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CYANOPROCARYOTA OF TUBALSKYI ESTUARY (AZOV SEA BASIN)

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Information about species composition of Cyanoprocaryota representatives in the natural boundary of Tubalskyi Estuary within Pryazov National Natural Park is supplemented. Taxonomic structure of identified algae species is given, the data about occurrence of species in different habitats within national park is provided. We present a systematic structure and geographical affinity of discovered algae species. We registered 38 species of cyanoprocaryotic algae of orders: Chroococcales, Oscillatoriales and Nostocales with predominance of Oscillatoriales representatives in different habitats of Tubalskyi Estuary within the areas of Pryazov National Natural Park. The greatest number of algae species had genera *Lyngbya, Phormidium, Microcoleus Leptolyngbya* – 4 species per each genera. The majority of algae species were the cosmopolitans. *Microcoleus tenerrimus* was registered in all the studied plots of soil sampling and in the water reservoir of Tubalskyi Estuary. The most abundant and distributed species was *Lyngbya aestuarii*, which formed the macroscopic growths (cyanobacterial mats).
Key words: Cyanoprocaryota, algae, Tubalskyi Estuary, Northern Pryazovye, national park.

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Доповнені відомості видового складу представників відділу *Cyanoprokaryota* урочища Тубальський лиман в межах Приазовського національного природного парку. Наводиться систематична структура виявлених видів водоростей, надано дані щодо трапляння видів в різних біотопах урочища.
Ключові слова: Cyanoprocaryota, водорості, Тубальский лиман, Північне Приазов'я, національний парк.

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Дополнены сведения видового состава представителей отдела Cyanoprokaryota урочища Тубальський лиман в пределах Приазовского национального природного парка. Приводится систематическая структура выявленных видов водорослей, предоставлены данные по встречаемости видов в различных биотопах урочища.
Ключевые слова: Cyanoprocaryota, водоросли, Тубельский лиман, Северное Приазовье, национальный парк.

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North-Western territories of the Azov Sea shore have unique landscapes and high biodiversity is extremely valuable in the economical aspect and have great recreational potential. In 2010 by decree of President of Ukraine the environmental institution – Pryazov National Natural Park (hereinafter - PNNP) was established for the rational use and conservation of natural resources in this area (Chronicles…, 2012). One of the main objectives of environmental institutions (including PNPP) is to carry out the monitoring researches of natural ecosystems. The cyanoprocaryotic algae could be used as the convenient and reliable bioindicators of processes in ecosystems. The results of researches of algae from the North-Western territories of the Azov Sea shore were presented in several articles (Solonenko et al., 2006, 2008), but cyanoprocaryotic algae within the natural boundary of Tubalskyi Estuary are studied unevenly and should be updated by additional data.

Natural boundary of Tubalskyi Estuary is situated near the Village Prymorskyi Posad. Its' territories have a flat landscape and formed by the mouth of River Domuzla (Fig. 1). The maximum length of the tract - 4.15 km, maximum width - 2 km, altitude of slopes of the right bank - 9 m. The coordinates of extreme points: North - 46°37'5.93"N 35°42'11.27"E; South - 46°34'51.04"N 35°43'4.87"E; West - 46°36'18.83"N 35°40'49.32"E; East - 46°35'46.97"N 35°43'58.63"E. Water regime depends mainly on precipitation as well as river water, sea water infiltration, periodic flooding through the sand bar. The maximum length of water - 300 m, maximum width - 100 m, maximum depth - 25 cm. The water surface area greatly varies and depends on the season. The salinity of the water is 55-112 ‰; pH 6.1-6.4. Tubalskyi Estuary is included in the list of protected areas with a status of the wetland of regional importance.

The higher vegetation is presented here by plant communities with dominance of *Phragmites australis* (Cav.) Trin. ex Steud. and halophilic communities with dominance of *Salicornia europea* L., *Halocnemum strobilaceum* M. Bieb., *Salsola soda* L., *Suaeda altissima* (L.) Pall. There is a pond in the southern part of the natural boundary, and in the warmer months the *Potamogeton pectinatus* (L.) Börner develops powerful growths over there.

Figure 1. Map of sampling points

MATERIALS AND METHODS

The soil samples were carried out in the 2014-2015 on the four fixed sampling points in the natural boundary of Tubalskyi Estuary within the territory of PNNP (Pryazov district, Zaporizhzhya region), namely: steppe slopes, sandy soils, saline soils and in the reservoir. Samples were collected in spring, summer and autumn by the conventional phycology methods (Hollerbach, 1969; Topachevskyi, 1984). Totally, we sampled and processed 18 terrestrial samples and 9 water samples. The subsequent identification of algae was performed at the Department of Botany and Landscape Architecture in the laboratory of algal and ecological studies of the terrestrial and aquatic ecosystems in the Bogdan Chmelnitskiy Melitopol State Pedagogical University.

