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Ecological assessment using diatom community in Avarga Toson Lake (Mongolia)

Экологическая оценка состояния озера Аварга Тосон с помощью диатомовых водорослей (Монголия)

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Summary. A total of 32 diatom species were recorded in Avarga Toson Lake. Motile diatom species are dominating in diatom communities. The species composition of two coexisted lakes is markedly different. Diatom richness, species composition, and dominant species indicate that Burd lake is polluted by livestock grazing or domestic pollution, and Toson Lake is polluted by human activities with high sediment accumulation at the bottom.

Key words. Avarga Toson Lake, diatom richness, motile diatoms, human activity.

Реферат. Всего в озере Аварга Тосон было зарегистрировано 32 вида диатомей. В диатомовых сообществах доминируют подвижные виды. Видовой состав двух соседствующих озер заметно отличается. Богатство диатомей, видовой состав и доминирующие виды указывают на то, что озеро Бурд загрязнено в следствие выпаса скота и бытовыми стоками, а озеро Тосон – в следствие деятельности человека с большим скоплением осадка на дне.

Ключевые слова. Антропогенный фактор, богатство диатомовых водорослей, подвижные диатомеи, озеро Аварга Тосон

Introduction. In Mongolian arid regions, the lake area decreases by 9,3 % annually (Kang, Hong, 2016). Water level changes also alter the intensity of mixing, impacting water quality (Tuvikene et al., 2011), especially in shallow lakes. Global climate change is also impacted the freshwater ecosystem (Döll, Zhang, 2010). Climate can, directly and indirectly, alter species composition, abundance, and seasonal dynamics of both periphytic and planktonic diatoms (Rühland et al., 2015).

Since 1989, Toson Lake and Burd Lake areas diminished by 21.1 % and 23.5 %, respectively, within 30 years (Mandakh et al., 2020). Many people visit this lake every year for sanatorium purposes. In 1977, the Center for Dermatology began organizing a seasonal home for treating people with chronic diseases, such as neurodermatitis and flat red and established a 30-bed resort in the Avarga Toson (Yadamsuren, Tseveendorj, 1980). Avarga Toson Lake area, located in Delgerkhaan Soum, Khentii Province, is composed of two neighboring lakes: Toson Lake and Burd Lake. Even though, for sanitorium purposes, only Toson lake is used.

Percent motile diatoms are indicating land-use variables (Smucker et al., 2010). Eutrophication is probably one of the main threats to charophytes (Blindow et al. 2003). The diatom-based indexes are widely used to detect organic pollution and eutrophy (Martin, Fernández, 2012).

In Avarga Toson lake, algae investigation was not published previously. The study describes the diatom richness in Avarga Toson Lake under changes in the lake area and human activities.

Material and method. In Zuun burd lake seven samples and in Toson lake three samples were collected for diatom taxonomic study. The following tab. 1. details the algae material.

In Mandakh et al., 2020, the lakes of Toson and Zuun Burd appear in two different colors. We add-

ed the sampling point by colored green point from each lake to the downright corner of the figure above (fig. 1).

Table 1

Sampling in Lakes

Lake	Date	Latitude	Longitude	Samples
Zuun burd lake	15 Aug 2020	47°11’18.6”	109°09’03.0”	macro algae
Zuun burd lake	19 Oct 2020	47°11’18.6”	109°09’03.0”	epipelic
Zuun burd lake	19 Oct 2020	47°11’17.4”	109°09’13.8”	epipelic
Zuun burd lake	19 Oct 2020	47°11’18.6”	109°09’03.0”	plankton
Zuun burd lake	19 Oct 2020	47°11’15.5”	109°08’59.3”	macro algae
Zuun burd lake	19 Oct 2020	47°11’17.2”	109°09’10.0”	epipelic
Zuun burd lake	19 Oct 2020	47°11’02.1”	109°08’39.0”	plankton
Toson lake	19 Oct 2020	47°11’02.1”	109°08’39.0”	epipelic
Toson lake	19 Oct 2020	47°11’02.1”	109°08’39.0”	epipelic
Toson lake	19 Oct 2020	47°11’02.1”	109°08’39.0”	plankton

