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STUDY OF SOIL FUNGI IN THE TERRITORY OF KAPAN CITY AND ITS SURROUNDING

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During the studies of micromycetes-decomposers of Kapan City and its surrounding, 32 species of fungi were detected, 8 of which belong to Zygomycetes and 24 belong to Ascomycetes classes. In the studied soils there were widespread species of genus *Penicillium* (9), *Aspergillus* (8) and representatives of mucoral fungi (8 species).

***Keywords*:** soil fungi, micromycetes, dilution method, contaminated territory.

Introduction. Fungi are very important organisms in terrestrial ecosystem function. Micromycetes-decomposers, which are found in the soil, in a large number, and diverse species are active components of biogenocenosis.

The negative impact on the environment of Armenia is extended by air emission of a number of industrial enterprises, the technological processes of which where developed out of the view of their conservation. As a result, various toxic chemicals settle on the soil. The mycelium of soil fungi absorbs nutrients from the roots it has colonized, surface organic matter or from the soil.

From this point of view, it is of great interest to conduct mycological analysis of soils on the territories or surroundings of industrial factories with the aim of studying the effect of industrial wastes and emissions on the changes of the soil mycobiota. The species composition characterizes the degree of anthropogenic disturbance in polluted environmental conditions.

Studies of soil fungi in Armenia were conducted from 1961 by J.H. Abrahamyan. She investigated micromycetes in the contaminated soil near factories, industrial enterprises and other places in some regions of Armenia: Kirovakan, Hrazdan, Hoktemberyan Cities [1].

We started mycological studies of the soil fungi in Kapan City and its surrounding territories in 2017.

Materials and Methods. In studied areas of Kapan City meet subtype carbonate mountain cambisol.

This type of soils is generally characterized by: differentiation of genetic horizons; brown tint of humus accumulating horizon; the slight cloddy-granular

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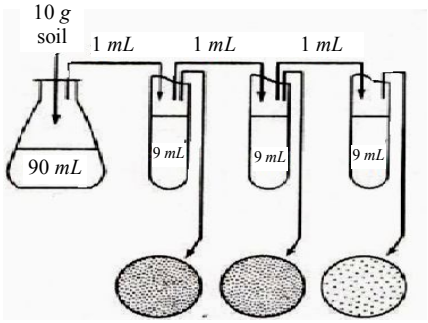
structure of the upper horizon; more coarse granular structure of intermediate horizon; clayiness of intermediate horizon; clayey and loamy mechanical structure; mean humus content; high absorbing properties.

Among the mountain brown forest soils the decalcified, typic and carbonate subtypes are distinguished which in turn also have some variations. The decalcified mountain brown forest soils are formed basically in higher regions, on northern and northwestern slopes of mountains. The carbonate mountain brown forest soils are formed in comparatively lower regions of this zone, on southern and southeastern slopes. The typic mountain brown forest soils occupy intermediate position between the carbonate and decalcified subtypes by their geographical location as well as by morphological and physicochemical characteristics [2].

For mycological research samples of soil were taken from different points of the indicated territory. All the important notes were made after taking the sample (date, location and depth, horizon of the soil, etc.).

For mycological preliminary analysis of micromycetes the dilution method was used (see Figure), which is based on the use of water-soil suspension and its transposition on the agar medium [3].



Scheme of inoculation.

For suspension breeding preparation 10 g of crushed soil was added to 90 *mL* of water, then the mixture was diluted with distilled water with correlation of 1:100, 1:1000, 1:10 000. Afterwards, 1 *mL* of suspension at different dilutions was poured into a Petri plate, where the agar medium was placed (pH 4.5 to prevent the growth of bacteria). The cultivation of fungi was carried out at temperature 23–25°*C*. Cultivation duration was from 4 to 14 days [4].

For determining micromycetes we used binocular magnifying MBS-9, and digital microscope ML-300 VWR. Some fungi images were made by digital microscope and computer software. Identification of soil microscopic fungi was done by using the following determinants: N.M. Pidoplichko [5]; N.M. Pidoplichko, A.A. Milko [6]; M.A. Litvinov [7]; V.I. Bilai, E.Z.Koval [8]; E.Z.Koval, A.V. Rudenko et al. [9].

The soils samples were taken near the territory of Kapan MPC and its surroundings.

From the surface (0–20 *cm*) and from the depth of the soil (25–70 *cm*) 12 samples were taken, 11 of which from the contaminated zones (Geghanush tailings) and 1 – as a control (depth 0–20 *cm*), at a distance of 1 *km* from the tailing dump.

Results and Discussion. As a result of soil investigation, 32 species of fungi were detected, 8 of wich belong to Mucoromycota (Zygomycota), and 24 belong to the Ascomycota classes (Tab. 1). Systematics is given according to modern classification [10, 11].

Exploration of clean and contaminated soil samples showed a number of changes in the species composition of soil micromycetes. The data on the ratio of the number of species of dominant micromycetes showed, that in the studied soils

there are widespread species of genus *Penicillium* (9), *Aspergillus* (8) and representatives of mucoral fungi (8 species).

