vegetation at the study site could be divided into two categories: halophytes, which form salt-tolerant vegetation communities, and hygrophytes, which exhibit weak salt tolerance. The halophytes were influenced by Na^+, Cl^-, and the salt content. The soil of these vegetation communities had higher salt and Na+ contents and lower Ca^{2+} and K^+ contents. The hygrophytes were mainly controlled by the Ca^{2+}/Na^+ and K^+/Na^+ ratios. In these communities, the soil salt and the Na^+ contents were low, and the soil Ca^{2+} content was high. The distribution model of plants from sandy gravel Gobi to a dry salt lake community was established. The plants on the playa would be the bio-resources for developing salt lake agriculture in Tibetan plateau.

Key words: halophytes; salt lake; Tibetan Plateau; PCA; salt lake agriculture.

ELEMENTAL COMPOSITION AND SALT-ACCUMULATING ACTIVITY OF HALOPHYTES IN THE COASTAL ZONE OF SALT LAKES

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In the dry steppe zone of Transbaikalia, mostly drainless soda-salt lakes with different mineralization of water, unstable water area and hydrological regime cycling are prevalent. With a frequency of 50-60 years, they pass the stage of rising and falling of the water level. In this regard, the coastal zone (from the water edge to the indigenous board) is characterized by the variability of the water area and soil-ecological conditions for the plant growth. The basis for the formation of halophytic communities here is the optimum ratio of soil moisture and salt concentration. Therefore, only relatively large lakes are peculiar local centers of plant diversity, which cause the joint growth of salt-accumulating, salt-permeable and salt-releasing halophytes, halotolerant species and glycophytes. Since the halophytes are heterogeneous in their ecological and physiological-biochemical properties, the elemental composition of species and communities in the coastal zone of salt lakes has been studied. The results showed that halophytes differ quantitatively in the macro- and microelement content (especially the ash concentration, Na, S, Ca and Mg), depending on the species and growth conditions.

ACTINOMYCETES IN SOILS OF MONGOLIA AND BURYATIA

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Actinomycetes are the most difficultly differentiated mycelial bacteria which are of an integral part of the soil microbial complex. They constitute one-fourth of the total number of bacteria growing on traditionally used nutrient media. Only spore-forming bacteria can be compared by the complexity of cellular differentiation with actinomycetes, forming a differentiated mycelium with different types of branching.

The purpose of this work is to reveal the patterns of distribution of actinomycetes in soils of Mongolia and Buryatia for establishing the ecological status of these mycelial prokaryotes. In the work, samples from the upper horizon of soils near lakes of Mongolia: Orog Nur (alluvial dark-humus saline), Ughiin Nur (sandy dark chestnut), Hagiin Nur (dark chestnut), Hariin Nur (chestnut), and chestnut soils of Buryatia were studied.

For the complete isolation of rare forms of actinomycetes from the soil, a combined method (selective medium with sodium propionate) was used. Before passages samples were heated at 120°C for 1 hour and than incubated for 3-4 weeks at 28°C. Identification of isolated strains was carried out according to Berdzhi's determinant and the “Prokaryotes” manual, as well as chemotaxonomic signs. For the species identification of streptomycetes, cultural, morphological and physiological-biochemical indices were used, according to the determinant of actinomycetes.

In lacustrine soils of Mongolia the number of actinomycetes ranges from hundreds to tens of thousands of colony-forming units per gram of the soil. In the investigated soils of Buryatia, a wide distribution of actinomycetes was noted, which is a distinctive feature of the microbial coenoses. Three genes of *Streptomyces*, *Micromonospora* and *Streptosporangium* were identified there. Obviously, the most favorable conditions for the micromonospore are evident, many species of which have hydrophilic spores and belong to hygrophilic microaerophiles. There is also a variety of streptomycetes.

In turn, these microbiological indicators can be used to diagnose the biological state of studied soils, and, along with other soil properties, should be taken into account when developing techniques for increasing the productivity of existing here hayfields and pastures.

THE AFFECT OF ARIDITY ON THE SWAMPY VEGETATION (IN CASE UGII LAKE AND KHUGSHIN ORKHON RIVER)

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The study was conducted in a swampy area of the Old Orkhon river floodplains and lakes Ugii again in 2013 after a 10 year period. The aim of our study was to establish changes of vegetation in floodplain, swampy and steppe communities due to the arid climate taking place in recent years. Precipitation fallen in recent years in the study area have been changed to decrease in 2004-2008 to 2.3 parts compared to 2003, and since 2009th rain again began to increase. Changes in plant communities we studied using own species that were treated at the water regime to certain environmental groups. According to these characteristics indicator calculated ratios xerophytic plants, salinity and degradation of the formula Odum. Plant communities studied in 2003, over the past ten years it has been quite a big change, as community swampies otmechennyxh in 2003 was dry and his place was formed lapchatkovo-pickled grassy meadow and meadow communities are still severely degraded by grazing, which is occupied almost entirely adamsovoy wormwood (*Artemisia adamsii*). At the site of some of the steppe communities a new pool. Overall, a pretty big change occurred towards xerophytization and salinity. Since, in the species composition of communities of xerophytic average ratio of 0.6 against an average-normal-1.2 in 2003, a strong salinity ratio of 0.4 against an average of 0.6, while the coefficient of degradation is very strong 0.5-against-average 0 7.

Key words: swampy area, Climate drought.

SOILS OF THE LAKESIDE HALOMORPHIC ECOSYSTEMS OF THE BARGUZIN HOLLOW

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In zones of tectonic faults of the Baikal rift, there are numerous wedging out of mineralized deep waters. Often they are the source of lacustrine or lacustrine-alluvial landscapes. Unlike all the other rift depressions, in the Barguzin hollow unloading of mineral waters leads to forming salt lakes and large areas of the lakeside halomorphic ecosystems, among which there are mineralized lakes of Alginskaya, Khara-Modunskaya, Nuha-Nurskaya, Kokuiskaya groups, and sore lakes near Zahalan area, and adjacent saline lands. For the geographic latitudes of Eurasia (53-55°N) with altitudes of more than 450 m, on which the Barguzin depression is located, the formation of the areas of saline lakes and halomorphic ecosystems is not characteristic, even with sources of salinity. Lithological composition of rocks and sedimentary cover are not favorable for this process. However, salinization has become large scale due to hollow effect of climate and permafrost regime of soils, and salts are actively involved in biological circulation of substances, and affect the evolution of the surrounding landscape. Depending on the conditions of unloading, debit, chemism type and salinity level a variety of salt lakes and halomorphic soil and botanical complexes develop in the hollow. Conducted studies have shown the specificity of soil salinization in places of saline water unloading and a pedogenic transformation of the salinity chemistry both in the zone of lakes impact and in the territories that have come out of active influence of mineral sources. The main factors of halomorphic soils formation were identified, soil diversity was studied, and classification status of the soils was determined. The accumulation of salts in soils is facilitated by numerous closed depressions - thermokarst subsidence, arid climatic conditions of the spring and early summer period determining the exudative water regime, and permafrost aquiclude, preventing the removal of salts from the soil profile. Soils of lakeside depressions are characterized by spatial ring zonality in the content of easily soluble salts, high level of profile salinity, morphological features in the form of cryoturbations and quasi-gleying. Highly saline soils of the primary trunk of soil formation (solonchaks) dominate, sometimes there are dark solonchaks. The most saline soils in the hollow are sulfide solonchaks. They are common in closed lake depressions of the southern part of Barguzin hollow on exposed bottoms during dry periods or around drying up salt lakes. In the North, on the unload area of mineralized hydrothermal spring “Kuchigersky” dark solonchaks occupying the bottom of a small thermokarst subsidence are developed. On areas coming or came out from the influence of saline springs, solonchaks pass through transformation in solonetz. Soil salinity chemistry depends to a greater extent on the composition of the salts of the initial mineralized sources. However, as their influence decreases, the chemistry changes under the influence of pedogenic processes. Among other factors of soil formation of saline areas, one should note the impulverization and partial liberation of saline landscapes from salts during severe prolonged droughts. At this time, the salt crusts of the bottoms of drying lakes and adjacent territories are fragmentarily destroyed by hoofed animals or otherwise. By acquiring physical properties close to dust, they are transported with aerodynamic flows over considerable distances due to strong wind regime of the Barguzin hollow, deposit and are fixed by soils.

TRANSFORMATION OF RECTORITE FROM ALLUVIUM AT THE BARGUZIN DEPRESSION IN DARK-HUMUS QUASI-GLEYIC SALINE CRYOTURBATED SOIL

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Regular mica-smectite interstratification called rectorite was found in alluvial loamy sediments at the Ulygna River Valley (the right tributary of Barguzin River) in the northern part of Barguzin Depression (Buryatia). Rectorite is a scarce mineral in sediments and soils. In studied soil rectorite occurs in clay fraction (<0.001 mm) and is associated with irregular mica-smectiteand chlorite-vermiculite interstratifications (25-29 %), trioctahedralhydromicas (50-60 %), magnesium-ferrous chlorite (6-9 %) and kaolinite (5-8 %).

