Research of cyanobacterial complexes in Krasnoyarsk in the context of creation of a complex of actions for ecological engineering

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Abstract. The research is devoted to studying of cyanobacterial complexes in Krasnoyarsk and their influence on an ecosystem. For the first time in Siberia a specific variety of soil algae while using different options of fertilizers in greenhouse facility is studied. The taxonomical structure of the studied algal flora includes 4 species, however the obtained data quite are agreed with available in literature. In total within the region 238 species and intraspecific algae of taxons are revealed. In a floristic range of all soil algae studied algaosinuziyas a ratio on departments is as follows: Cyanophyta - 40.4%, Chlorophyta - 39.7%, Xanthophyta - 14.1%, Bacillariophyta of - 5.8%. The greatest role in forming of algaeosinuziyas belongs to representatives of cyanoprokaryotes and green algae, and on undisturbed areas presence of flavovirent algae species is noted.

The highest manifestation of interconditionality in collateral development of organisms is formation of the communities representing a certain ecological unity. Communities of the phototrophic microorganisms were the first to be created on Earth; however, degree of their study considerably lags behind that for macrophytes. Microbial consortia are very specific as the biosphere approved variety of biotic communications in them. Cyanoprokaryotes – a special group of organisms which for a long time was considered as one of soil algae departments. Representatives of cyanobacteria are present at any ecosystems, studying them is important for assessment of biodiversity and identification of regularities of formation of algal flora of land communities. Being producers of oxygen and organic matters and being in the beginning of trophic chains, cyanoprokaryotes act as a key link of the algalbakterial cenoses including anthropogenically transformed.

Now urban ecosystems are a significant component of the biosphere and represent a set of factors capable to influence negatively on all components of a biota. Estimating an environment condition for the recreational territories located within the city the significant change in parameters of soils because of pollution by household garbage, trampling, oil spill, burning out is noted. Specific structure of the autotrophic microorganisms participating in addition of a herbage cover of urban ecosystems
sensitively reacts to anthropogenic influence, and their reactions to recreational loading are suitable for
assessment and the forecast of a condition of city agglomerations.

The urban environment represents a set of factors which often negatively influence on both a biota
in general and on human health in particular. Pollution by household garbage, consolidation of soil, a
spill of fuel liquids, burning off high soil layers, regular excavation is characteristic of recreation areas
(recreational zones) located within the city. In this regard the research of reaction of soil algal flora to
recreational loading for assessment, the forecast of a condition of city agglomerations and creation of a
complex of actions for ecological engineering is relevant.

Algal flora of soils of recreational zones of Krasnoyarsk is little studied. At the same time all range
of floristic, taxonomical and ecological researches will allow to reveal specific reactions of soil algal
flora to recreational loading of various degree.

The main goal of the presented research is studying of specific structure and dynamics of a number
of soil algae, identification and assessment of their reaction to recreational load.

Microscopic cyanoprokaryotes and soil algae are similar to the higher plants in reaction to a
condition of soil and in influence on heterotrophic organisms that allows extrapolating the obtained
data to the higher plants, and the algological method and its versions can be used where it is
inapplicable vegetative [1]. Usage of soil algae as bioindicators differs in simplicity and low cost.
They are rather easily identified to a species that allows comparing the results of biotesting received in
various regions.

In the conditions of recreation cyanoprokaryotes and algae play an important role in maintaining
stability of the woods, part in creation of primary products [2]. The structure of natural biocenosis
includes representatives of various trophic levels, including autotrophs: the higher plants, eukaryotic
and prokaryotic algae. In nature, where dominance of organisms- photosynthetics is noted, there are
processes of clarification of water and the soil, the microclimate favoring for existence of heterotrophs
is formed, and the conditions necessary for life support of the person are created. Therefore, in recent
years increasing attention is paid to researching the role of phototrophic microorganisms as factors of
environment protection against anthropogenic pollution.

In work of N V Sukhanova [3] features of distribution of diatomic algae in the green space are
considered. Specific structure and abundance of types of diatomic algae in parks considerably depend
on the nature of herbal community and compactness of the soil. On heavily trodden areas (footpaths)
the total abundance of types in tests is reduced almost by half, it is bound to trampling of a grass cover
that leads in the present climatic conditions to moisture evaporation from the soil surface, to decrease
doing in Floristic wealth and decrease of intensity of development. In turn, algocenoses of coniferous forests
are characterized by poverty of a specific variety and low in number of cells. According to the floristic
variety green and yellow-green algae prevail, blue-green and diatomic algae develop much more weakly. It is explained by biochemical and ecological properties of soils of coniferous forests.

Recreational load involves changes of space cenotic organization of soil algae: change of algal
dominant with inclusion in the dominating complex of blue-green and green algae ubiquists is found,
there is a decrease of a species variety and strengthening of adaptation of algae to "the interdependent
existence" at the expense of a stressful factor, but not as a result of a environmental role of algae-
dominants.