Table 1

Species composition of detected micromycetes by taxonomical groups

Taxon of fungi	
Mucoromycota (Syn.: Zygomycota)	Ascomycota
1. *Absidia coerulea*	1. *Aspergillus pulverulentus*
2. *Absidia ramosa*	2. *Aspergillus niger*
3. *Mortierella sclerotiella*	3. *Aspergillus crystallinus*
4. *Mortierella stylospora*	4. *Aspergillus flavus*
5. *Mucor lausannensis*	5. *Aspergillus ochraceus*
6. *Mucor piriformis*	6. *Aspergillus candidus*
7. *Rhizopus microsporus*	7. *Aspergillus versicolor*
8. *Rhizopus stolonifer*	8. *Aspergillus carbonarius*
	9. *Fusarium solani*
	10. *Fusarium heterosporum*
	11. *Fusarium martii*
	12. *Hormiscium stilbosporum*
	13. *Penicillium adametzii*
	14. *Penicillium cyclopium*
	15. *Penicillium granulatum*
	16. *Penicillium fellutanum*
	17. *Penicillium frequentans*
	18. *Penicillium aurantiogriseum*
	19. *Penicillium martensii*
	20. *Penicillium lanoso-coeruleum*
	21. *Penicillium sp.*
	22. *Scytalidium lignicola*
	23. *Trichoderma koningii*
	24. *Verticillium puniceum*

Contaminated soils contain a rich variety of micromycetes – 32 species, 5 of which (*Aspergillus crystallinus*, *A. pulverulentus*, *Fusarium martii*, *Mortierella sclerotiella*, *M. stylospora*) are registred in Armenia for the first time, compared with the control soils (KAP.03A), where four species have been found, one species is new for Armenian mycobiota (*Penicillium aurantiogriseum*) (Tab. 2).

Only 2 genera are recorded in control soils (*Penicillium* and *Scytalidium*), and 10 genera in contaminated soils.

It should be noted that the significant dominance of the genera *Aspergillus* and *Penicillium* observed by us in contaminated soils is confirmed by many authors. Many publications have shown that the species of these genera tend to grow on contaminated soils [12–14].

A good indicator of contaminated soils are the changes of the quantity of light and dark colored fungi species. According to literature data in contaminated soils there were dominating species of Dematiaceae family, although in our soil samples these species were not indicated [15].

There is evidence that most of different industrial factories have various effects on indicators, for example the waste of copper-nickel factories are stimulating the growth of dark colored fungi, aluminium waste has opposite effect.

Table 2

Species composition of micromycetes of soil samples in various dilutions

Soil samples	Species of fungy		
	I dilution	II dilution	III dilution
KAP.01A	*Rhizopus microsporus*	*Aspergillus niger* *Penicillium fellutanum*	*Verticillium puniceum* *Absidia ramosa* *Aspergillus ochraceus* *Fusarium solani* *Aspergillus versicolor*
KAP.02A	*Trichoderma koningii* *Mortierella sclerotiella**	*Trichoderma koningii* *Mortierella sclerotiella**	–
KAP.02B	–	–	*Aspergillus carbonarius*
KAP.03A (Cont.)	*Scytalidium lignicola* *Penicillium frequentans* *P. granulatum*	*Penicillium frequentans*	*Penicillium aurantiogriseum**
KAP.04A	*Aspergillus versicolor* *A. crystallinus** *Rhizopus stolonifer*	*Rhizopus stolonifer*	*Rhizopus stolonifer*
KAP.04B	*Aspergillus niger* *Aspergillus ochraceus* *Aspergillus crystallinus** *Fusarium heterosporum*	*Aspergillus ochraceus* *Aspergillus crystallinus* *Fusarium heterosporum*	*Aspergillus versicolor* *Aspergillus crystallinus*
KAP.05A	*Penicillium martensii* *Hormiscium stilbosporum* *Penicillium adametzii*	*Hormiscium stilbosporum*	–
KAP.05B	*Mortierella stylospora* *Penicillium cyclopium* *Mucor lausannensis*	*Absidia coerulea* *Penicillium cyclopium*	*Penicillium cyclopium*
KAP.06A	*Mortierella stylospora* *Aspergillus candidus* *Mucor piriformis* *Aspergillus pulverulentus**	*Mortierella stylospora** *Aspergillus niger*	–
KAP.06B	*Penicillium lanoso-coeruleum*	*Aspergillus versicolor*	*Aspergillus niger*
KAP.07A	*Penicillium sp.* *Aspergillus niger* *Fusarium martii* *Hormissium stillosporum* *Mortierella sclerotiella**	*Aspergillus niger* *Fusarium martii** *Aspergillus flavus*	*Rhizopus stolonifer*
KAP.07B	*Rhizopus stolonifer*	*Absidia ramose* *Aspergillus candidus* *Penicillium cyclopium*	*Aspergillus niger*

* New species mycobiota for the Republic of Armenia.

Thus, contaminated soil contains accumulation of opportunistic fungi that can have a negative impact on the ground, as well as break of the trophic relationships, which can endanger human health.

The received data indicate that the changes in the composition of the species of micromycetes of soils and their structural changes can be used as indicators of air pollution and for studying the degree of the antropogenic impact on various ecosystems.

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