Collected material was processed using cultural methods: 1) soil culture with glasses of growth; 2) agaric Bold's nutrient media with normal and tripled quantity of nitrogen (1N BBM and 3N BBM, respectively) (Arce, 1958). Researches were held on by the light binocular microscope "MICROmed XS-5520" using 40^{x} and 100^{x} lenses. Identification was carried out by the identification guide of algae (Komárek, Anagnostidis, 1998; 2005). Analysis of the revealed algae species in relation to some geographical confinement was carried out according to Barinova (2006). Systematic list of the identified algae species was structured by system adopted in the monograph of I. Kostikov (2001) with additions and clarifications according to a check-list by Wasser (2000) and Tsarenko (2006).

RESULTS AND DISCUSSION

We identified 38 species of algae in the natural boundary of Tubalskyi Estuary. These species belongs to 3 orders, 12 families and 19 genera (Table. 1).

Table 1. Systematic structure of cyanoprocariotic algae, Tubalskyi Estuary

№	Taxon
Phylum	**Cyanoprocaryota**
Class	Cyanophyceae Sachs 1874
Order	Chroococcales Cavalier-Smith, 2002
Family	*Merismopediaceae* Elenkin 1933
Genus	*Synechocystis* Sauvageau 1892
1.	*Synechocystis salina* Wislouch 1924
2.	*Synechocystis crassa* Woronichin 1929
Genus	*Merismopedia* Meyen 1839
3.	*Merismopedia elegans* A. Braun in Kützing 1849
4.	*Merismopedia glauca* Kützing 1845
5.	*Merismopedia punctata* Meyen 1839
Family	*Microcystaceae* Elenkin 1933
Genus	*Microcystis* Kützing 1907
6.	*Microcystis pulverea* (Wood) Forti emend Elenkin 1933
Genus	*Chondrocystis* Lemmermann 1899
7.	*Chondrocystis sarcinoides* Komárek et Anagnostidis 1995
Family	*Chroococcaceae* Nägeli 1849
Genus	*Pseudocapsa* Ercegović 1925
8.	*Pseudocapsa sphaerica* Kováčik 1988
Family	*Entophysalidaceae* Geitler 1925
Genus	*Johannesbaptistia* De Toni 1934
9.	*Johannesbaptistia pellucida* Taylor et Drouet 1938
Family	Hyellaceae Borzi 1914
Genus	*Hyella* Bornet et Flahault 1886
10.	*Hyella caespitosa* Bornet et Flahault 1888
Order	Oscillatoriales *Elenkin 1934*
Family	*Oscillatoriaceae Engler 1898*
Genus	*Lyngbya Agardh 1892*
11.	*Lyngbya aestuarii* Liebman ex Gomont 1892
12.	*Lyngbya semiplena* J. Agardh ex Gomont 1892
13.	*Lyngbya salina* Kutzing ex Starmach 1966

№	Taxon
14.	*Lyngbya major* Meneghini 1892
Genus	*Oscillatoria* Vaucher 1892
15.	*Oscillatoria tenuis* Agardh ex Gomont 1892
16.	*Oscillatoria geminata* Meneghini 1892
Family	*Phormidiaceae* Anagnostidis et Komárek 1988
Genus	*Phormidium* Kützing 1892
17.	*Phormidium uncinatum* (Agardh) Gomont 1890
18.	*Phormidium autumnale* Gomont 1892
19.	*Phormidium paulsenianum* Boye-Petersen 1930
20.	*Phormidium takyricum* Novitschkova 1960
Genus	*Pseudophormidium* Anagnostidis et Komárek 1988
21.	*Pseudophormidium edaphicum* (Elenkin) Anagnostidis et Komárek 1988
Genus	*Microcoleus* Desmaziéres 1892
22.	*Microcoleus vaginatus* Gomont 1892
23.	*Microcoleus paludosus* (Kützing) Gomont 1892
24.	*Microcoleus tenerrimus* Gomont 1892
25.	*Microcoleus chthonoplastes* Thuret ex Gomont 1892
Genus	*Spirulina* Turpin ex Gomont 1892
26.	*Spirulina subsalsa* Oersted ex Gomont 1892
Family	*Plectonemataceae* Elenkin 1934
Genus	*Plectonema* Thuret 1892
27.	*Plectonema notatum* (Schmidle) Anagnostidis & Komárek 1988
Genus	*Symploca* Kützing 1892
28.	*Symploca elegans* Kützing 1892
Family	*Schizotrichaceae* Elenkin 1934
Genus	*Schizothrix* Kützing 1892
29.	*Schizothrix coriacea* Kützing ex Gomont 1892
30.	*Schizothrix friesii (*Agardh) Gomont 1892
31.	*Schizothrix lardacea* (Cesati) Gomont 1892
Family	*Pseudanabaenaceae* Anagnostidis et Komárek 1988
Genus	*Leptolyngbya* Anagnostidis et Komárek 1988
32.	*Leptolyngbya valderiana* (Gomont) Anagnostidis et Komárek 1988
33.	*Leptolyngbya halophila* (Hansgirg ex Gomont) Anagnostidis et Komárek 1988
34.	*Leptolyngbya boryana* (Gomont) Anagnostidis et Komárek 1988
35.	*Leptolyngbya notata* (Schmidle) Anagnostidis et Komárek 1988
Order	Nostocales Cavalier-Smith 2002
Family	*Nostocaceae* Eichler 1886
Genus	*Nostoc* Vaucher 1886
36.	*Nostoc punctiforme* (Kützing) Hariot 1891
37.	*Trichromus ellipsosporus* (Fritsch) Komárek et Anagnostidis 1989
Family	*Rivulariaceae* Kützing 1843
Genus	*Calothrix* Agardh 1886
38.	*Calothrix parietina* Thuret 1886