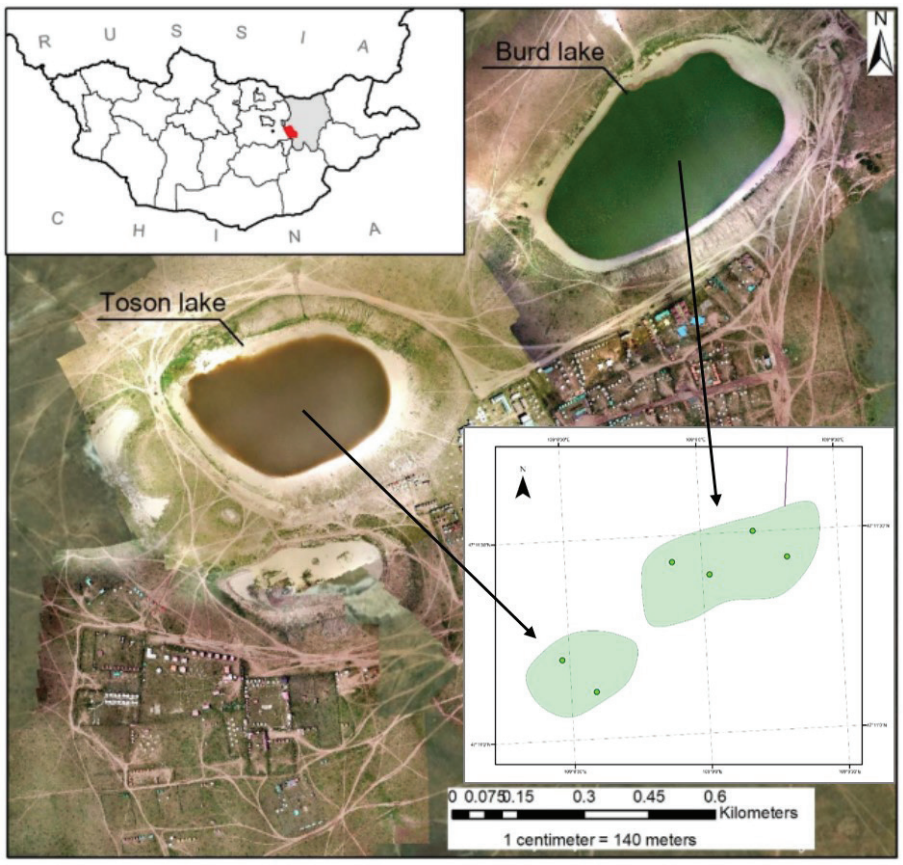

Fig. 1. Sampling point. Source map: Mandakh et al., 2020/included our study point in right down corner.

To identify a diatom are permanent slides and prepared as follows. To prepare a permanent slide from the collected sample, cut a small amount of the sample, place it into a beaker, add 30 ml of nitric acid and gently heat for about one hour. It is then deoxidized six times by cooling to room temperature and adding distilled water. The cleaned sample was placed in a unique bottle, and the sample number was affixed. The sample is dropped onto the cover glass and then dried and mounted using a naphrax balsam, and the label with the sampling information is affixed to the left side of the slide. The specimen was determined under the microscope at 1000 magnification using the essential books (Trobajo, Mann, 2019).

In the study of species level, a relative abundance of each species was identified, and 200–300 individuals were counted in each sample. Species diversity and evenness were calculated using Shannon’s index. The Jakarta coefficient assessed the similarity of the community, and the community similarity tree was determined by the euclidean distance method using the average method. The JMP program performed all numerical processing.

