ASIAN STEPPES LAKES ALGAL DIVERSITY UNDER CLIMATE CHANGES

РАЗНООБРАЗИЕ АЛЬГОФЛОРЫ АЗИАТСКИХ СТЕПНЫХ ОЗЕР ПРИ ИЗМЕНЕНИЯХ КЛИМАТА

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Aquatic environments in arid regions experience a stressful impact of high concentrations of mineral and organic substances due to high evaporation rates (Subyani 2005). Algal habitats are characterized by a high amplitude salinity variation that in large lakes suppress algal diversity (Hammer 1986). Many algal species are indicators of environmental conditions reflecting the influence of salinity on aquatic communities and the regional flora as a whole. A decrease of algal diversity is in turn related to reduce productivity of aquatic ecosystem and thereby of the trophic level of wetlands. It is well known that an increase of salinity 20 ‰ suppress the overall taxonomic diversity of lake biota's worldwide (Hammer 1986).

The arid regions of Central Asia and Middle East occupy a considerable part of Eurasia (Köppen and Geiger 1953). In Kazakhstan, the arid and semiarid dry grasslands to deserts are widespread in the upper reaches of Ob' River Basin and the Turkestan Desert (Природное районирование... 1960). Large highly mineralized lakes Balkhash, Tengiz, Issyk Kul' and Karakul', as well as the Aralian and Caspian seas, are confined to this climatic (Hammer 1986). Phytogeographically, this region is situated near the boundary of the Irano-Turanian province and the Boreal province north of it (Тахтаджян 1978). A large number of lakes in this area are protected on account of their importance for biodiversity conservation (Брагина и Брагин 2002).

In view of remoteness of Kazakhstan's protected areas, algal diversity there remained virtually unstudied. Lakes that we studied can be considered as typical for this region. Their salinity varies from 0.19 to 39.9 г NaCl per liter increasing during the summer dry period. The acidity varies from slightly acid to alkaline, whereas the concentration of nitrates and phosphates attests to a sufficient trophic base for algal development.

Methods used to reveal environmental impacts with the help of ecological indicators are: the community structure fluctuation analysis, bio-indication of major impacting factors, calculations of integral density-diversity indices, and statistical approaches, linking the community structural and functional aspects with environmental fluctuation (Heywood 2004).

Our ecological analysis has revealed a grouping of freshwater algae in respect to salinity indicators. The bioindication of salinity is based on the classification system by Hustedt with groups ranging from polyhalobes to oligohalobes-halophobes according to Kolbe system of halobity (Баринова и др., 2006).

Statistical methods were used in comparative floristic approaches (Новаковский 2004) for clarifying of algal floras similarity in the natural protected wetlands in semi-arid climate of the Northern Kazakhstan.

Our main idea of this research was to try to analyse salinity indicators distribution over the all communities of the studied lakes and combine this result with statistical calculation of algal diversity similarity in the same lakes.

The material came from 98 samples of phytoplankton and periphyton collected from October 1999 to May-June 2000 in 34 lakes as well as the mouth of Karasu River near Lake Tuntugur, Jailmo Well near Lake Kulykol, and Jarsor Brook near Lake Jarsor located on the northern Kazakhstan arid area.

As an ecological analysis result, salinity indicators are assigned to five ecological groups with oligohalobes-indifferents as a dominant group, although the oligohalobes-halophiles and mesohalobes are also common, as well as a single species of polyhalobes. Among the oligohalobes-

indifferents the most common are *Amphora ovalis*, *Epithemia turgida*, *Fragilaria ulna*, *F. vaucheriae*, *Nitzschia acicularis*, *N. palea*, *Rhoicosphenia abbreviata* (Bacillariophyta), *Crucigenia tetrapedia*, *Pediastrum boryanum* (Chlorophyta), *Trachelomonas hispida T. volvocina* (Euglenophyta). Remarkably, the blue-greens are mostly halophilic, but include also the only palyhalobic species *Phormidium paulsenianum*. All the halophobes are diatoms, among them several species of *Eunotia*.

Therefore, can be seen, that algal communities can gives response to gradient of salinity in the different lakes of arid region, but in the sometime cannot show climatic impact to the lakes ecosystems. For clarify this problem, we use statistical approach in algal communities similarity calculation, which can give response to long-term climatic impact on the lakes ecosystems. Tree diagram in Fig. 1 constructed with Statistica 7.0 Program show three main clusters which are rather different each from others.