Mineralogical composition of clay fraction (<0.001 mm) from different genetic horizons of dark-humus quasi-gleyic saline gypsum-comprising cryoturbatedalluvial loamy soil (EutricCalcaricStagnicFluvisol (Loamic, Humic, Protosalic, Turtic)) was studied. The soil profile is AUca,s,cs – Qca,dc,@,s,cs – Cca,s,q˜˜ - Cca,s˜˜⊥ in terms of Russian soil classification system (Field guide for identification of soils in Russia, 2008). The upper boundary of permafrost is at the depth about 130 cm. Rectorite was found in hor. C.

Soil formation gives an impulse to transformation of rectorite and disturbance of its regular structure into irregular mica-smectite interstratifications with different share of smectite packets.

The main soil-forming processes in the studied soil are as follow: (1) humus accumulation in the epipedon with variable thickness and resulting organic carbon content 2.96 %; (2) accumulation of soluble salts (sodium sulfate) in the solum from groundwater; (3) accumulation of gypsum in the upper horizons AU and Q; (4) accumulation of calcium carbonates with maximum content of about 14 % at the depth from 20 to 54 cm; (5) cryoturbation of the middle part of the soil profile due to vortex motion of olive-pale and grey materials; (6) reduced conditions during over-moistening periods; (7) destroy and transformation of clay minerals in the solum.

A source of soluble salts in landscape is the thermal spring “Kuchigersky” with low total salt concentration and alkaline hydrocarbonate-sulfate-silicate sodium composition. The spring is situated at the footslope of mountain in several kilometers from the studied alluvial soil.

The most noticeable change of clay minerals occurs in the surface horizon AUca,s,cs. Both regular interstratification rectorite and irregular mica-smectite interstratifications with high (>50 %) content of smectite packets are absent in it due to their destroy under saline conditions. There are noticeable decreasing of X-ray peak’s intensities, accumulation of X-ray amorphous substances and increasing of relative share of chlorite-vermiculite interstratifications and hydromicas in the clay fraction at the hor. AUca,s,cs. With that total content of mentioned clay minerals in hor. AUca,s,cs is the smallest in the profile due to decreasing of clay content, perhaps as a result of partial movement of smectite minerals downward and/or destroy of rectorite.

Quasi-gleyic horizon Qca,cd,@,s,cs confines the highest share (45 %) of irregular mica-smectite interstratifications with high content of smectite packets in association with trioctahedralhydromicas (40 %), chlorite and kaolinite.

It is supposed, that regular structure of rectoritewith mica and smectite packets (motive ABAB…) is transformed into irregular one of mica-smectite interstratifications by solutions with soluble sodium salts in soil horizons.

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SERVICES PROVIDED BY SALT LAKES: FROM CHEMICAL RESOURCES TO CULTURAL AND SOCIAL SERVICES

CAN SALINE AND HYPERSALINE LAKES CONTRIBUTE TO AQUACULTURE DEVELOPMENT?

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Is it possible for humanity to meet the demands of its growing population for food and fresh water? How may saline and hypersaline lakes contribute to overcome this problem? Looking for answer on this is a goal of this presentation. There is common vision that to meet the demand in food is possible by increasing aquaculture production. A steady increase of total food output of aquaculture in marine and inland waters was observed; production in inland waters exceeds that in the marine waters. FAO data indicate that inland aquaculture demonstrates the fastest growth in freshwaters contributing to eutrophication of freshwaters, thus reducing the reserve for drinking waters. The increase of freshwater food production in aquaculture prevents a successful response to other problem - the increasing demand for fresh water. A way to overcome this is to develop aquaculture in saline lakes without compromising the supply of drinking water. Total volume of all freshwater lakes on the Earth is very close to that of salt lakes – 126 and 104 km3, respectively, and bioproductivity of saline lakes as usually is very high; these facts show that there is a large potential for saline lake aquaculture development in the world. Developing aquaculture in saline lakes we must take into account that there is big diversity of such lakes with different aquaculture opportunities, which need to be considered. Salinity regime of a lake is one of most important things. If salinity fluctuates between 3 and 10 (15) g/l it is possible to cultivate many freshwater hydrobionts in such lakes with high profit. In lakes with salinity up to 50-60 g/l, we may cultivate some marine and brackishwater species of fish and shrimps as in Lake Qarun (Egypt). The lakes with very high salinity up to 200-250 g/l can be used for cultivation of some invertebrates (Artemia, chironomids, etc.), microalgae, and protists. Problems, perspectives and difficulties of aquaculture development in different types of the saline lakes are discussed.

SOLVENT EXTRACTION PROCESS AND THE SOLVENT MECHANISM ON LITHIUM RECOVERY FROM HIGH Mg/Li RATIO BRINE

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Lithium as the energy metal and strategic resource is widely used in batteries, refrigeration, metallurgy, medicine, aerospace, military industry, atomic energy and other fields [1-6]. The resources of lithium mainly associated within lithium mica, spodumene, salt lake brines and oil/gas field water, and with the increasingly exhaustion of solid lithium mineral resources, the effectively exploitation and utilization of lithium from brines has already become the hotspot of research. On account of similar properties of magnesium and lithium, solvent extraction technique is more effective to continuously extract lithium from salt lake brines with high Mg/Li ratio. In our present work, a novel co-extraction system of TBP-KPF6 was used in the extraction for lithium from brines with high concentration ratio of magnesium to lithium. Subsequently, the technological parameters for lithium extraction and back-extraction from high Mg/Li ratio salt lake brine were optimized. As a result, the single-stage extraction efficiency and back-extraction efficiency were no less than 80 %. Moreover, the mechanism for lithium extraction by TBP-KPF6 system was investigated by calorimeter.

EFFECTS OF CONCENTRATION OF $MgCl_2$ ON THE GROWTH OF $Mg(OH)_2$ CRYSTALS

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High-purity $Mg(OH)_2$ could be processed by hydrothermal method [1-3], by adding different concentrations of $MgCl_2$, researched effects of concentration of $MgCl_2$ solution and water temperature on the growth of $Mg(OH)_2$ crystal. The conclusions of particle size analyzer, XRD (Fig. 1) and SEM (Fig. 2 and 3) could be drawn as follow: brine pyrolysis MgO had good activity, producted high-purity $Mg(OH)_2$. The product was flaky at 70℃ in hydrothermal condition for the concentration of $MgCl_2$ was less than 1.00 mol/L. The product was strip in hydrothermal condition for the concentration of $MgCl_2$ was more than 1.50 mol/L. Flaky $Mg(OH)_2$ can be producted at 160℃ in hydrothermal condition for each concentration of $MgCl_2$. Fur-thermore, product was regularly crystal ribbon in hydrothermal condition for the concentration of MgCl2 was 1.00 mol/L.

Key words: crystal growth; magnesium hydroxide; $MgCl_2$; hydrated reaction

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THERMODYNAMIC PROPERTIES OF ALKALI BORATES AND ALKALINE EARTH BORATES

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Owing to the excellent performance of borate crystal materials, they are widely used in many high-tech fields [1]. It is famous for the rich resources of solid boron ores in the provinces of Liaoning and Jilin, and the liquid boron brines in salt lakes in Tibet and Qinghai provinces [2]. Studies on the thermodynamic properties of borates including standard enthalpy of formation, heat of dissolution, specific heat capacity, phase transition temperature and crystal transformation can be used to provide basic thermodynamic data for its application and related theoretical research, and it is also important to guide chemical production [3]. In this paper, it was summarized on the thermodynamic properties of solid borate measured by using the calorimetric technique including differential scanning calorimeter and adiabatic calorimetry for the first time. On the basis of literature, thermodynamic data on the heat of dissolution and the standard enthalpy of formation of the natural alkali metal and alkaline earth metal boron minerals existed in deposits have been reported. The double salts of natural alkali metal and alkaline earth borate have not been reported yet. The specific heat capacities of solid alkali and alkaline earth borate are scarce. Among these reports, the temperature range measured was narrow and mainly focused on the low temperature. Some more works needed on the thermodynamic properties of solid borates are pointed out, and some new trends in the future are also discussed in details.

Key words: solid borates; thermodynamic property.

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SOLID-LIQUID PHASE EQUILIBRIUM IN THE QUATERNARY SYSTEM (Li^+, K^+, Mg^{2+}//$B_4O_7^{2-}$–H_2O) AT 298.15 K

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Saline lakes are known for large number, wide area, multi types, rich brine resources with value of exploitation and utilization in China. The study found that the salt lake brine is the complex seven-component salt-water system composed of Li^+, Na^+, Mg^{2+}, K^+//Cl^-, SO_4^{2-}, $B_4O_7^{2-}$–H_2O. Solubility data and physic-chemical properties including density, refractive index and pH value of the quaternary system Li^+, K^+, Mg^{2+}//$B_4O_7^{2-}$ at 298.15 K have been studied experimentally by the method of isothermal solubility equilibrium. Based on the experimental data, the phase diagram (Fig. 1) and physicochemical properties versus composition diagrams were obtained at 298.15 K. The results show that the system is the hydrate type I, and neither complex salt nor solid solution generated. It were composed of one invariant point, three univariate curves and three solid-phase crystallization fields corresponding to $Li_2B_4O_7·3H_2O$, $K_2B_4O_7·4H_2O$ and $Mg_2B_6O_{11}·15H_2O$ at 298.15 K, respectively. The crystallization area of $Mg_2B_6O_{11}·15H_2O$ is the largest on account of its smallest solubility. And $Li_2B_4O_7·3H_2O$ has the salting-in effect on $Mg_2B_6O_{11}·15H_2O$ with the presence of $K_2B_4O_7·4H_2O$, while the solubility of $Mg_2B_6O_{11}·15H_2O$ exist a trend of increasing and decreasing with the increasing of $K_2B_4O_7·4H_2O$.