The greatest species diversity had order Oscilllatoriales (21 species) followed by *Phormidiaceae* – 10 species, *Lyngbya*, *Phormidium*, *Microcoleus Leptolyngbya* – 4 species. Such genera as *Merismopedia*, *Schizothrix* and *Synechocystis*. *Oscillatoria* were represented by 3 and 2 species respectively; other genera – by 1 species. According to literature data 19 identified algae species could be related to cosmopolitan (16) and Holarctic species (3). Among all studied habitats the largest number of cyanoprocaryotic algae (15 species) were found on the steppe slopes: *Leptolyngbya boryana, Lyngbya semiplena, Microcoleus paludosus, Microcoleus tenerrimus, Microcoleus vaginatus, Nostoc punctiforme, Oscillatoria*

tenuis, Phormidium uncinatum, Pseudophormidium edaphicum, Schizothrix coriacea, Schizothrix friesii, Schizothrix lardacea, Symploca elegans, Plectonema notatum, Trichromus ellipsosporus. Algae of the steppe slopes formed local greening-like macroscopic growths on the ground surface, which were observed in the lower parts of the slopes in the places of moisture accumulation. Also the great species variety was registered in saline soils (solonchak) and in the reservoir – 11 species per each habitat. In the salt marshes we founded such species as: *Leptolyngbya halophila, Leptolyngbya valderiana, Lyngbya major, Lyngbya aestuarii, Lyngbya salina, Lyngbya semiplena, Microcoleus chthonoplastes, Microcoleus tenerrimus, Phormidium paulsenianum, Phormidium takyricum, Schizothrix coriacea*. *Lyngbya aestuarii* was the only species which formed the dark-green solid slime of macroscopic growths.

We identified *Chondrocystis sarcinoides, Hyella caespitosa, Johannesbaptistia pellucida, Merismopedia punctata, Microcystis pulverea, Microcoleus chtonoplastes, Microcoleus tenerrimus, Pseudocapsa sphaerica, Synechocystis crassa, Synechocystis salina, Spirulina subsalsa* for the area of Tubalskyi Estuary whereas the characteristic algal water blooms were not observed in warm periods. The limited number of blue-green algae species were sampled in sandy soils: *Calothrix parietina, Leptolyngbya notata, Lyngbya semiplena, Merismopedia elegans, Merismopedia glauca, Oscillatoria tenuis, Oscillatoria geminata, Phormidium autumnale* where the algae did not form the massive growths during the research period. The most abundant and frequent species in all the habitats were *Microcoleus tenerrimus, Microcoleus chthonoplastes, Lyngbya semiplena, Schizothrix coriacea,* while *Microcoleus tenerrimus* was registered in all studied habitats of terrestrial and water zone of Tubalskyi Estuary area.

CONCLUSIONS

We registered 38 species of cyanoprocaryotic algae of orders: Chroococcales, Oscillatoriales and Nostocales with predominance of Oscillatoriales representatives in different habitats of Tubalskyi Estuary within the areas of Pryazov National Natural Park. The greatest number of algae species had genera *Lyngbya, Phormidium, Microcoleus Leptolyngbya* – 4 species per each genera. The majority of algae species were the cosmopolitans. *Microcoleus tenerrimus* was registered in all the studied plots of soil sampling and in the water reservoir of Tubalskyi Estuary. The most abundant and distributed species was *Lyngbya aestuarii*, which formed the macroscopic growths (cyanobacterial mats).

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