Result. As a result, 32 diatom species belonging to 3 classes, nine order, 16 families, and 23 genera were registered. All species listed: Aulacoseirales – Aulacoseiraceae - *Aulacoseira granulata* (Ehrenberg) Simonsen 1979; *Aulacoseira italica* (Ehrenberg) Simonsen 1979 // Melosirales – Melosiraceae - *Melosira varians* C.Agardh 1827 // Stephanodiscales – Stephanodiscaceae - *Cyclostephanos dubius* (Hustedt) Round in Theriot et al. 1988; *Cyclotella meneghiniana* Kützing 1844; *Lindavia affinis* (Grunow) Nakov, Guillory, Julius, Theriot et Alverson 2015; *Pantocsekiella ocellata* (Pantocsek) K.T.Kiss et Ács in Ács et al. 2016; *Stephanodiscus medius* Håkansson 1986 // Fragilariales – Fragilariaceae- *Fragilaria crotonensis* Kitton 1869; Staurosiraceae - *Staurosira construens* Ehrenberg 1843; *Staurosirella pinnata* (Ehrenberg) D.M.Williams et Round 1988 // Bacillariales – Bacillariaceae - *Nitzschia acicularis* (Kützing) W.Smith 1853; *Nitzschia heufleriana* Grunow 1862; *Nitzschia palea* (Kützing) W.Smith 1856; *Nitzschia vitrea* G.Norman 1861 // Rhopalodiales – Rhopalodiaceae - *Epithemia adnata* (Kützing) Brébisson 1838; *Epithemia gibba* (Ehrenberg) Kützing 1844 // Thalassiophysales – Catenulaceae - *Amphora copulata* (Kützing) Schoeman et R.E.M.Archibald 1986 // Cymbellales – Anomoeoneidaceae - *Anomoeoneis costata* (Kützing) Hustedt 1959; *Anomoeoneis sphaerophora* Pfitzer 1871; Gomphonemataceae - *Encyonema cespitosum* Kützing 1849; *Gomphonema angustatum* (Kützing) Rabenhorst 1864 // Naviculales – Amphipleuraceae - *Halamphora oligotraphenta* (Lange-Bertalot) Levkov 2009; Diadesmidaceae - *Luticola mutica* (Kützing) D.G.Mann in Round, R.M.Crawford et D.G.Mann 1990; Naviculaceae - *Caloneis bacillum* (Grunow) Cleve 1894; *Caloneis silicula* (Ehrenberg) Cleve 1894; *Navicula radiosa* Kützing 1844; *Navicula reinhardtii* (Grunow) Grunow in Van Heurck 1880; Sellaphoraceae - *Sellaphora ellipticolanceolata* Metzeltin, Lange-Bertalot et Soninkhishig 2009; *Sellaphora kretschmeri* Metzeltin, Lange-Bertalot et Soninkhishig 2009; Stauroneidaceae - *Craticula ambigua* (Ehrenberg) D.G.Mann in Round, R.M.Crawford et D.G.Mann 1990; Naviculales incertae sedis - *Mayamaea atomus* (Kützing) Lange-Bertalot 1997.

The most notable ten species belong to order Naviculales, while there is four order with only one species. The most common species were from Stephanodiscaceae – five species and Nitzschia – four species. There are 18 species with only one genus recorded. There are 15 prostrate diatom species, two stalked species, unattached ten species, and four motile species.

The species number and diversity of diatoms recorded in each lake are shown in tab. 2. The 31 species of diatom have been recorded in Zuun Burd lake. Only six diatom species have been identified in Toson Lake. Also, the species Shannon diversity is 1.91 and 1.5, respectively, in Lake Zuun Burd and Lake Toson.

Based on the species composition recorded in the ten samples and the relative abundance of each species, the community similarity analysis shows that the diatom communities of lakes are very different. The results are shown in fig. 2. *Nitzschia palea* and abundance of motile diatoms are dominating in Toson lake due to 67–100 percent of the total community, that sedimentary species. *Nitzschia heufleriana* is consisting 56 percent of the algae community in Zuun burd lake. The *Anomoeoneis sphaerophora* species consisted of 23 percent of the community, salinity indicator. Diatom diversity and Shannon evenness and some centric diatoms abundance are high in some sampling and communities of Zuun burd lake, this result is against in Toson lake. In following fig. 3 shows detailed the relative abundance of species by growth form. Motile diatom abundance is most abundant in Toson Lake than Zuun burd lake. Prostrate diatom abundance

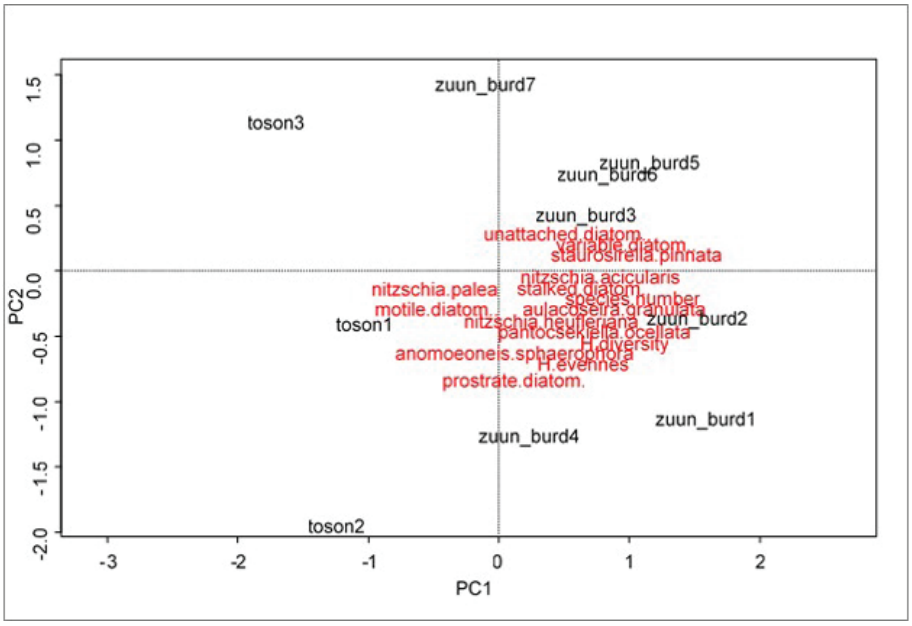

Fig. 2. Diatom community analysis.