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TECHNOLOGY RESEARCH ON EXTRACTING BORON FROM SALT LAKE BRINE BY SOLVENT EXTRACTION

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The development and utilization of boron resource in modern industry and its social and economic development, has become indispensable in modern industrial chemical raw materials. Therefore, the demand of boron compounds are rapid increasing, causing the industrialization production requirements more and more stringent [1]. In recent years, a large number of boron ore mining led to depletion of ore resources. Whereas, China has a boron-rich salt lake brine advantages of resources, and has not yet been effectively developed, so brine boron gradually become the focus of attention and research areas [2]. Solvent extraction has the advantages of good selectivity, thorough separation of impurities and high recovery rate of boron, and is widely used in salt lake brine. In numerous 1,3-hexanediol, 2-ethyl-1,3-hexanediol is a kind of ideal extraction agent in many foreign countries to be the most widely applied to the research of boron and boric acid. Studies show that 2-ethyl-1,3-hexanediol has best extraction effect, when containing a large amount of magnesium salt brine contributes to improve the extraction rate of boron [3]. Five effects on the extraction of boron were systematically discussed. Obtained the optimum condition to extract boron from brine can meet the requirements of industry production. Extractant can be recycled to make the production cost greatly reduced. It can provide a basis for industrialization, and be generally applied to boron extraction from brine.

Key words: Salt lake brine; Solvent extraction; Boric acid.

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NOVEL TECHNOLOGY RESEARCH ON SOLVENT EXTRACTING BORON FROM SALT LAKE BRINE

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With the rapid development of modern industry, social and economic demands, the raw chemical of boron and its compounds have become indispensable [1]. After several decades exploiting for the solid boron ores, which are mainly distributed in Shandong and Liaoning Provinces, China, the solid boron resources are exhausted. However, it is famous that there are high concentrations of boron resources in salt lakes, which are widely distributed in the west of China. Fortunately, there is a large scale of liquid boron resources in salt lake brines, and those salt lake resources have not yet been effectively exploited. Therefore, the investigations on liquid boron ore resource exploiting are gradually focused on salt lakes [2]. Solvent extraction has the advantages of good selectivity, thorough separation of impurities and high recovery rate of boron, and is widely used in salt lake brine. A numerous reports on monohydric alcohol and dihydric alcohol are the ideal extraction agents in many foreign countries to be the most widely applied to recovery boron and boric acid from brines. Our works show that dihydric alcohol has a excellent extraction effect when compared with monohydric alcohol for the brine resources containing a large amount of magnesium salt [3]. Five effects existed on the extraction of boron were systematically discussed. The optimum condition to extract boron from brine was obtained to satisfy the requirements of industry application. Extractant can be used circularly to decrease the cost. It can provide a basis for industrialization, and be generally applied to boron extraction from brine.

Keywords: Salt lake brine; Solvent extraction; Boric acid.

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THE ONLINE DATABASE OF SALT-WATER SYSTEMS

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Salt lakes are a naturally occurring complex body of water and salt interaction [1]. There are different phase change processes in the salt lake around the world. The phase diagram of salt-water system is the geometric representation of the equilibrium of salt-water system. Due to its obvious geometric intuition, it has been the most widely used in the process of describing the phase change of salt-water system. It is well known that salt-water phase equilibrium plays an important role in exploiting the brine resources and describing the geochemical behavior of brine-mineral. Salt-water system phase diagrams are widely adopted either in the processes of solar pond evaporation, separation and recovery of various slats or in the field of thermodynamic model construction and application to simulating the utilization of salt lakes resources [2]. Because the phase equilibria are difference with the different salt lake composition, the researches need a lot of solubility data for the multi-component systems at different temperatures. On the basic of several decades investigations and research accumulations, our research team has established the online database of salt-water systems in China, which contains the solubility data for more than 9,000 different systems since 1919. The database includes the modular: the solubility of multi-component salt-water systems containing Li^+, Na^+, Cl^-, B_2O_3; solubility data evaluation system; expert system for dynamic prediction at variable temperatures [3]. The databases can also provide services such as browsing, query, access, data evaluation, phase diagram plotting, dynamic prediction of phase equilibria, process analysis and the best process research and so on [4, 5].

Key words: Salt-water systems; Solubility; Database; Online resource.

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TRANSFORMATION OF CO_2 CATALYZED BY IONIC LIQUIDS

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Carbon dioxide (CO_2) is an abundant, nontoxic, nonflammable, easily available, and renewable C1 resource. CO_2 chemistry has become one of the most important branches of chemistry. CO_2 has been transformed into various useful chemicals. The exploration of new, green, and metal-free catalysts for the reaction of CO_2 is a very interesting topic in environmental field [1]. Ionic liquids (ILs) have some very attractive properties, such as negligible vapor pressure and nonflammability. They are excellent solvents for both organic and inorganic substances and their functions can be tuned by changing the structures of their cations or anions [2]. ILs have been recently explored as novel and green materials for the capture and fixation of CO_2 [3]. They have also been used in materials synthesis and in chemical reactions especially as effective catalysts and additives in CO_2 reactions. We demonstrate herein the use of IL as both the catalyst and solvent for the chemical fixation of CO_2 into various useful chemicals under metal-free and mild conditions (Scheme 1) [4]. The IL was found that could be used as both catalyst and solvent for the reactions. It was very effective for the CO_2 transformation reactions, giving the desired product in high yield under mild conditions, and could be easily recovered and reused. Scheme 1. The reaction of CO_2 with propargylic amines to form 2-oxazolidinones.

Key words: Carbon Dioxide, Ionic Liquid Acknowledgment: Financial supported by the Higher School Science and Technology Development Fund of the Education Committee of Tianjin in 2017.

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IN SALE SALUS: HEALTH PROVISION FROM SALT AND SALINE WETLANDS IN EUROPE

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Among the often cited 14,000 uses of salt, many are related to wellness and health. Its different physical-chemical properties allow many health-related applications of salt itself, brine, mother lay and saline muds. Salt can be used as skin rubs or in blocks, for building halochambers; inhaled as aerosols or even ionized by lamps. Brine can be ingested or used for bathing and exercising in it. Mother lay is usually employed as a basis for cosmetics and skin treatments and muds are traditionally applied directly on the skin for similar ailments. Many of these applications have been known since the Antiquity and are still in use today. Some have disappeared or are only known at local scale, while others are growing in popularity, amid the surge of spa and wellness facilities worldwide. The also increasingly popular natural and alternative treatments have included salt-related healing. In this contribution, we will review among others the traditional uses of brine and salt for health provision; the therapeutic and wellness uses of mother lay and mud as a side activity for traditional salinas, some of which have built ad hoc spa and wellness centers; the now widespread phenomenon of salt caves and mines for halotherapy and the historical spas built around saline lakes, now in disuse. Some treatments can also be applied away from the source of salt, in homes, clinics or urban wellness centers. Examples from many European saline sites, be it mines, solar evaporation salinas, graduation and seething sites, as well as saline lakes, will be drawn. A distinction will be made among those treatments that have been acknowledged by medical science and are applied under professional supervision, as opposed to those that have a weaker scientific support, as well as those that mainly rely on popular belief or superstition.

SOLID-LIQUID EQUILIBRIUM FOR THE TERNARY SYSTEM SODIUM, STRONTIUM, CHLORIDE AND WATER AT 288.15 K

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Recently, in the Nanyishan Section of the Qaidam Basin, China, a huge store of oilfield brine was discovered, in which the hydrochemistry is the calcium chloride type with high concentrations of sodium, potassium, and calcium. The brine mostly belongs to the complex system of ($Li-Na-K-Ca-Sr-Cl-B_4O_7-H_2O$). For comprehensive utilization of this valuable oilfield brine, the solubility data and phase diagram of the relative systems are urgently needed. They can reveal the interaction between brine and minerals and show the crystallization path of the various salts. In this paper, the phase equilibria of the ternary system (Na^+, Sr2+//Cl^-–H_2O) at 288.15K were investigated using the method of isothermal dissolution equilibrium, solubilities and physico-chemical properties including density and pH in this system were determined experimentally. In the phase diagram of the ternary system at 288.15 K, there are one invariant point, two variant curves, and two crystallizing zones corresponding to strontium chloride hexahydrate ($SrCl_2 \cdot 6H_2O$) and sodium chloride (NaCl). Neither double salts nor solid solutions are found, and it belongs to a simple hydrates type-I. The density and pH value of the stable equilibrium solution change regularly with the increasing composition of strontium chloride in the solution. These data will play a significant role in describing geochemical evolution and guiding the industrial process.

