Results of the Study of Algae and Cyanobacteria in Various Ecotipes of Soils in Adjara, Georgia

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Abstract

The publication deals with the studies on the diversity of species composition of Algae and cyanobacteria in various layers of soils (yell, red, soilsod-podzolic, marsh, urban) of the Adjara. The aim of the study was to identify and determine the composition of Algae and cyanobacteria; Establishment of the scale of development and spread of algoflora; Assessment of the ecological state of the Algae and cyanobacteria in adverse and favorable conditions. The diversity of algae and cyanobacteria was studied in soil cultures using the method of fouling glasses. Each treatment included 5 ste-rile cover glasses for micropreparations; cultures were wetted with distilled water. The presence of algoflora was detected in various soil samples based on morphological characteristics, percentage frequency, growth rate, and colony forming units. The study has found 171 species and subspecies of soil Algae and cyanobacteria, belonging to the divisions of Ochrophyta (59 species), Chlorophyta (51 species), Xanthophyta (8 species), Eustigmatophyta (1 species) and Cyanobacteria (52 species). Classes Bacillariophyceae, Chlorophyceae, and Cyanophyceae were considered polymorphic among the leaders. 11 species of algoflora involved in algoflora of the consortium have been specified as well. The most widely distributed algoflora in soil samples were of the genera Chlamydomonas (20 species), Eunotia (17 species), Phormidium (11 species), Pinnularia (11 species), Tetracystis (10 species), Leptolyngbya (9 species), Nitzschia (9 species), Chlorococcum (8) species, Nostoc (7) species and Oscillatoria (6 species) were dominant flora in all soil samples. Frequency percentage algoflor showed that from all of the soil, the maximum quantities of algoflora and cianobacteria in marsh soil that was 65.49%, in sod - podzolic soil 34.51%, in yell soil 19.88, in red soil 18.71%, the lowest frequency of occurrence of algoflora and cianobacteria was shown in urban soil 9.35%. Due to seasonal changes in soil and air temperature, there are 71 species (41.52%) in spring, 65 (38.95%) in summer, 78 (45.61%) in autumn, and 53 (30.99%) in winter. A lower level of biological activity in the urban soils was found. Morphometric trait differences in test objects activated on the soil samples have been observed. The study was found specialized species of Algal-cyanobacterial communitiesfrom each ecotype of soil. The soil samples collected from polluted sites were more affected by waste water which affected the population densities of Algal-cyanobacterial communities. Found that Adjara support a large and diverse community of Algal-cyanobacterial on soil, many species of which are previously undiscovered and undescribed. On this basis, works of longer duration and more intensive sampling are needed to obtain data regarding Algal-cyanobacterial communities, with more attention to specific variables such as microclimate, soil moisture, soil type, soil pH and vegetation types.

Keywords: algae, cyanobacteria, ecotipes of soils, adjara, georgia

Introduction

Algae and cyanobacteria play an important role in all stages of soil development. At different stages, ecologically diverse group of algae participate in this processes. Some species are the best food products [1, 2]. Algae influence is seen most clearly at the initial stage of soil formation, ie during the colonization of an abiotic ground and the formation of a primary layer enriched in organic carbon on this mineral substrate. Almost to the present, this role has been ascribed to lichens. Autotrophic algae have an ability to produce and accumulate organic matter and, by doing so, stimulate the development of heterotrophic organisms. In the soil environment, they initiate biochemical processes that release nitrogen and phosphorus. Potassium, calcium, magnesium and other microelements are released from mineral substances [3, 4]. Algae are very significant to soil formation in arid and semiarid regions [4] and in moderate climate zones, both in natural and anthropogenic ecosystems [5,6]. Their participation in primitive soil formation, particularly in desert areas, was thoroughly explained in different works [7, 8]. As algae, lichens and lower plants form the basic biological set in arid areas, their importance and role in soil formation is better known in those environments than it is for soils in moderate climate zones, where higher plants are much more important [5, 6]. The term 'soil algae' includes the whole set of ecologically diverse groups such as (a) algae growing over the entire surface of soil and forming a crust, (b) algae living on moist soil surfaces and (c) algae occurring within the soil [9, 10]. Underground soil algae in arid habitats rarely occur as solitary organisms but are, more commonly, associated with fungi, lichens, club mosses and bryophytes forming continuous biological soil crusts [3, 9, 11].