M F Dorokhova [4] in her work on studying soil algae as indicators of soils condition in areas of oil
production notes that studying of a microbiota in soils showed that algae most sensitively react to
anthropogenic changes of soils and ground. It defines prospects of algaindication of soils condition
and soils in areas of oil production. Specifics of technology of production and petroleum composition
define a circle of the environmental problems, the characteristic of regions of oil fields.

As soil algae, being the integral component of herbal communities, sensitively react to
characteristics of a surrounding medium, changing the qualitative and quantitative characteristics,
studying their reaction to these or those factors, it is possible to draw conclusions on an ecological
condition of soils.
Significant characteristic of alga groups is the ratio in it of the types which refer to different departments – a systematic range. To each type of an ecosystem corresponds a particular systematic range of algal flora. For an alga indication it is possible to use change of structure of vital forms of soil algae. E A Shtina [5] allocated main responses of algal flora to sudden changes of soil conditions:

- depressing and loss of some groups of algae;
- complete replacement of some groups with others;
- total disappearance of algae.

Soil algae are bioindicators that have according to R.R. Kabirov the following set of features:

- algae used as indicator have to be easily identified, have high sensitivity to the being studied factor;
- complex of indicator species has to include representatives of four main departments of soil algae; indicator species have to refer to widespread soil algae;
- it is desirable for them to be a part of dominants or subdominants whose change demonstrates radical reorganization of all community of algae.

L I Domracheva and L V Kondakova (2006) generalized the following axioms of a soil algology allowing using algae in environmental monitoring including indication and testing of the polluted soils:

- Algal flora is characteristic of any types of soils.
- These products are created by dozens of species of representatives of Chlorophyta, Xanthophyta, Bacillariophyta, Cyanophyta which normally surely form a serial number of algocenosis during a seasonal succession with the mobile change of dominant.
- The intra soil pool of algae is a matrix basis for formation of land algocenosis in which there are species of the relations similar to phytocenotic.
- In natural uncontaminated cenosis there are constant repeating from year to year algocycles: intra daily, inter daily and yearly the reasons for which are various: temperature variations, humidity variations, algofag activity.
- For algal flora, as well as in case of bacterial population, there is an excess pool – the "dozing" species whose activity wakens only at radical change of conditions.

Thus, algal flora acts as one of radical elements of a biological component of soil, more independent in its development in comparison with bacteria and fungi at the expense of photolithotrophy of all algae and nitrogen fixation. For city soils we suggest to divide nominally all range of researches into two sections: soil algae reaction test to various pollution and studying of a condition of algal flora of the soils subjected to recreational load.

Flora in city boundaries and its suburbs differs depending on river banks: the left bank of the Yenisei - a typical forest-steppe, and the right bank – a marked mountain taiga. The city is surrounded by forests. In a soil cover the prevailing distribution is occupied by the black soils presented by three subtypes: ordinary; lixivious; podsolized. Apart from black soils there are gray forests, inundated, meadow-black soils and etc.

Large mesoclimatic areas are allocated considering the influence of such factors as area topography, existence of large water objects, location of industrial enterprises, gardening status affecting city climate formation several. Zoning is carried out on the basis of the existing meteorological stations, microclimatic observations and expeditions. It allowed to gain an idea about temperature differences and air humidity in the city during daytime.
During the work for the experimental areas geobotanical descriptions were made and definition of physical and chemical indexes of soils was carried out, along with sampling soil temperature and humidity were defined. All studied areas are characterized by various degree of recreational load, heavy pollution by household garbage and poor vegetation cover. Herbal communities of experimental grounds represent typical for urban ecosystems herbal associations: low specific variety, homogeneity of species composition, prevalence of grassy forms.

Researches were conducted according to the practical standards of E A Shtina. Research methods of algae in the soil are distributed into three groups, according to stages:

- sample soil collection;
- soil algae species identification (qualitative research);
- quantitative algae record.

Alongside with collecting soil tests air temperature and atmospheric precipitation data were registered.

When identifying algae species different options of culture method were used: water cultures and cultures on glasses of growth. For water cultures Gromov's medium and Bristol medium in Gollerbach's modification were used. At formulation of cultures of soil algae standard methods of microbiological technique were used.

For identification of algae cytochemical reactions to amylin – by Lugol solution, on general mucilage outline– by 1% ink solution, on structural mucilage – by 0.1% solution of methylene blue were carried out.

During identification of a systematic range of algal flora the morphological, reproductive and cultural features, specific for each population were analyzed.

Results of identification were fixed by original drawings and microphotographs and also complemented with descriptions of the characteristics of diagnostic value.

Algal groups are presented in systematic list in the following order: Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta.

For all sample areas plant-sociological evaluation of herbal cover which included definition of the following indexes was carried out: total number of species of vascular plants, identification of the leading families, establishing of synanthropic species rate. Besides that projective coverage level (%), footpath structure and also biomorphological features of herbage were considered. In the selected samples granulometric size composition, density and humidity of soils were defined; calcareousness; gypsum bearing; pH water and salt extracts; exchangeable base status; carbon percentage; gross nitrogen content.