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VOLUMETRIC PROPERTIES OF AQUEOUS SOLUTIONS OF LITHIUM METABORATE AT THE TEMPERATURE RANGED FROM 283.15 TO 363.15 K AND 0.1 MPa

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With the progress of modern science and technology, borates occupy an important role in the modern inorganic salt industry, national economy and national defense because of their specific properties such as flame retardance, thermostability, high hardness, endurance and light weight [1, 2]. Borates are one type of inorganic compounds widespread in nature, and many salt lake brines in the northwest of China contain abundant boron and lithium resources with high concentrations. However, the solute-solvent and solute-solute interactions are complex. The knowledge of accurate thermodynamic properties of water and aqueous solutions of electrolytes is of considerable importance for the elucidation of the structure of water, and ion-water and ion-ion interactions [3]. The volumetric properties of borate solutions, particular in those of lithium borate, are essential for successful modeling of physical parameters and chemical processes. In order to further researching on the structural interactions occurring in solution, some systems have been researched, such as LiCl + H_2O [4, 5], Li_2SO_4 + H_2O [6]. There are no reports on the apparent molar volume data and the construction of aqueous lithium metaborate electrolyte solutions in the literature. Therefore, we present a series of experimental data on the volumetric properties of the system $LiBO_2$ + H_2O. In this paper, densities of ten lithium metaborate solutions with the concentrations from 0.04 to 0.42 mol•kg^{-1} have been determined at a 5 K interval from 283.15 to 363.15 K at 0.1 MPa, which were measured using an Anton Paar vibrating-tube densimeter (DMA4500, Austria). The apparent molar volumes of lithium metaborate solutions were calculated from the density data. Our results were fitted to functions of m and T, and estimated values of Vφ of the anions are compared over the ranges of m and T given above.

Key words: Density; Apparent Molar volumes.

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SOLID-LIQUID PHASE EQUILIBRIA OF THE TERNARY SYSTEMS $CaCl_2$ – $SrCl_2$ – H_2O AT 323.15 K

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Phase equilibria and phase diagrams are important theoretical foundations for the exploitation of brine resources. In this study, the solubilities and refractive indices of the $CaCl_2$ – $SrCl_2$ – H_2O system at 323.15 K were determined using the isothermal equilibrium solution method. The phase diagram and refractive index diagram were drawn for this system at 323.15 K. The phase diagram consists of two invariant solubility points, three univariant solubility curves, and three areas of crystallization: $CaCl_2$•$2H_2O$, $SrCl_2$•$2H_2O$ and $SrCl_2$•$6H_2O$. The crystallization area of $SrCl_2$•$2H_2O$ is largest, while the other two areas are relatively small. The system belongs to the hydrate II type. No double salts and solid solutions were found in the system. The refractive indices increase with the $CaCl_2$ concentration increasing. Compared with the experimental phase diagram at 298.15 K [1], the solid solution (Ca,Sr)Cl_2•$6H_2O$ disappears at 323.15 K, the crystallization regions convert into $CaCl_2$•$2H_2O$, $SrCl_2$•$2H_2O$ and $SrCl_2$•$6H_2O$. Combined the experimental results and the single-salt parameters available in the literatures [2,3], the mixed ion-interaction parameters θCa,Sr, ψCa,Sr,C and the equilibrium constants of the solid phases were obtained by the lease-square method on the basis of the Pitzer model and its extended Harvie-Weare (HW) model. Then the solubilities for the ternary system at 323.15 K were calculated. A comparison between the calculated and measured solubilities shows that the predicted data agree well with the experimental results.

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E EQUILIBRIA FOR THE AQUEOUS QUATERNARY SYSTEM (Na^+, Ca^{2+}//Cl^-, borate - H_2O) AT 288.15 K

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Calcium borates are widely used in terms of glasses industry, ceramics, flame retardant, nonlinear optical materials and agriculture for its special properties [1]. At present years, a large scale of oil-field brine and underground brine with high concentration of calcium and boron are widely distributed in the western of China [2]. In order to developing and utilizing these brine resources, some borate systems have been reported previously, but involving in calcium borate systems is scarce [3]. In this paper, the solubilities and physicochemical properties including refractive index, density, viscosity and pH in the quaternary system (Na^+, Ca^{2+}//Cl^-, borate - H_2O) at 288.15 K were determined experimentally with the method of isothermal dissolution equilibrium. According to the experimental data, the dry-salt diagram (Fig. 1), water-phase diagram and the diagram of physicochemical properties versus composition in the quaternary system were plotted, respectively. The experimental results showed that there is two invariant points named as F1 ($CaB_6O_{10}\cdot5H_2O$ + NaCl + $Na_2B_4O_7\cdot10H_2O$) and F2 ($CaCl_2\cdot6H_2O$ + $CaB_6O_{10}\cdot5H_2O$ + NaCl), five univariant curves and four crystallization regions corresponding to $CaCl_2\cdot6H_2O$, $CaB_6O_{10}\cdot5H_2O$, $Na_2B_4O_7\cdot10H_2O$ and NaCl in the quaternary system at 288.15 K. The diagrams of physical and chemical properties including refractive index, density, viscosity and pH versus composition were changed regularly with the increasing of the boron concentration and singular values were achieved at the invariant points of the quaternary system at 288.15 K. Those results are useful for guiding oil-field brine development and utilization process.

Key words: Phase equilibrium, Calcium chloride, Calcium hexaborate, Sodium chloride, Borax.

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PHASE EQUILIBRIA AND PHYSICOCHEMICAL PROPERTIES OF THE AQUEOUS TERNARY SYSTEM ($NaCl + NaClO_3 + H_2O$) AT 293.15 K

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Chlorate are not only occupied an important role in herbicide, explosives and oxidant in organic reaction, but also used in the production of perchloric acid and chlorate. The industrial production of sodium chlorate is often carried out by the electrolyzation of saline lake brine to form a mixed sodium chlorate and sodium chloride solution, and subsequently separated to obtain sodium chlorate. In order to separate the electrolytic salt water, the phase diagram of the ternary system ($NaCl + NaClO_3 + H_2O$) is essential. Solubilities and physicochemical properties including refractive index, density, Eh and pH of the ternary system ($NaCl + NaClO_3 + H_2O$) at 293.15 K were determined experimentally with the method of isothermal dissolution equilibrium [1-3]. Densities, pH and Eh values of the mixture solution of NaCl and $NaClO_3$ at 293.15 K with mass fraction (100w) from 0.00 to 12.00 and 0.00 to 49.00 were determined, respectively. Based on the experimental data, the phase diagram and the physicochemical properties versus the composition of NaCl diagram in the system at 293.15 K were plotted. And the salting-out effect of sodium chloride and sodium chlorate was compared. There are one co-saturation point and two univariant curves in the phase diagram of this ternary system at 293.15 K. The physicochemical properties (density, refractive index pH and Eh) are changed regularly with the increasing of sodium chloride mass fraction in solution. Based on the experiment results in this study, the separation of sodium chlorate and sodium chloride can be carried out by traditional evaporation, cooling or crystallization methods.

Key words: Stable phase equilibrium; Solubility; Sodium chlorate; Sodium chloride.

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VARIABLE TEMPERATURE CHEMICAL MODEL STUDY ON EQUILIBRIUM SOLUBILITIES IN THE TERNARY SYSTEM KCl – $SrCl_2$ – H_2O AT T = (273.15 K ~ 373.15) K

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Solubilities of the ternary system KCl – $SrCl_2$ – H_2O at 288.15 K were investigated with the isothermal dissolution equilibrium method. The crystallization of KCl and $SrCl_2$•$6H_2O$ has been established. On the basis of Pitzer extended ion-interaction model, the solubility data obtained have been combined with Pitzer parameters and solubility data of the binary system $SrCl_2$ – H_2O and ternary system KCl – $SrCl_2$ – H_2O at T = (288.15 ~ 373.15) K in the literature [1-3] to construct a chemical model that calculates solid-liquid equilibria of the brine systems. The temperature-dependent equations for the binary parameters for $SrCl_2$ – H_2O, the mixed parameters θK,Sr and ψK,Sr,Cl, and equlibrium constants of the solid phases $SrCl_2$•$6H_2O$ and $SrCl_2$•$2H_2O$ were obtained by adjusting selected constants. The calculated solubilities for $SrCl_2$ – H_2O system agree well with the references. The model for KCl – $SrCl_2$ – H_2O system also gives a good agreement with the experimental solubility data presented in this study at 288.15 K, and other temperatures at 298.15 K, 333.15 K and 373.15 K available in the literature [3], which shows the model is reliable. Temperature extrapolation of the mixed system model provides reasonable mineral solubilities at 273.15 K. The patterns for solubility curves of the ternary system at different temperatures are similar, but the crystallization area for strontium chloride salts changes from $SrCl_2$•$6H_2O$ to $SrCl_2$•$2H_2O$. Limitations of the mixed solution models due to data insufficiencies are discussed.