The microscopic inhabitants of the urban soils are very responsive to the anthropogenic transformation of their properties, which affects the parameters of algal-cyanobacterial communities [12,13], as well as the diversity and composition of soil invertebrates [14] and microscopic fungi [15,16]. This determines the suitability of these groups of soil organisms as indicators of the state of urban soils [17].

The studies of algal-cyanobacterial communities performed in several regions [18,19,20,21,22,23]; and et al. Algae and cyanobacteria in the urban recreation zones and on the lawns near motor roads are best unders-tood [24].

In Adjara agoflora quite well studied in both small and large water bodies, as well as in forests soil [25,26]. As for other soils (red, soddy-podzolic, marsh, urban) of Georgia, they have not been studied at present.

Outcomes of this, the purpose of the study was in these soils to identify and determine the composition of Algae and yanobacteria; establishment of the scale of development and spread of Algae and cyanobacteria; assessment of the ecological state of the Algae and cyanobacteria in adverse and favorable conditions.

Materials and Methods

Objects of study

Objects of this study were soil algae and cyanobacteria. Soil sampling was conducted throughout the year - in spring, summer, autumn and winter - based on a pre-planned route.The samples were collected from the 31 points: Adjaria, Georgia, in the vicinity of Batumi Bense, Garadoki) 17 July 2014 and 13 September 2015, Shainidze and Lamparadze; Kobuleti (Cixisdziri, Chakvi, Cecxlauri, Alambari) 11 November 2014, 22 August 2015, 16 October 2016, 23-30 December 2017 and 17 October 2018, Beridze; Chelvachauri (Acharisckali, Akhalsheni, Chutuneti, Gonio, Kvariati, Mirveti, Sarfi), 11 August 2017, Chkubadze; Keda (Dandalo, Tshmorisi, Pirvelimaisi, Kvashta, Kokotauri) 10-16 July 2018, Shainidze; Xulo (Agara, Didachara, Khikhadziri, Sxalta, Oktomberi, Dioknisi, Danisparauli) and Shuakhevi (Samoleti, Zamleti), 20-27 August 2019, Lominadze and Shainidze.

Collections of the species have been examined by standard light microscopy (Pereval, Carl Zeiss, Jena and Olympus, BX50, Hamburg, Germany). The SEM micrographs have been prepared by means of a JSM-35 (Japan) SEM microscope. The specimens examined are deposited at HAL, KW and TGM [27].

Isotypus

LAB M F BSU (Laboratory Mikologi and Fitopatologi, Batumi Shota Rustaveli State University, Adjara, Georgia).

Sterilization technique

Petri plates, media bottles, distilled water, syringes were sterilized in the autoclave. For sterilization purpose, all apparatus was autoclaved for 30 minutes at 121°C. After autoclaving, all sterilized material was dried in an oven at 90°C.

Metod of study

The diversity of algae and cyanobacteria was studied in soil cultures using the method of fouling glasses, which was first proposed by Lund [28] for the identification of soil diatoms but later became one of the main methods of studying other groups of algae and cyanobacteria in the soil [29,30]. Each treatment included 5 ste-rile cover glasses for micropreparations; cultures were wetted with distilled water. The cultures were grown under daylight at 20˚C for a month, during which they were inspected five times. The species identification of diatom algae was performed in permanent preparations on the Elyashev medium using cover glasses ignited on a copper plate for 1.5 h. The species composition of algae and cyanobacteria was determined also using liquid cultures on the Bold medium [31]. The species composition of algae and cyanobacteria was identified using the conventional guides [32,33].

Data Analysis

The following biological parameters were determined in soil cultures: the compositions and relative abundances of algae, cyanobacteria, and nano- and microfauna. The ecological parameters of indicator diatoms were borrowed from the monograph by Barinova et al. [34]. The similarity of the species compositions of algal-cyanobacterial communities in soils of different land-use zones was assessed from the Jaccard coefficient calculated using the Equation:

$$Kj = c / (a+b-c) \quad (1)$$

where a and b denote the numbers of species on the first and second test plots, respectively, and c is the number of common species for the both plots [35].