Evaluation criteria included: layer condition, projective coverage volume, ruderal species rate, expressiveness of footpath structure. Such indexes as herbage height and biomass volume were excluded in connection with regular haying, removal and cleaning of the territory on the majority of the analyzed areas.

On the basis of literary data and personal researches [6] five categories of ground cover disturbance are marked:

- undisturbed – layer and soil aren't disturbed, the projective coverage of grass cover is more than 60%, ruderal species are absent, the footpath structure isn't expressed;
- weekly disturbed – in a layer and soil there are signs of disturbances, a projective coverage of a ground cover up to 40%, weed species are singly present in the composition of herbage, the area of footpaths doesn't exceed 10%;
- average disturbed – the layer isn't disturbed, the soil is firmed, weed species rate in the composition of herbage increases up to 10%, the projective coverage decreases up to 30%, the area of footpaths is 20-30%;
badly disturbed – the layer is absent, the soil is firmed, for herbage signs of prairiefication are specific, a projective coverage of a ground cover of 10-15%, ruderal species dominate, the area of footpath structure reaches 50-60%;

degraded – are characterized by heavy density of soil and total absence of a layer and ground cover.

This scale of communities’ disturbance was changed by us before usage because besides geobotanical criteria for characteristics of recreational load we considered density and hydrophysical properties of soils of the analyzed platforms.

The reliability of the data obtained during the researches was checked by methods of mathematical statistics. Methods of multidimensional statistics: regression analysis, method of correlation pleiades, cluster analysis were used as additional methods of interpretation of the factual material.

Grassy associations of experimental grounds of Krasnoyarsk city are characterized by low specific variety, homogeneity of specific structure [7, 8]. In total for soils of recreational zones of Krasnoyarsk 156 species and intraspecific taxons of the soil algae which fall into 4 groups, 19 orders, 35 families and 58 genera are revealed.

In all communities the greatest representation of species is revealed for Cyanoprocaryota and Chlorophyta. The taxonomical structure of the studied algal flora has the following format: Cyanoprocaryota 40.4%, Chlorophyta 39.7%, Xanthophyta 14.1%, Bacilla-riophyta 5.8%.

Analysis of specific saturation of taxons of all studied areas revealed domination in a range of the leading families: Nostocaceae (19.2% of total number of types), Phormidiaceae (15.9%), Oscillatoriaceae (14.3%). Among soil algae found in recreations of Krasnoyarsk by high degree of specific saturation have p.p. Nostoc – 15 species (9.6% of total number of species), Anabaena – 11 species (7%), Oscillatoria and Phormidium – 9 species (5.8%) [8].

As a result of the researches recommendations about realization of ecological engineering were formulated.

Soil-algalogical researches in the territory of the Krasnoyarsk urban ecosystem are recommended to be conducted in August-September, as in the period of the richest representation of soil algal flora.

When identifying dominating types of algae, it is expedient to focus attention on results of direct microscopy of soil exemplars.

To determine the degree of recreational disturbance of urban ecosystems we offer V D Perevoznikova and O N Zubareva's modified scale with division into four categories [9]:

- low degree of a disturbance – in the surface soil there are marks of disturbance (campfire); in the herbage there are ruderal species – up to 20% (area near Vetluzhanka);
- average degree of disturbance – sod is well developed; the soil is firmed; there are marks of disturbances; synanthropic plants rate isn’t above 40%, herbage closed (Gvardeyskiy Park, DK 1May Park, Akademgorodok);
- high degree of disturbance – soil is heavily firmed, contains anthropogenic inclusions (crushed stone, glass, household garbage); ruderal plants rate reaches 40%; herbage cover unclosed, groundling herbs, squat plants (square "Circus");
- degradation degree – soil is heavily firmed; low specific variety with ruderal species domination (up to 60%) (Square n.a. Surikov).

The leading families for algasinuziya of the Krasnoyarsk urban ecosystem are Nostocaceae, Chlorococcaceae, Chlamydomonadaceae, Phormidiaceae, Oscillatoriaceae; leading genera: Nostoc, Anabaena, Oscillatoria and Phormidium, Chlorococcum, Chlamydomonas and Chlorosarcinopsis.

Change of ecological groups occurs during the vegetative period: explerents dominate during the spring- and -summer period, patiyents dominate in early autumn.

Number level of soil algae is mostly defined by soil humidity and temperature and is expressed by the nonlinear regression dependence which is characterized by low coefficient values of correlation.
The greatest influence of these ecological factors on the number of soil algae is manifested in areas subject to recreational load of low and average degree while in areas with high degree of recreational load the limiting effect is exerted by the press of anthropogenic factors.

Thus, the complex of the species sensitive to anthropogenic influences and the species-tolerants adapted to life under anthropogenic stress was identified. Change of the dominating complexes occurs with an increase in the degree of recreational load. Method of correlation pleiades using a ranged series of orders of soil algae allows to estimate most objective influence of various degree of recreational load on the taxonomic structure of algosinuziyas.

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