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FROM LAKE BAIKAL TO THE DEAD SEA: THE LIFE AND WORKS OF MOSHE NOVOMEYSKY

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The exploitation of the mineral resources of the Dead Sea started in the early 1930s thanks to the efforts of Moshe (Mikhail) Novomeysky who had earlier been involved in mining operations in Siberia and had explored the industrial use of salts from Lake Baikal. I will present an overview of Novomeysky's contributions to the study of salt lakes and their industrial exploitation, mainly based on his two autobiographic works: "My Siberian Life" (1956) and "Given to Salt" (1958). Novomeysky was born in 1873 in the village of Barguzin on the shores of Lake Baikal. After graduating from Irkutsk Technical School he obtained a degree in mining engineering from the Royal Prussian Königsberg University (now Kaliningrad). He then returned to Barguzin and engaged in gold mining. In 1900, he set up a company for production of salts from the waters of Lake Baikal for glass production. During that period Novomeysky became a prominent figure in the local Jewish community, and he attended the sixth Zionist Congress in Basel in 1903. In 1905 he was imprisoned for five months for "revolutionary activity". Novomeysky's interest in the Dead Sea can be traced back to his meeting in 1906 with scientist and fellow Zionist Otto Warburg. He first visited the Dead Sea in 1911 and performed preliminary experiments to explore the feasibility of the construction of evaporation ponds and extracting minerals from the lake. In 1920 he immigrated to Palestine, then under British mandate, and he purchased land on the Dead Sea's northern shore. In 1922 he obtained the rights to mine salt at Mount Sodom at the southern end of the lake. When the British Mandatory authorities issued a tender for mining the Dead Sea area, Novomeysky was one of the applicants. After a struggle lasting for ten years he was granted a 75 year concession from the British Colonial Office in 1929 and he established the Palestine Potash Company. The board of directors and marketing departments were in London, their management and research laboratories in Jerusalem, the production facility on the northern shore of the Dead Sea, and an experimental production facility was set up near Mount Sodom. By 1940 the Palestine Potash Company was responsible for half of the country's industrial export, and during World War II it supplied half of Britain's demand of potash fertilizer. To maintain a good relations with the local Arab population Novomeysky learned Arabic, and he established good connections with King Abdullah I of the Emirate of Jordan at the eastern side of the Dead Sea. When the British left the area in May 1948, leading to the founding of the State of Israel and of the Kingdom of Jordan, Novomeysky tried to strike a deal with King Adbullah in an attempt to create a neutral zone and spare the potash works. However, the effort failed, and the potash factory and all facilities on the northern shore of the Dead Sea were destroyed by Abdullah's Arab Legion. Only the potash plant at the southern end of the lake near Sedom survived. In November 1948, Israel's provisional government appointed a commission to examine the Palestine Potash Company's operations. Novomeysky, then 75 years old, was forced out, and in 1952 the Dead Sea Works Ltd. was established as a state-owned enterprise at Sedom. Novomeysky moved to Paris, where he passed away in 1961 at the age of 87. Today the Dead Sea Works (Israel) and the Arab Potash Company (Jordan) exploit the mineral resources of the Dead Sea and produce potash, bromine, elemental magnesium, and halite, based on processes established during the pioneering work of Moshe Novomeysky.

DIVERSITY AND CAROTENOGENIC CAPACITY OF NEW MICROALGAE STRAINS FROM THE GENUS *DUNALIELLA* (CHLOROPHYCEAE)

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Green unicellular algae from the genus *Dunaliella* are the main or even sole primary producers in environments with salinity close to saturation and represent an important source of β-carotene. In Russia there are a lot of hypersaline lakes which can be used as resource of new strains of these valuable microalgae. Phylogenetic position of nine *Dunaliella* isolates from Salt-Iletsk' Lakes in Orenburg region and Elton Lake in Volgograd region was studied based on the ITS1–5.8S rRNA–ITS2 sequence. The capability of accumulation of secondary (uncoupled from the photosynthetic apparatus) β-carotene in five novel strains of halophile microalga from the genus *Dunaliella* was analyzed in condition of high photosynthetically active radiation and nirogen deficiency. The growth rate, pigment and fatty acids content and composition as well as suspension absorbance spectra were investigated in microalgae cultures under optimal and stress conditions. Under conditions optimal for growth, chlorophylls and primary carotenoids (mainly lutein) dominated in the pigment profile of all investigated strains. The main fatty acids were represented by unsaturated C18 FA typical of thylakoid membrane structural lipids. In all studied cells, stressors caused a decline in chlorophylls and an increase in saturated C16 and C18 FA associated with reserve lipids. Fatty acid saturation increased (apparently due to net loss of lipids associated with thylakoid membranes).The carotenogenic species *D. salina* demonstrated 10-fold increase in carotenoids accompanied by a decline in lutein and a drastic increase in β-carotene (up to 75 % of total carotenoids). In *D. parva* and *D. viridis*, only 1.5-fold increase in carotenoid content took place, the ratio of major carotenoids remaining essentially unchanged.

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PHASE EQUILIBRIUM FOR THE TERNARY MIXTURE SOLVENT SYSTEM (NaCl + CH_3OH + H_2O) AT 298.15, 308.15, 318.15 K AND 0.1 MPa

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A large amount of inorganic salt mixtures containing several organic substances are usually generated in the process of specialty plastics production [1]. The green recycle utilization of the high-value components in waste or by-product would have important significances for the sustainable development of plastics industry, salt chemical industry and chlor-alkali industry. The by-product slurry of polyphenylene sulfide (PPS) industrial production containing large amounts of sodium chloride, lithium chloride and a small amount of oligomers [2]. The solubility data and physicochemical properties (including refractive index and density) of the ternary system (NaCl + CH_3OH + H_2O) at 298.15, 308.15 and 318.15 K and 0.1 MPa were determined experimentally with the isothermal dissolution equilibrium method [3]. According to the experimental data, the phase diagram of the system at different temperature and the diagram of physical properties versus composition are plotted. In Figure 1 for the phase diagram of the ternary system (NaCl + CH_3OH + H_2O) at 298.15, 308.15 and 318.15 K, the solubility of NaCl in water is higher than that in methanol, and the solubility of NaCl decreases with the increasing of methanol content. It is obvious that methanol has great salting-out effect to NaCl. When compared with the phase diagrams of the ternary system at three temperatures, it was found that the solubility of NaCl is minor changed with the increasing of temperature. The density and refractive index change regularly with the increasing of the mass fraction of NaCl in the solution. No stratification phenomena were observed for the liquid phase in the ternary system, and the equilibrium solid phase is NaCl.

Key words: Sodium chloride; Methanol; Ternary system; Phase equilibrium.

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EXTRACTION OF LITHIUM FROM SALT LAKE BRINE OF HIGH Mg/Li USING Na[$FeCl_4$*2TBP] AS EXTRACTANT: THERMODYNAMICS, KINETICS AND PROCESSES

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A systematic investigation on the extraction of lithium from salt lake brine with high Mg/Li using a novel extractant, Na[$FeCl_4$*2TBP]org, is reported with an emphasis on the extraction thermodynamics, kinetics and process. In liquid-liquid extraction, this extractant shows high separation factor of lithium/magnesium up to 178.4. Thermodynamic analysis indicated that the extraction is an exothermic process. However, when integrated with the kinetic effect, the lithium mass transfer increases at elevated temperature. The kinetics of lithium extraction by this extractant was investigation via a single drop column method. The magnesium, lithium concentration in brine, sodium, ferric concentration in organic extractant were studied, and a linear relationship was found between the rate of lithium transfer and the concentration of eachcomponent. The contribution of the formation/coalesce of organic extractant droplet, end-effect, to the lithium mass transfer was investigated. Perturbation at the brine/organic phases was found to promote lithium mass transfer during the rising step of droplets, mainly due to the low interfacial tension. Finally, a process was proposed to extract lithium ions from East Taijinaier salt lake brine and the stability of the new extractant was demonstrated by four extraction/stripping/saponification cycles. These results indicate present extractant was suitable for extracting lithium from brines with high Mg/Li ratio.