Results and Discussions

The study has found 171 species and subspecies of soil Algae and cyanobacteria in Adjara (table 1), belonging to the divisions of Ochrophyta (59 species), Chlorophyta (51 species), Xanthophyta (8 species), Eustigmatophyta (1 species) and Cyanobacteria (52 species). Among classes, Bacillariophyceae is the clear leader, comprising 57 species and subspecies, and accounting for 33.33% of the total algoflora; Class Cyanophyceae contains 52 species (30.40%), Chlorophyceae 39 (22.80%). The rest of the classes contain unit species.

As Figure 1 shows, the dominant genus is Chlamydomonas (20 species, 11, 70), Eunotia (17 species, 9,94), Phormidium (11 species, 6,43), Pinnularia (11 species,6.43), Tetracystis (10 species, 5.85), Leptolyngbya (9 species,5.3), The rest of the genus contain unit species

Tab. 1. Systematical structure of algae and cianobacteria soil Adjara

Domain	Phylum	Class	Order	Family	Genus	Species
Eukaryota	Ochrophyta	Bacillariophyceae	Achnanthales	Cocconeidaceae	2	2
			Bacillariales	Bacillariaceae	2	8
			Cymbellales	Gomphonematacecae	1	3
				Cymbellaceae	1	2
			Eunotiales	Eunotiaceae	1	17
			Naviculales	Naviculaceae	1	6
				Neidiaceae	1	1
				Pleurosigmataceae	1	1
				Pinnulariaceae	1	11
				Stauroneidaceae	1	2
				Amphipleuraceae	1	1
			Aulacoseirales	Aulacoseiraceae	1	2
			Rophalodiales	Rophalodiaceae	1	1
			Thalassiophysales	Catenulaceae	1	1
		Fragilariophyceae	Fragilariales	Fragilariaceae	1	1
					19	59
	Chlorophyta	Zygnematophyceae	Zygnematales	Desmidiaceae	4	6
		Trebouxiophyceae	Prasiolales	Prasiolaceae	1	2
		Chlorophyceae	Chlamydomo-nadales	Chlorococcaceae	4 5	11
				Chlorosarcinaceae	1	1
				Oocystaceae	1	6
				Chlamydomonadaceae	1	20
			Microsporales	Microsporaceae	1	1
		Ulvophyceae	Ulotrichales	Ulotrichaceae	2	4
					15	51
	Xanthophyta	Xanthophyceae	Vaucheriales	Vaucheriaceae	1	2
			Tribonematales	Tribonemataceae	2	2
			Mischococcales	Characiopsidaceae	1	1
				Pleurochloridaceae	2	3
					6	8
	Eustigmatophyta	Eustigmatophyceae	Eustigmatales	Eustigmataceae	1	1
Prokaryota	Cyanobacteria	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	3	14
				Pseudanabaenaceae	1	1
				Phormidiaceae	1	11
			Nostocales	Nostocaceae	2	9
				Rivulariaceae	1	1
			Chroococcales	Miscrocystaceae	2	2
				Merismopediaceae	1	1
				Chroococcaceae	1	1
				Synechococcaceae	2	2
			Synechococcales	Leptolyngbyaceae	1	9
Total:	5 9	20 1034	51 23 124	38	15	52
					55	171