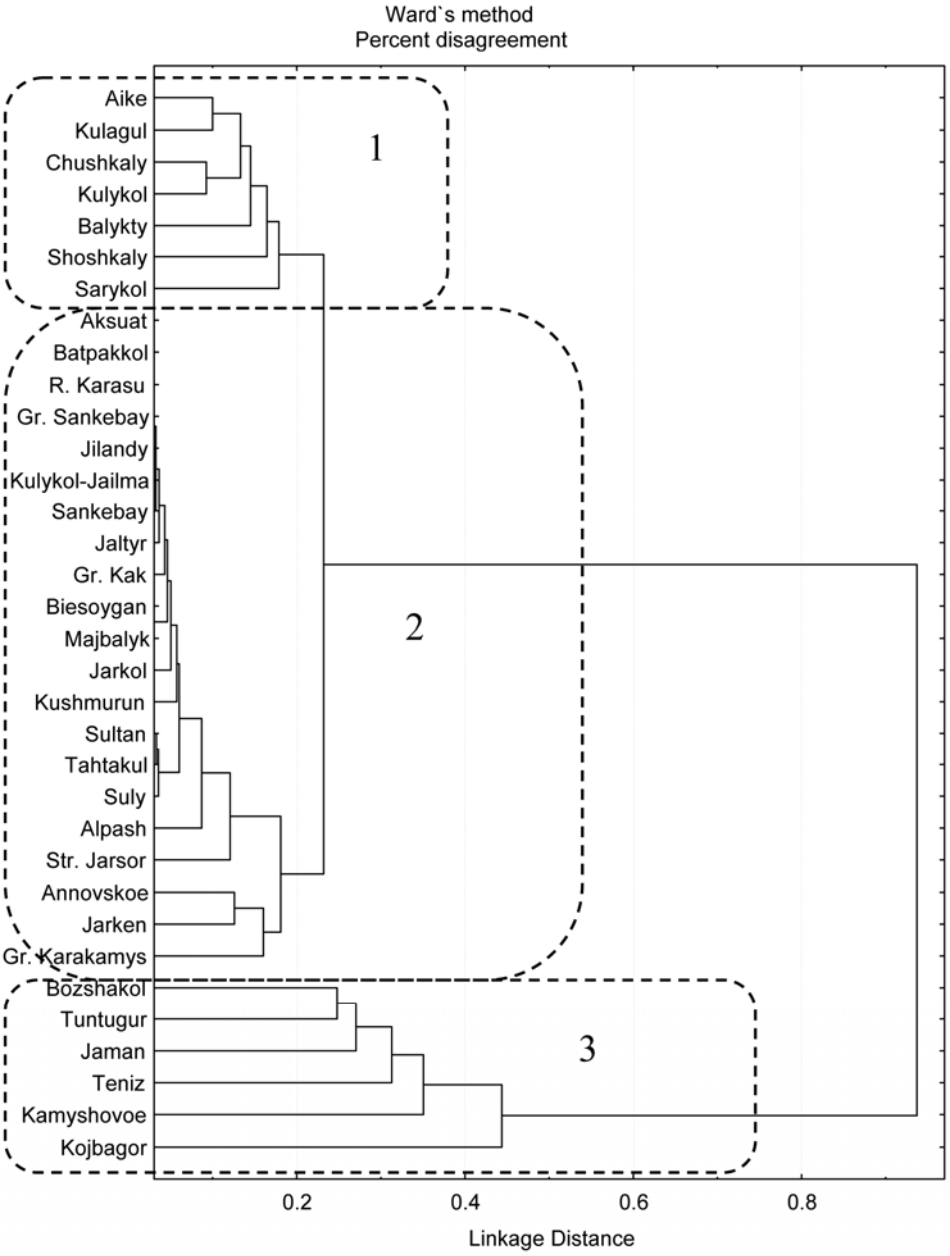

Fig. 1. Tree diagram for algal species diversity in the wetland lakes of Kazakhstan, Ward's method, percent disagreement.

When we analyzed species content in the each cluster lakes, we can see that in each cluster prevailed different group of salinity indicators.

The group discriminated at 82% similarity level (cluster 1) comprises assemblages of moderately mineralized lakes of III-IV salinity classes, with the species numbers 18 – 37. The dominant indicators are oligohalobes-indifferent, halophiles and occasionally mesohalobes.

The second group designated at the 82% similarity level (cluster 2) comprises algal assemblages of lakes with great amplitude of salinity fluctuations (II to IV classes), with species numbers 1 – 28. The dominant indicators are oligohalobes-indifferent, halophiles and mesohalobes.

Custer 3 of low similarity level comprises assemblages of slightly mineralized lakes of IV salinity class: Bozshakol, Tuntugur, Jaman, Teniz, Kamyshovoe, and Kojbagor, with species numbers 57 (Jaman) to 112 (Kojbagor), dominated by oligohalobes-indifferent and halophiles; mesohalobes are lacking in these lakes.