SOLID–LIQUID PHASE EQUILIBRIUM IN THE TERNARY SYSTEM $MgSO_4$–MgB_4O_7–H_2O AT 308.15 K

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It is famous that the salt lakes are rich in magnesium boron in the Qinghai-Tibet plateau. The composition of many sulfate brine can be approximated as the complex system of Li^+, K^+, Mg^{2+}//Cl^-, SO_4^{2-}, borate–H_2O. Meanwhile, salt lake research has a guiding role in the separation and extraction of boron and magnesium in brine [3]. Phase equilibrium of the ternary system $MgSO_4$-MgB_4O_7-H_2O at 308.15 K has been researched with the isothermal dissolution equilibrium method. The solubilities and physicochemical properties of the system including density, refractive index and pH value were analyzed. Based on the experimental data, phase diagram at 308.15 K and physicochemical properties versus compositions diagrams were plotted respectively. The results show that this system belongs to the hydrate type I, and no complex salt and solid solution generates. There is one invariant point ($MgSO_4 \cdot 7H_2O$ + $MgB_4O_7 \cdot 9H_2O$) which liquid compositions are $MgSO_4$ 29.07 %, MgB_4O_7 1.598 % in mass fraction, two univariant solubility curves of AE and BE, and two crystallization fields which correspond to $MgSO_4 \cdot 7H_2O$ and $MgB_4O_7 \cdot 9H_2O$, respectively. The solubility of MgB_4O_7 increases with the increasing of $MgSO_4$ in the equilibrium liquid phase, which indicates that $MgSO_4$ has the salting-in effect on MgB_4O_7. Meanwhile it has been found that the $MgB_4O_7 \cdot 9H_2O$ is not stable, and is easily converted into the $Mg_2B_6O_{11} \cdot 15H_2O$. And with the increasing of $MgSO_4$, the conversion of $MgB_4O_7 \cdot 9H_2O$ to $Mg_2B_6O_{11} \cdot 15H_2O$ is inhibited. Physicochemical properties change regularly with the increasing of $MgSO_4$ content.

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APPLICATION STATUS OF RUBIDIUM, CESIUM AND RESEARCH SITUATION OF ITS EXTRACTION IN BRINE WITH t-BAMBP

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Rubidium, cesium and its compounds are applied in the field of high-tech more and more, natural brine is rich in rubidium and cesium resources, but now is not achieve the industrial production. Therefore, the extraction of rubidium and cesium resources from the brine to achieve its industrial production is necessary. The current research status of extraction rubidium and cesium in brine using t-BAMBP are mainly introduced, then points out the characteristics of this method, it can be used to realize the industrial production of rubidium and cesium from brine. Some researchers engaged in relevant studies. For example, Lu zhi, researched the extraction of rubidium and cesium from high potassium brine with t-BAMBP, using xylene as diluent, 1 mol/L t-BAMBP, 1 mol/L sodium hydroxide, phase ratio O/A=3/1, extraction time 2 min. In these condition, the purity of RbCl products reached 99.80 %, the extraction rate was 97 %, the stripping rate of rubidium was 98.40 %, the totally withdraw ratio 95.55 %. Hu Liyin, extracting rubidium and cesium from the liquor after extracting lithium and potassium of lapidolite with t-BAMBP in Yichun Jiangxi, total metal recovery rate of Rb>94.00 %, Cs>98.00 %, the products quality more than KBI of the USA industrial grade production. Separation and extraction of its in brine using t-BAMBP obtained the better process parameters in laboratory, but this method used for the brine with high potassium is not ideal, and the alkali consumption is too large, higher requirements on equipment, all these factors limit its industrial application. Further research is needed to overcome these shortcomings.

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CHEMICAL RESOURCES OF SALINE LAKE KIRAN FOR PROVISION OF MEDICAL SERVICES (BURYATIA, EASTERN SIBERIA)

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Mud specializing hospital Kiran is located in the territory of Kyakhta district of the Republic of Buryatia. It is located on the shore of Saline Lake Kiran, 300 km from the city of Ulan-Ude and 30 km from the city of Kyakhta. The length of the lake is about 3 km and the width is 700 meters on average. The chemical composition of the lake water is chloride-hydro carbonate and magnesium-sodium. The lake is without drainage. The thickness of the mud is about 2 meters. The mud has the following physicochemical parameters: humidity 36-59 %, volume weight 1.3 -1.7 g/cm^3, content of substances 0.8-1.7 %, iron sulfide content 0.1 % on average, mineralization of the mud solution varies from 24.2 Up to 93.8 g/l, pH – 8.5 – 9.1. Balneologically valuable components are determined in lake water: bromine up to 3.4 mg/dm^3, orthoboric acid up to 19.7 mg/dm^3. According to the organoleptic characteristics, mud samples are uniform, have a gray color, soft consistency, a weak hydrogen sulphide smell, and contain slightly perceptible sand particles. Mineral inclusions larger than 5 mm in the samples are absent. Mud contains 76.7 % - 82.2 % of ash components. Environment conditions contribute to the predominant accumulation of reduced forms of iron in the mud (FeO – up to 310 mg per 100 g of moist mud). The reaction of the mud medium and the mud extract, isolated by centrifugation, is alkaline.

Sanitary-microbiological state of mud meets the requirements of therapeutic mud. The physiological groups of microorganisms are represented by the following bacteria: ammonifying bacteria 10^2, denitrifying – 10^2, cellulose-destroying -10, mycobacterium saprophytes - 10^2, sulfate-reducing bacteria – 10. The presence of mycobacterium saprophytes indicates a considerable amount of decomposing cellulose and protein complexes in the mud.

Hydro-carbonate-chloride and sodium water and sulfide mud of the lake is used for therapeutic treatment. Mud is characterized by high plastic-viscous properties, complete absence of gypsum, increased alkalinity. The treatment profile of patients is very wide: diseases of the musculoskeletal system, diseases of the nervous peripheral system, skin diseases, diseases of the genitourinary system, female diseases, cerebral palsy. Mud can be used in cosmetology.

PHASE EQUILIBRIUM AND PHASE DIAGRAM FOR THE QUATERNARY SYSTEM (Li^+, K^+//Cl^-, SO_4^{2-}-H_2O) AT 288.15 K

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Salt lakes are widely distributed in the western of China, especially in the area of Qinghai-Xizang (Tibet) Plateau. A series of salt lakes in the Qaidam Basin, located in Qinghai Province, China, is famous for their abundance of lithium, potassium and boron resources. It is well known that the thermodynamic phase equilibrium and phase diagrams play an important role in exploiting the brine resources and describing the geochemical behavior of brine and mineral system. The investigation of the thermodynamics and phase diagram of the system is of theoretical and practical importance. The phase equilibria of the quaternary system (Li^+, K^+// Cl^-, SO_4^{2-}-H_2O) were studied at 288.15 K by the isothermal solution equilibrium method. The solubilities and relevant physico-chemical properties including density, refractive index and pH values were determined for the first time. According to the experimental results, the dry-salt phase diagram (Fig. 1), water diagram and physico-chemical properties versus composition diagrams were plotted. In the stable phase diagram, there are three co-saturated invariant points (E, F, G), seven univariant solubility isotherm curves(AG, BF, HE, CE, EF, FG, DG), and five crystallization regions, which correspond to lithium chloride monohydrate ($LiCl{\cdot}H_2O$), lithium sulfate monohydrate ($Li_2SO_4{\cdot}H_2O$), potassium chloride (KCl), potassium sulfate (K_2SO_4), and the double salt lithium potassium sulfate ($Li_2SO_4{\cdot}K_2SO_4$), where the double salt lithium potassium sulfate ($Li_2SO_4{\cdot}K_2SO_4$) is an incongruent double salt. The crystallization area of potassium sulfate (K_2SO_4) is the largest, and the crystallized zone of lithium chloride monohydrate ($LiCl{\cdot}H_2O$) is the smallest. These results indicate that potassium sulfate is easy to saturate and crystallize from solution and that lithium chloride has a high solubility during isothermal evaporation. In the experiment it also indicates that the physicochemical properties of the stable equilibrium solution are in regular changes with the concentration of Li^+ along the univariant solubility isotherm curves.

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THERMODYNAMICS EQUILIBRIUM OF THE INTERACTIVE QUATERNARY SYSTEM (Li^+, Na^+/Cl^-, CO_3^{2-}-H_2O) AT 363.15 K, p=0. 10 MPa

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Extraction of Li^+ from brine was focused recently, since the fact of conflict between widely application of lithium battery and insufficient of high quality source of lithium. Crystallization of Li_2CO_3 is an effective technology for extraction of lithium. The reactive crystallization process mainly operated in Li^+, Na^+/Cl^-, CO_3^{2-}-H_2O interactive quaternary system. Phase equilibria diagrams of Li^+, Na^+/Cl^-, CO_3^{2-}-H_2O quaternary system is the key to designing the crystallization process. In this work, the equilibrium solubility and density of the aqueous quaternary system (Na^+//Cl^-, NO_3^-, SO_4^{2-}-H_2O) at 363.15 K and 0. 10 MPa were determined by the isothermal method. The composition of liquid phase and solid phase with equilibrium state were analyzed by chemical analysis and XRD, respectively. Chemical analysis of chloride, carbonate, lithium, and sodium were corresponding to silver nitrate volumetric method, neutralization method, ICP-OES method, and minusing combine with ICP-OES method, respectively. The phase equilibria diagrams of dry-salt and water-phase of the system were achieved based on the solubility data. The experimental evidence indicates that interactive quaternary system phase diagram of Li^+, Na^+/Cl^-, CO_3^{2-}-H_2O was composed of 4 two-salts cosaturated points, two three-salt co-saturated point, five univariant curves, and four crystallization regions corresponding to NaCl, Na_2CO_3•H_2O, LiCl and Li_2CO_3. There is no formation of double salt and solid solution. The phase region of Li_2CO_3 occupied most area, which indicates low solubility and easily crystallizing from brine. Five double saturated solubility curves of AE1, CE1, E1E2, BE2 and DE2 as presented in Fig.1 corresponding to Na_2CO_3•H_2O+NaCl, Na_2CO_3•H_2O+Li_2CO_3, Li_2CO_3+NaCl, LiCl+Li_2CO_3, LiCl+ NaCl respectively. Three-salts cosatured points of E1 and E2 correspoding to Na_2CO_3•H2O+NaCl+Li_2CO_3 and LiCl+Li_2CO_3+NaCl. The corresponding liquid phase composition of E1 are w(Li^+) =0.85 %, w(Na^+)=10.56 %, w(Cl^-)=12.94 %, w(CO_3^{2-})=6.49 %, w(H_2O) = 69.16 %. The corresponding liquid phase composition of E2 are w(Li^+) =7.59 %, w(Na^+)=4.86 %, w(Cl^-)=45.76 %, w(CO_3^{2-}) = 0.41 %, w (H_2O) =41.39 %. The maximum value of density of 2.3810 kg•L^{-1} was found at co-saturated point E1.