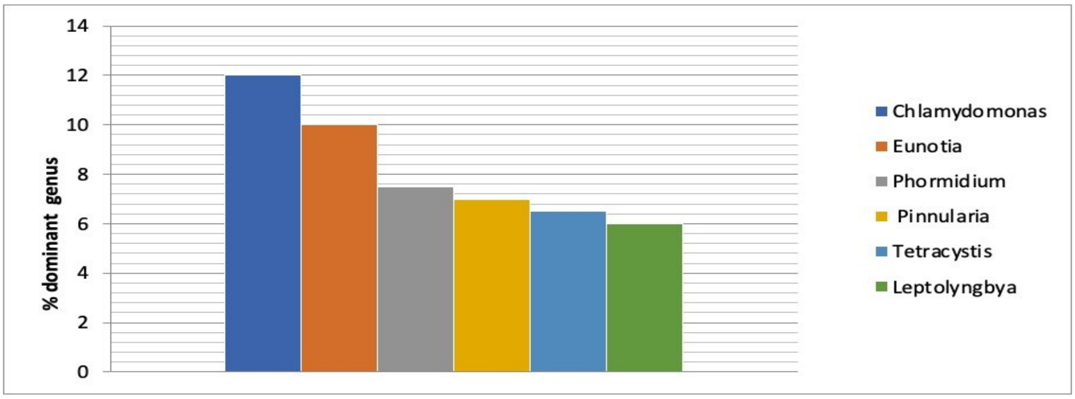

Fig. 1. Dominant genera of algae and cyanobacteria

Frequency percentage algoflor showed that from all of the soil, the maximum quantities of algoflora and cianobacteria in marsh soil that was 65.49%, in sod - podzolic soil 34.51%, in yell soil 19.88, in red soil 18.71%, the lowest frequency of occurrence of algoflora and cianobacteria was shown in urban soil 9.35% (Figure 2 and table 2). Such a large composition of algae and cianobacteria on Marsh soils is due to the fact that it is not contaminated with heavy metals, wastewater and et al. As a result of the study, specialized types of algoflora were found from each soil ecotype.

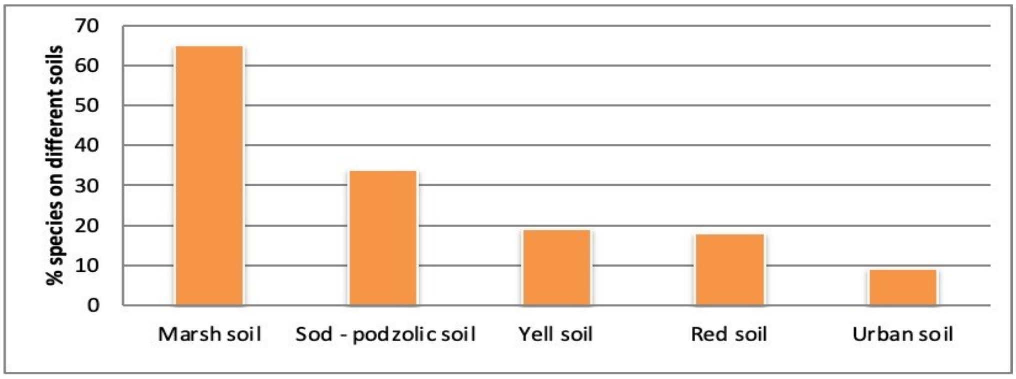

Fig. 2. Percentage distribution of algae and cianobacteri in different types of soil of Adjara

With a high frequency in the soils of the study region, there are: Botrydiopsis eriensis, Bracteacoccus aggregatus, B. minor, Bumilleriopsis terricola, Chlamydomonas actinochloris, Chlorella vulgaris var. vulgaris,Chlorococcum infusionum, C. lobatum, Coelastrella terrestris, Coenochloris signiensis, Cylindrocystis brebissonii, Elliptochloris bilobata, Eunotia fallax, Eustigmatos magnus, Hantzschia amphioxys, Klebsormidium accidum, Leptolyngbya foveolara, Leptosira terricola, Macrochloris dissecta, Microcoleus autumnalis, Mychonastes homosphaera, Myrmecia bisecta, M. incisa, Nitzschia palea, Nostoc commune, N. punctiforme, Phormidium ambiguum, P. corium, Pinnularia borealis, P. subcapitata, Pseudococcomyxa simplex, Scenedesmus rubescens, Scotiellopsis levicostata, Stichococcus bacillaris, S. minor, Spongiochloris excentric, Stenomitos frigidus, Stigonema minutum, S. ocellatum, Tetracystis aeria, Tolypothrix tenuis, and et al.

It was found that the Nostoc commune characterized by widespread among detected macroscopic species. Although it considered Nostoc lgae Arctic, sub-Arctic, steppes and savannas, so it is quite common in the subtropical zone of Adjara, especially on the surface of the inclined soil soaked with moisture. The strong growth of large, round slime colonies of Nostoc commune was observed in study area (Figure 3).