Our analysis of dendrogram shows clustering upon three major variables: species richness of algal communities, salinity class, and the dominant salinity indicators. The most similar are species rich communities of slightly mineralized lakes, as well as the species-poor communities of highly mineralized lakes.

These regularities indicate that, the other conditions alike, salinity is the main depressing factor of algal diversity irrespective of the type and distribution of the water body. In other words, the compositions of algal communities reflect in the first place the salinity level related to climatic aridity.

We used comparative floristic approaches for revealing this major factor influence to the lacustrine floras enriching process. In the statistical program GRAPHS (Novakovsky 2004) which presented not only tables of calculation but also constructed visual graphs, we analyzed present-absent of 254 species in 34 lakes with Serensen-Chekanovsky indices calculation. Dendrite of similarity (Fig. 2) shows five floristic cores which marked by dushed lines.

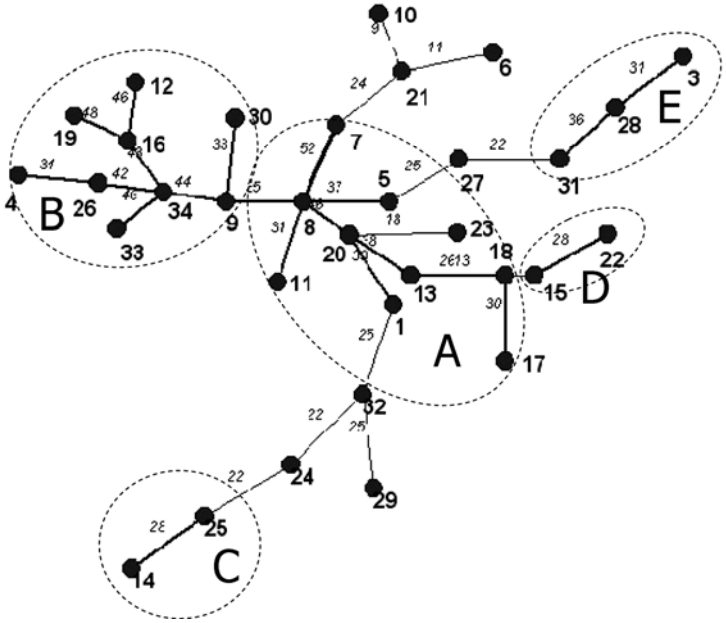

Fig. 2. Dendrite of similarity of the Kazakhstan lakes algal communities constructed on the base of Serensen-Checkanovsky indices.

Because the species diversity in the protected wetlands is mostly influenced by natural factors, the floristic cores can reflects historical natural impact to algal biodiversity. On Fig. 2 can be seen that most of lakes with species rich communities and freshwater combined into central core (A). The lakes Bozshakol with 63 species and Kojbagor with 112 species placed in center of core A. All lakes from core (A) are 3-4 salinity class with high species diversity, low to middle dissolved solids and seasonally fluctuated Electrical conductivity, neuthal to low acidic range of pH, low to middle nutrients concentration, and III-IV Class of water pollution. It means that ecosystems in core (A) lakes are well developed.

Core (B) formed 9 freshwater lakes with middle species diversity, middle dissolved solids and nutrients concentration, more clear than in core (A), but with neutral to low alkaline water.

Core (C) included two lakes only that connected with core (A) and characterized as freshwater, low alkaline, low organic polluted with low to middle dissolved solids and nutrients concentration.

Core (D) formed two lakes also, which have similar conditions with lakes of core (C) and also closely related with diversity of core A.

The last core (E) included three freshwater lakes, which have similar conditions with lakes from the major core (A).

Few lakes that are not included in the mentioned above cores have intermideate (as in Tahtakol or Kushmurun) or extremal environmental conditions such as in the Great Kak Lake: high salinity and electrical conductivity, low acidic water with low phosphates and middle nitrates concentration and as a result low species diversity.

Our algological studies show that salinity as a consequence of aridization in the area under investigation suppresses algal diversity thereby decreasing productivity of the first trophic level undermining the trophic base of wetlands as water fowl habitat.

Therefore, we conclude that salinity is most important factor, which have historical influence on algal diversity in the studied wetland lakes.

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К ВОПРОСУ ИЗУЧЕНИЯ ПРОЦЕССОВ АККЛИМАТИЗАЦИИ ОНДАТРЫ В УСЛОВИЯХ ПАЛЕАРКТИКИ

ON THE STUDI OF PROCESSES IN ACCLIMATION MUSKRAT PALAEARCTIC

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Как известно, сохранение, изучение биоразнообразия природных экосистем и разработка новых подходов к их изучению является актуальной задачей (Яблоков, 1987; Кобышев, Кубанцев, 1988; Шилов, 2001).