Key words: Thermodynamics Equilibrium; interactive quaternary system; Crystallization.

PHASE EQUILIBRIA OF THE TERNARY SYSTEM ($MgSO_4 + Mg_2B_6O_{11} + H_2O$) AT 298.15 AND 308.15 K

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China has numerous types of salt lakes, and the large numbers are high concentrations of sodium, potassium, lithium, magnesium, boron as well as rare elements. The brine resources with high concentrations of magnesium and boron are widely distributed in the western of China, especially in Qinghai-Tibet Plateau [1]. These brines mostly belong to the complex salt-water system (Li^+, Na^+, K^+, Mg^{2+}//Cl^-, SO_4^{2-}, borate–H_2O) [2]. As well known, the phase equilibrium and phase diagrams are essential for exploiting the brine resources and describing the geochemical behavior of brine and mineral system [3]. Therefore, the studies on the thermodynamic phase equilibrium containing magnesium and boron could provide the scientific guidance and theoretical foundation to separate and purify the boron and magnesium effectively from the mixture. In this work, the solubilities and physicochemical properties including density, refractive index and pH values of the ternary system ($MgSO_4 + Mg_2B_6O_{11} + H_2O$) at 298.15 and 308.15 K were investigated using the isothermal equilibrium method [2]. Based on the experimental data, the phase diagrams and the physicochemical property diagrams (density, refractive index and pH value) versus composition of magnesium sulfate were plotted. It was found that there are all in one invariant point, two univariant curves and two crystallization regions corresponding to inderite ($Mg_2B_6O_{11}$•$15H_2O$, Ind) and epsomite ($MgSO_4$•$7H_2O$, Eps). In figure 1, point E and E' are the invariant points of the coexisted solid phases of ($MgSO_4$•$7H_2O$ + $Mg_2B_6O_{11}$•$15H_2O$), and the compositions of $MgSO_4$ and $Mg_2B_6O_{11}$ in the invariant points with mass fraction of 100w are 27.38, 0.67 at 298.15 K and 29.50, 0.89 at 308.15 K.

Key words: Phase equilibrium; Solubility; Inderite; Epsomite

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SEPARATION OF LITHIUM AND MAGNESIUM IN SALT LAKE BRINE BY EXTRACTION OF MAGNESIUM

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Lithium is honored as "the energy metal in the 21st century" and magnesium enjoys the reputation of "the national defense metal". There are abundant brine resources with high Mg/Li ratio in China, but their exploitation still can not meet the requirement of domestic market for the great difficulties of lithium and magnesium separation. In order to realize the separation of lithium and magnesium as well as high-value utilization of magnesium in high Mg/Li ratio brine, a novel solvent extractive system was established to extract magnesium from high Mg/Li ratio brine. The conditions for magnesium extraction and back-extraction such as R(O/A), saponification rate and pH were optimized, and the separation effect between magnesium and lithium was also investigated. The results showed that the single stage extraction rate increases with the increasing of saponification rate, and the single stage extraction rate was no less than 90 % at the conditions of R(O/A) = 6:1 and 70 % saponification rate. In other words, this new extracting agent system can effectively extract magnesium from high Mg/Li ratio brine, by which the separation between lithium and magnesium will be realized, and the magnesium in extracted organic phase can be further high-value utilization by the other methods.

Key words: Salt lake brine, magnesium recovery; extraction process; high Mg/Li ratio.

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PROGRESSES ON PHASE EQUILIBRIA OF THE BRINE SYSTEMS CONTAINING STRONTIUM AND CALCIUM

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Inorganic liquid mineral resources are abundant in seawater, salt lake brines, and oil-field brine. Calcium salts are widely found in variety of natural brines. The concentration of calcium of the oil-field brines in Nanyishan District of the Qaidam Basin in China is extremely high. The brine is classified as calcium chloride type according to the Sulin classification [1]. In addition to calcium chloride, the concentration of strontium in the oil-field brine is up to 4450 mg/L [2]. Due to the extremely similar chemical properties between strontium and calcium, there is a challenge to separate calcium and strontium in the coexistence of calcium and strontium brines [3]. The phase diagram can be used to judge the precipitation sequence and conversion rules of various salts in the system, exploring the chemical production process, determining the optimum production conditions and formulating the optimal technological process. Therefore, the researches on phase equilibria for the systems containing strontium and calcium are necessary. In this article, those aspects are discussed in the following: Firstly, to develope an analysis method which is suitable for the coexistence system containing strontium and calcium ions. Secondly, progresses on phase equilibria of the brine systems containing strontium and calcium were summarized. In briefly, the solid solution $(Ca,Sr)Cl_2 \cdot 6H_2O$ forms in the coexistence system containing strontium and calcium at low temperatures, but the solid solution does not form at high temperatures [4]. The results are essential for strontium and calcium separation from the brines. Thirdly, some problems have been discussed, and the research direction in the future for the phase equilibria of salt lake brine systems, which contain strontium and calcium ions, have been pointed out.

Key words: Brine system; Phase equilibrium; Calcium; Strontium.

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EXTRACTING LITHIUM FROM TIBETAN DANGXIONG TSO SALT LAKE OF CARBONATE TYPE BY USING GEOTHERMAL SALINITY-GRADIENT SOLAR POND

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Given their unique resources, the carbonate salt lakes in Tibet offer significant advantages in the extraction of lithium, but some disadvantages are being exposed in production. These disadvantages include the long period of lithium extraction and the low grade of lithium carbonate caused by geographical conditions and climate factors of the Qinghai-Tibet plateau. Based on the above reasons, we rebuilt the traditional solar ponds by introducing a kind of heat exchanger in a bid to speed up the temperature rise of brine, whereby we planned to make use of the high-temperature geothermal resources around the lakes to produce lithium carbonate in large-scale applications. We carried out a small lithium-extraction experiment with hot water as the heat source for the purpose of verifying the feasibility of lithium extraction by geothermal-salinity gradient solar pond (G-SGSP). In the experiment, the contrastive analysis method was employed as a means to study the relationship between ion diffusion and temperature, as well as salinity in G-SGSP and these controllable factors' impact on the precipitation of lithium carbonate. The results of the experiment show that it is highly feasible to extract lithium through G-SGSP, thus enhancing the efficiency of lithium extraction and generating higher-grade lithium carbonate. Thus, the experiment serves as a dramatic reference for extracting lithium from Dangxiong Tso Salt Lake through the application of geothermal resources.

RECOVERY OF LITHIUM FROM BRINE BY CONTINUOUS CENTRIFUGAL EXTRACTION

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Lithium is honored as the energy metal of 21st century, and has important applications in lithium-ion batteries [1]. There are abundant lithium resources in salt lake brine of the Qaidam Basin, China. Due to the lower cost and more available reserves, recovery of lithium from salt lake brine will be a new trend in lithium industry. However, recovery of lithium from salt lake brine at present is complicated or costly by the presence of other elements especially magnesium, which universally exists in salt lake brine of the Qaidam Basin. Solvent extraction is a flexible separation technique, and more researches are focused on the extraction system containing tributyl phosphate (TBP) [2, 3]. At present, the research emphasis is mostly focused on the optimum extraction conditions and how to solve the high acidity during back-extraction. The extraction of lithium from brine with high Mg/Li ratio using a novel solvent extractive system by continuous centrifugal extraction, and subsequently back-extraction with alkaline solution was carried out. The effect of basicity on the degradation of TBP was also investigated. The results showed that lithium in brine can be effective extraction at the extraction condition of phase ratio R(O/A)=1:2 by five-stage continuous centrifugal extraction, and the extraction rate is no less than 95 %. Meanwhile, the lithium in organic phase after extracting can be easily and almost completely back-extracted by alkaline solution only through mixing by mechanical vibration within two minutes. The assistant extracting agent generated during back-extraction can be recycled after converting with concentrated HCl. On the other hand, the degradation of TBP during back-extraction is negligible at certain pH range.