(a) (b) (c) (d)

Fig. 3. Nostoc commune on different types of soil: marsh soil (a), sod – podzolic (b), yell soil (c), red soil (d)

The studies have shown that consort algae inhabit on the colonial slime of Nostoc commune 11 species (Clorella moewusii, Ch. oblongella, Ch. vulgaris, Clorococcocus sp., Eunotia bigibba, E. tenella, Oscillatoria limnetica, Phormidium ambiguum, Ph. Corium, Ph. tenue, Spongiochloris excentric) are identified on this habitat in any periods of seasons.

In the present study a lower level of biological activity in the urban soils was found (total of 16 species were isolated: Achnanthes lanceolata, Caloneis aerophila, C. bacillum, Chlorococcum sp., Navicula atomus, N.minima, Nitzschia pusilla, Pinnularia lagerstedtii, Pseudococcomyxa simplex, Scenedesmus rubescens, Scotiellopsis levicostata, Spongiochloris excentric, Stichococcus bacillaris, Stenomitos frigidus, Stigonema minutum, Tetracystis aeria, because urban soils are contaminated of heavy metals and sources are automobiles exhaust, sewage water, industrial aste, Batumi oil terminal et al. Similar results were received by almost in yell, red and sod-podzolic soils that were receiving wastewater of Kintrishi and Chakvis ckali for several years. Practically similar results were obtained by various researchers [19, 27, 28, 29, 43].

Wastewater is often the only source of water for irrigation in these areas. The reality is that wastewater generated in Adjara receives no treatment at all. The use of wastewater for irrigation may affect the whole biological community, including species diversity and accumulation of toxic contaminates in the food chain.

Table 2. The distribution of algae and cianobacteria in different soil types Adjara

Species	Soil type				
	Marsh soil	**Sod–podzolic soil**	**Yell soil**	**Red soil**	**Urban soil**
Achnanthes lanceolata	+	+	+	+	+
Achnanthidium kryophila	+	-	-	-	-
Amphipleura pellucida	+	-	-	-	-
Aulacoseira distans	-	-	+	+	-
A. italica	+	-	+	-	-
Botrydiopsis eriensis	+	-	-	-	-
Bracteacoccus aggregates	+	-	-	-	-
B. minor	+	-	-	-	-
Bumilleriopsis terricola	+	-	-	-	-
Caloneis aerophila	+	+	+	+	+
C. bacillum	+	+	+	+	+
C. truncatula	-	-	+	-	-
C. undulata	+	-	-	-	-
Chamaepinnularia begeri	-	+	-	-	-
C. soehrensis	+	-	+	-	-
Chlamydomonas actinochloris	+	-	-	+	-
Ch. callunae	+	-	-	-	-
Ch. cf. culleus	-	-	+	-	-
Ch. debaryana var. atactogama	-	-	-	+	-
Ch. elliptica	+	-	-	-	-
Ch. globosa	+	-	-	-	-
Ch. gloeogama	-	+	-	-	-
Ch. gloeophila	-	+	-	-	-
Ch. incerta	+	-	-	-	-
Ch. intermedia	+	-	-	-	-
Ch. isogama	-	-	-	+	-
Ch. kakosmos	-	+	-	-	-
Ch. lobulata	-	+	-	-	-
Ch. macroplastida	-	-	+	-	-
Ch. macrostellata	+	-	-	-	-
Ch. minutissima	+	-	-	-	-
Ch. moewusii	-	+	-	-	-
Ch. oblongella	+	-	-	-	-
Ch. perpusilla	+	-	-	-	-
Ch. peter	-	-	+	-	-
Chlorella vulgaris var. vulgaris	+	-	-	-	-