is enumerated 23 percent of community in Toson lake, and 11 percent in Zuun burd lake. Stalked diatom is not determined in Toson lake, even though 2.7 percent in Zuun burd lake.

Based on the ecological characteristics of the species, the quality of freshwater lakes in Zuun Bur is still fresh, but pollution is ongoing. In Toson Lake, high nutrient content and low biological oxygen demand have been observed (tab. 3). Another way, there are determined heterotrophic species in Toson lake.

Table 2

Description

Descriptive	Zuun burd lake	Toson lake
Species number	31	6
H' diversity	1.91	1.55
H' evenness	0.55	0.70
Phylum number	2	2
Class	4	2
Order	10	5
Family	16	5
Genera	22	5

Table 3

Assessment of water using Van Dam, 1994

	Zuun burd Lake	Toson Lake
pH	3.3	2.9
Salinity	1.6	2
N	1.6	3.4
Oxygen requirements	1.3	3.6
Saprobity	1.7	4.3
Trophic state	4.4	5.3

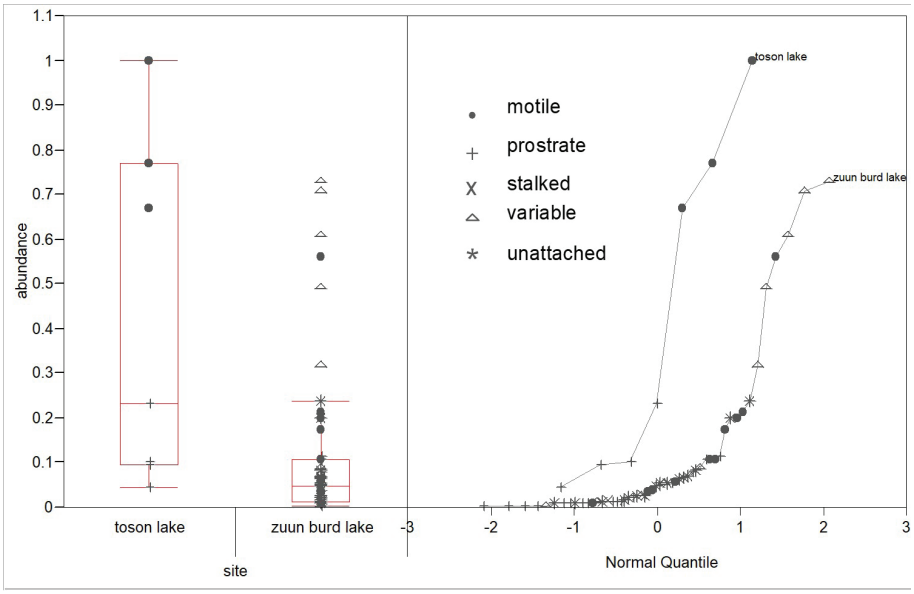

Fig. 3. Species abundance each growth form in lakes.

Discussion and conclusion. It was concluded that Avarga Toson Lake has a positive relationship with the impact of human activities or the number of passengers. In contrast, Zuun Burd Lake has a positive relationship with livestock grazing intensity in the area (Mandakh et al., 2020).

The diatom diversity index in Toson lake is lower than in Zuun burd lake; in contrast, Shannon's evenness is higher. The fact shows that Toson Lake has a micro-stability community dominated by a few species. Diatom communities are dissimilar in neighboring lakes caused by different human activities

under the same climate condition (Berthon et al., 2014). This result is just the same in our study. The number of species in the neighboring lakes is very different, and the results of the different species composition and Shannon evenness indicate that Toson Lake is vulnerable to exploitation and biodiversity is deteriorating. Although the relative abundance of riparian soil erosion indicator species is low in the lakes, it is estimated that the abundance of sediment accumulation indicator species is due to the increased micro-content of wind-blown soil. Zuun burd lake is polluted by livestock grazing or domestic pollution, and Toson Lake is polluted by human activities with high sediment accumulation at the bottom.

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