Key words: Lithium; Centrifugal extraction, Salt lakes; Brine.

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RESEARCH PROGRESS OF LITHIUM EXTRACTION FROM SALT LAKE BRINE WITH HIGH Mg/Li RATIO

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The application of lithium and its compounds are widely used in many fields. There are large amount of lithium resources in China with a character of high ratio of Mg/Li, so separation and recovery of lithium and magnesium has become the pressing problem to us. In the paper, the processes and techniques for lithium recovery from saline brine with high Mg/Li ratio were introduced, such as precipitation method, absorption method and extraction method, etc. [1] The advantages and disadvantages were compared, too. The development of lithium separation was discussed and the future direction was pointed out. It was reference for the salt lake lithium researchers and also important to develop and utilize brine lithium. This paper focuses on the method of solvent extraction. It is one of the most potential brine lithium extraction methods [2]. However, some problems still urgent to be solved in the future, including the recycling of the extractant and hydrochloric acid and the selection and maintenance of the equipments. Recently, there are experimental methods using hydrophobic ionic liquid as extractant [3,4]. The production costs, the corrosion of equipments and environmental pollution can be reduced in this way.

Key words: salt lake brine with high Mg/Li ratio; lithium separation; separation.

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ISOPIESTIC INVESTIGATION ON THERMODYNAMIC PROPERTIES OF LITHIUM BORATES AND MAGNESIUM BORATES

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Lithium borates and magnesium borates are both important chemical raw materials, which are widely used in ceramics, flame retardants, non-optical linear materials, agricultures and so on for their excellent characteristics [1]. Salt lakes with high concentrations of lithium, magnesium and boron resources in the western of China, such as DaChaiDan Salt Lake, YiliPing Salt Lake and DongtaiJiNair Salt Lake in the Qaidam Basin are well known around the world [2]. Studies on thermodynamic properties of aqueous electrolyte solutions are essential and important for understanding the rules of thermodynamic behavior, and for estimating ion-interaction model parameters values that can be applied to prediction of thermodynamic properties and solubilities. This knowledge is essential for the chemical industry, modeling the separation of salts from seawater and salt lake brines, and environmental and geochemical activities [3]. Isopiestic method is the experimental method commonly used in the study of the thermodynamic properties of electrolyte solutions, which obtain the osmotic and activity coefficients. This paper introduces the types and the forms of lithium borates and magnesium borates in salt lakes, and isopiestic investigation of lithium borates and magnesium borates [4]. The water activity, single salt parameters and mixing ion-interaction parameters of lithium borates and magnesium borates at different temperatures were summarized, and the parameters are also compared with by different calculation methods [5]. More works and new trends in the future for rich boron salt lake brines are discussed as well.

Key words: Isopiestic, Lithium borate, Magnesium borate, Osmotic coefficients.

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SYNTHESIS AND THERMODYNAMICS OF CALCIUM METABORATE

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Calcium borates have been widely used in the fields of nonlinear optical materials, ceramics, flame retardant, glasses industry, and agriculture due to their special propertie [1, 2]. In recent years, oil/gas-field brine resources with high concentration of calcium and boron were found in the western of China, which could provide the raw materials for the development and utilization of calcium borates. Heat capacities of salt-water systems associated with the physicochemical processes and can explain the relationship between the solvent and solute. In order to exploit the calcium borates resources in oil/gas-field, it is critical to investigate the thermochemical properties of the species exist in aqueous borate solution containing calcium and boron because the evaporation and crystallization behaviour of concentrated brine can be predicted. In this work, highly purified hydrated calcium metaborate (CaB_2O_4•$6H_2O$) was prepared by water solution method through controlling the style of feeds, reaction times, pH value et al. after a series of studies. The synthesized product was purified and characterized by elemental analysis, X-ray diffraction (XRD) (Fig. 1) and simultaneous thermal analysis (TG-DSC). The heat capacities of CaB_2O_4-H_2O system at 298.15 K were also measured by a micro calorimeter (BT2.15) and used for the calculation of apparent molar heat capacity. According to the Pitzer ion-interaction equation, the Pitzer single-salt parameter of Ca_2B_6O11•$9H_2O$, and were acquired. The calculated apparent molar heat capacities based on ion-interaction model are in accordance with the experiment value (Fig. 2), indicating the Pitzer single-salt parameter of CaB_2O_4•$6H_2O$ is reliable.

Key words: Thermodynamic properties; Heat capacity; Calcium borate; Ion-interaction model.

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THE ELECTROGENIC POTENTIAL OF THE MICROBIAL MAT OF SODA LAKE VERKHNEYE BELOE

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In the steppe and forest-steppe zones of the Transbaikal Region with a sharply continental climate, shallow drying lakes with water mineralization ranging from several grams of salt per one liter of water to the saturation level are common. Microbial mats are represented mainly by Gammaproteobacteria. Anoxigenic phototrophic bacteria play a significant role, this makes them exclusive candidates for use in microbial fuel cells (MFC). An important aspect of this technology is the selection of active electrogenic microorganisms capable of generating electricity with vigorous elimination of various contaminating components in corrosive conditions wastewater. In this regard, an important feature of such microorganisms is a broad substrate specificity, resilience environment and development ability under anaerobic conditions, since the absence of oxygen – an important condition for operation of the biofuel cell. Plurality of such important characteristics and properties have alkaliphilic microbial mats, as well as individual strains of microorganisms belonging to the microbial mat. Carrying out model experiments showed electrogenic ability of these microbial mats in the biofuel cell.

In this study we use microbial mat isolated from the soda lake Verkhneye Beloye (25°C, pH-10.0) as a model system in MFC. A study of the electrogenic activity of alkalophilic microbial mat in MFC (Patent for utility model No. 151764 of June 24, 2014) was carried out on carbonate/bicarbonate buffer 0,05 M (pH 9,6 ± 0,1) with Na_2HPO_4 (0,25 g/l) and $NaNO_3$ (0,25 g/l). Glucose at 0.25 % concentration was used as substrate.

The microbial mat was cultured in MTE at 25 ± 1°C for 120 hours. Carbon fabric "Ural" T22R (OJSC "Svetlogorskkhimvolokno", Republic of Belarus) was used as electrodes. Measurement of electrogenic characteristics was carried out using the digital multimeter RESANTA DT830B. For 120 hours of incubation, the electrogenic characteristics were 276 ± 20 mV in voltage and 1.8 ± 0,2 mA in terms of current strength.

Thus, the electrogenic activity of a microbial mat isolated from the soda lake was shown, which has broad metabolic pathways. The obtained material makes it possible to talk about the prospects of using in MFC as an electrogen in the disposal of wastewater components.

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ENVIRONMENTAL MANAGEMENT OF SALT LAKES

PROGRESSES ON SPECIATION ANALYSIS OF PHOSPHORUS IN AQUATIC ENVIRONMENT

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Phosphorus is one of the important sources in aquatic ecosystem. It is an essential nutrient for animals, plants and algae cells, and also affects the primary productivity of major water systems [1]. However, excessive input of phosphorus can cause a series of environmental problems, such as eutrophication, red tide and cyanobacterial bloom, and bring a lot of ecological disasters. Therefore, accurate determination of phosphorus speciation is critical for the study of the transport and transformation processes of phosphorus at the sediment water interface. The classical determination method of phosphorus is mainly for phosphate, mainly includes ion chromatography, spectrophotometric method, stannous chloride reduction molybdenum blue method and malachite green spectrophotometry. These classical methods are economical, practical, stable, reliable and low detection limit, but the operation steps are tedious, time - consuming and consuming, and the demand for samples is large. In recent years, with the development of instrument analysis automation, flow injection analysis [2], NMR and capillary electrophoresis [3] technology is widely used in the analysis of nutrient elements, which can not only improve the precision and sensitivity, but also solve the problems in the determination of organic form which traditional methods cannot solve.

Key words: Speciation analysis; Analytical method; Phosphorus speices.

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MULTIPLICITY OF THE ALTERNATIVE ECOSYSTEM STABLE STATES AND ADAPTIVE ENVIRONMENTAL MANAGEMENT: SALINE LAKE ECOSYSTEMS AND SALINOLOGY

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Our sustainable environmental management must be based on adequate ecological concepts. Question arises: What concept is better to use for understanding and management of ecosystems? To look for answer we concentrate our attention on the saline lakes. Every ecosystem has several alternative stable states and may demonstrate the regime shifts, which are large, abrupt, persistent changes in the structure and function of a system. To understand dynamics of ecosystems the Concept of multiplicity of ecosystem alternative stable states as a new ecological paradigm is been developing now. The author analyzes the emerging paradigm using a case of the saline lakes, and discusses how to base our adaptive environmental management on developing paradigm. The concept may serve as one of the key theoretical blocks in sustainable environmental management. Taking into account some peculiarities of the saline and their using by humans salinology, as a scientific base for an integrated saline lake and its watershed management, was suggested. Different issues of development of the concept and its application to salinology are discussed.

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