Table 2. Continue

Species	Soil type				
	Marsh soil	**Sod–podzolic soil**	**Yell soil**	**Red soil**	**Urban soil**
Chlorococcum ellipsoideum	-	-	-	+	-
C. infusionum	+	-	-	-	-
C. minimum	-	+	-	-	-
C. lobatum	-	+	-	-	-
C. oleofaciens	+	-	-	-	-
C. schizochlamys	+	-	-	-	-
C. vacuolatum	+	-	-	-	-
Chlorococcum sp.	+	+	+	+	+
Coelastrella terrestris	+	-	-	-	-
Coenochloris signiensis	+	-	-	-	-
Cocconeis placentula	-	+	-	-	-
Cocooneis placentula	+	-	-	-	-
Cymbella heteropleura	-	-	+	-	-
C. ventricosa	-	+	-	-	-
Cymbella sp.	-	+	-	+	-
Cymbopleura naviculiformis	+	-	-	-	-
Chlamydocapsa lobata	-	+	-	-	-
Cymbella parva	-	+	-	-	-
Cylindrocystis brebissonii	+	-	-	-	-
Diatoma mesodon	+	-	-	-	-
Didymosphenia geminata	+	-	-	-	-
Encyonema gracile	-	+	-	+	-
Elliptochloris bilobata	+	-	-	-	-
Epithemia turgid var. westermannii	+	-	-	-	-
Epithemia sp.	-	+	-	-	-
Eunotia bidens	+	-	-	-	-
E. bigibba	+	-	-	-	-
E. bilunaris	-	+	-	-	-
E. diodon	+	-	-	-	-
E. exigua	+	-	-	-	-
E. faba	+	-	-	-	-
E. fallax	+	-	-	-	-
E. incisa	-	+	-	-	-
E. intermedia	+	-	-	-	-
E. lunaris	-	+	-	-	-
E. parallela	+	-	-	-	-
E. praerupta	+	-	-	-	-
E. revoluta	-	-	+	-	-
E. septentrionalis	-	+	-	+	-
E. tenella	-	+	-	-	-
E. trinacria	+	-	-	-	-
E. valida	-	+	-	-	-
Eustigmatos magnus	+	-	-	-	-
Gyrosigma acuminatum	-	+	-	-	-
Hantzschia amphioxys	+	-	-	-	-
Hantzschia virgara	-	-	-	+	-
Klebsormidium accidum	+	-	-	-	-
Leptolyngbya angustissima	-	+	-	-	-
L. boryana	+	-	-	-	-
L. foveolara	-	-	-	+	-

Table 2. Continue

Species	Soil type				
	Marsh soil	Sod–podzolic soil	Yell soil	Red soil	Urban soil
L. gracillima	+	-	-	-	-
L. komarovii	+	-	-	-	-
L. nostocorum	-	+	-	-	-
L. tenuis	+	-	-	-	-
L. valderiana	+	-	-	-	-
Leptolyngbya sp.	-	-	+	-	-
Leptosira terricola	-	-	-	+	-
Macrochloris dissecta	-	-	-	+	-
Microcoleus autumnalis	-	+	-	-	-
Mychonastes homosphaera	+	-	-	-	-
Myrmecia bisecta	+	-	-	-	-
M. incisa	+	-	-	-	-
Navicula atomus	+	+	+	+	+
Navicula binodis	+	-	-	-	-
Navicula elongata	-	-	-	+	-
Navicula minima	+	+	+	+	+
Navicula mutica	+	-	-	-	-
Navicula veneta	-	+	+	-	-
Neidium iridis	-	-	+	+	-
Nitzschia acicularis	+	-	-	-	-
N. angustata	-	-	-	-	-
N. dissipata	+	-	-	-	-
N. fonticola	-	+	+	-	-
N. frustulum	+	-	-	-	-
N. gracilis	+	-	-	-	-
N.palea	-	-	-	+	-
N. pusilla	+	+	+	+	+
N. vitrea	-	+	-	-	-
Nostoc calcicola	+	-	-	-	-
N. commune	+	-	+	-	-
N. edaphicum	+	-	-	-	+
N. linckia	+	-	-	-	-
N. microscopicum	-	+	-	-	-
N. paludosum	+	-	-	-	-
N. punctiforme	+	-	-	-	-
Oscillatoria komarovii	-	+	-	-	-
O. limosa	+	-	-	-	-
O. spirulinoides	+	-	-	-	-
O. tenuis	+	-	-	-	-
O. tenuis f. *uralensi*	-	+	-	-	-
O. terebriformis	-	+	-	-	-
Parietochloris alveolaris,	+	-	-	-	-
Pinnularia appendiculata	+	-	-	-	-
P. borealis	+	-	-	-	-
P. brauniana	-	+	+	+	-
P. brevicostata	+	-	-	-	-
P. innularia	+	-	-	-	-

Table 2. Continue

Species	Soil type				
	Marsh soil	Sod–podzolic soil	Yell soil	Red soil	Urban soil
P. lagerstedtii	+	-	-	-	-
P. rabenhorstii	+	+	+	+	+
P. rangoonensis	-	+	-	-	-
P. subcapitata	-	+	+	-	-
P. sublinearis	-	+	-	-	-
P. viridis	+	-	-	-	-
Phormidium ambiguum	+	-	-	-	-
Ph. corium	+	-	-	-	-
Ph. deflexoides	-	+	-	-	-
Ph. dimorphum	+	-	-	-	-
Ph. favosum	+	-	+	-	-
Ph. henningsii	-	+	-	-	-
Ph. interruptum	+	-	-	-	-
Ph. puteale	-	+	-	-	-
Ph. retzii	-	+	+	-	-
Ph. uncinatum	+	-	-	-	-
Ph. woronichinianum	+	-	-	-	-
Pseudococcomyxa simplex	+	-	-	-	-
Scenedesmus rubescens	+	+	+	+	+
Scotiellopsis levicostata	+	+	+	+	+
Spongiochloris excentric	+	+	+	+	+
Stauroneis anceps	+	+	+	+	+
Stauroneis linearis	+	-	-	-	-
Stauroneis phoenicenteron	+	-	-	-	-
Stichococcus bacillaris	+	-	-	-	-
S. minor	+	+	+	+	+
Stenomitos frigidus	+	-	-	-	-
Stigonema minutum	+	+	+	+	+
S. ocellatum	+	+	+	+	+
Tetracystis aeria	+	-	-	-	-
T. aggregata	+	+	+	+	+
T. compacta	+	-	-	-	-
T. dissociata	+	-	-	-	-
T. excentrica	-	+	-	-	-
T. isobilateralis	+	-	-	-	-
T. pampae	+	-	-	-	-
T. pulchra	-	+	-	-	-
T. tetraspora	+	-	-	-	-
Tetracystis spp.	+	-	-	-	-
Tolypothrix tenuis	-	+	-	-	-
Total:171	112 (65.49%)	59 (34.51%)	34(19,88%)	32(18.71%)	16(9.36%)

From the collected soil samples, the occurrence of species in different samples soil is shown in Table 2 (presence"+" and absence"–").

At some observation points, an increase in air and soil temperature, a decrease in humidity and fertility, a decrease in the number of soil algae due to seasonal precipitation, erosion were detected. Conversely, an increase in organic and mineral matter is explained by an increase in the number of soil algae in irrigation and the transfer of algae from groundwater to the soil. Due to seasonal changes in soil and air temperature,there are 71 species (41.52%) in spring, 65 (38.95%) in summer, 78 (45.61%) in autumn, and 53 (30.99%) in winter.

Conclusion

The study has found 171 species taxa of soil algae and cianobacteria, belonging to the divisions of Ochrophyta (59 species), Chlorophyta (51 species), Xanthophyta (8 species), Eustigmatophyta (1 species) and Cyanobacteria (52 species). Classes Bacillariophyceae, Chlorophyceae, and Cyanophyceae were considered polymorphic among the leaders. 11 species of algoflora involved in algoflora of the consortium have been specified as well.

The most widely distributed algoflora in soil samples were of the genera Chlamydomonas (20 species), Eunotia (17 species), Phormidium (11 species), Pinnularia (11 species), Tetracystis (10 species), Leptolyngbya (9 species), Nitzschia (9 species), Chlorococcum (8) species, Nostoc (7) species and Oscillatoria (6 species) were dominant flora in all soil samples.

Frequency percentage algoflor showed that from all of the soil, the maximum quantities of algoflora and cianobacteria in marsh soil that was 52.04%, in sod - podzolic soil 19.88%, in yell soil 18.71, in red soil 18.12%, the lowest frequency of occurrence of algoflora and cianobacteria was shown in urban soil 9.35%.

Due to seasonal changes in soil and air temperature,there are 71 species (41.52%) in spring, 65 (38.95%) in summer, 78 (45.61%) in autumn, and 53 (30.99%) in winter.

The soil samples collected from polluted sites were more affected by wastewater which affected the population densities of algae and cianobacteria.

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