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Change of Species Composition of Fungi, Spread in Various Cenoses in the Conditions of Azerbaijan

Gulnar Rahim Aliyeva[1*], Emelia Mizandar Safaraliyeva[1], Afag Latif Rzayeva[2] and Fidan Rasim Mammadova[3]

[1]*Institute of Microbiology of the NAS of Azerbaijan, Baku*
[2]*Institute of Soil Science and Agrochemistry of the NAS of Azerbaijan, Baku*
[3]*Baku State University, Azerbaijan, Baku*

**Corresponding author*

Abstract

In the presented work, was researched soil mycobiota subjected to the various technogenic (contaminated with petrol, chemical industry waste, irrigated, urban soil) influences in the conditions of Azerbaijan. It was determined that the nature of technogenic impact contributes to the formation of soil microcomplexes with specific numerical and species composition, as well as ecologo-trophic relation. In addition, soil pollution with petrol and petrol products, not only violates its physico-chemical structure, but also worsens the phytosanitary situation by increasing the specific weight of pathogenic fungi.

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Anthropogenic impact, Soil, Mycobiota, Toxigenic fungi, Phytotoxic activity

Introduction

It is known that a special place among the natural habitats of living beings of the microscopic (bacteria, micromycetes, soil invertebrates) as well as macroscopic (macromycetes, plants, etc.) size is covered by the soil which occupy a central place in the livelihood of mankind and the functioning of biosphere, and they to a large extent determine the stability of biosphere and its purification from pollutants [6]. According to modern concepts, the soil is a biological and biochemical system, a major component of which is the soil microbiota [14] which is formed at the expense of bacteria (including the actinomycetes) and fungi that over the years are the subject of various studies [2].

Even with modern achievements in the field of environment protection, it is currently characterized by the increased anthropogenic load on the environment (use of fertilizers, pesticides, pollution with oil and petroleum products, different ways of soil treatment, etc.) [1] which is primarily reflected in the living beings inhabiting a particular habitat. The anthropogenic impact on the ecosystem can be evaluated based on many parameters. The main parameters taken into account by the majority of researchers when assessing the degree of negative impact of technogenic pollution on the soil and efficiency of the used remediation techniques is the content of residual petroleum products and the total microbial soil activity [2, 8]. The soil micro-organisms due to their high levels in numbers, the complex structure of communities which they form, an important

role in the soil formation processes and sensitivity to various similar factors are the ideal bioindicators of soil changes. All this in turn requires the accurate determination of the species composition of microorganisms inhabiting any habitat subjected to the anthropogenic impact.

However, the soil microorganisms primarily the micromycetes represent a group of microorganisms universal by its value for the soil fertility formation [14]. The certain types of them are involved in the transformation of cellulose, humus, mineral elements, biostimulants, toxins and many other substances in the soil. In addition, the need to monitor the development of microscopic fungi in the soils is determined also by their impact on the higher organisms because of the presence of toxic and pathogenic representatives among the fungi.

In connection with this, the aim of this work was to study the anthropogenic impact on the quantitative and qualitative properties of complexes of the soil microscopic fungi.

Materials and Methods

The studies were conducted at the territory of Apsheron peninsula of Azerbaijan Republic and 5 sites (100x100 m) characterized by the nature of the pollution were selected for the sampling (Table 1). Furthermore, during 2010- 2018 about 1.500 of samples of the soil and plants with obvious signs of fungal diseases in the parks, at private lands and during the expedition collections at the various territories of Azerbaijan were collected and analyzed.

To determine the species of fungus the samples were studied using the conventional methods [9-10] of the mycological and microbiological analysis which were used in our previous works [5]. The identification of fungi was carried out using a variety of determinants [7, 11-12] drawn up under the culture morphological and physiological properties of fungi.

Results and Discussions

During the conducted studies it was found that, depending on the source of anthropogenic pollutants, the differences both in the numerical and species composition of the mycobiota in the investigated soils (Table 2) are detected which results in that the specific mikocomplexes are formed in each biotope. Thus, 3 species (*Chaetomium celluloliticum, Gliocladium virens, Trichoderma asperillum* and *T.harzianum*) of the fungus are found only in clean soil, the fungi found only in the technogenic soils composed only of 10 species (*Aspergillus apicalis, Candida alpicans, C. lipolytica, Cladosporium oxysporum, C. sphaerospermum Penicillium brevi-compactum, P. cuclopium, P. granulatum, P. oxalicum* and *Trichoderma viride*). However, 68 species have been the so-called “universal” species, i.e. they are found both on the clean and anthropogenically disturbed soils.

It is known that oil pollution causes the changes in the chemical composition, properties and structure of soils. First of all, it affects the humus horizon: the amount of carbon in it sharply increases, but the property of soils as a growing medium for plants deteriorates. The oil pollution also results in the sharp disturbance of the soil microbiocenosis that was confirmed by our research. It should be noted that 8 species of *Trichoderm*a are distributed in a variety of habitats in Azerbaijan. However, many of them (*Trichoderma album, T. aspergillum, T. citrinoviride, T. hamatum* and *T. harzianum*) as well as *Gliocladium virens* are not found in the oil-contaminated soils although these fungi are used to produce the drug used to improve the phytosanitary condition of soil. The fungi *Aspergillus fumigatus, A. ochraeus, Fusarium semitectum, F. sporotrichiella, Penicillium cuclopiu*m, etc., which have been found only on the oil-contaminated soils are harmful and toxigenic causing the high phytotoxic activity. Since the study carried out by us on the example of wheat and pea showed that on soils have been subjected to oil pollution up to 1% the yield of the sprouts of these plants reduces from 14-17%, therefore, the oil pollution not only violates the physical and chemical structure of the soil but also increases the phytotoxic activity of soils and deteriorates their phytosanitary condition.

Currently, the increased role of microscopic fungi in human pathology is observed; herewith a trend in relation to the increase of lesions caused by the toxigenic micromycetes was clearly determined [3]. The toxin-forming micromycetes constitute a large and heterogeneous group of microscopic fungi which differ by the morphology, methods of reproduction and nutrition, development cycles and habitats, as well as by the degree of pathological impact on the humans and animals [4].

It should be noted that 81 species of micromycetes most of which relate to the anamorphic fungi are involved to

the formation of mycobiota of all the investigated sites. So, Zygomycota division in the total mycobiota is represented by 8, Ascomycota division (telemorfy) – by 10, Ascomycota division (anamorphs) – by 63 species. These fungi also included such species as *Aspergillus flavus, A. fumigatus, A. niger, A. ochraeus, Candida alpicans, Cladosporium herbarium, F. moniliforma, F. oxysporum, F. sporotrichiella, Penicillium citrinum, P. cuclopium, P. rubrum, Rhisobus stolonifer*, etc., which are toxigenic [3, 13] and cause diseases even in humans.

It should be noted that the formation by fungi of microscopic substances – different by chemical structure as secondary metabolites, having a toxigenic properties – was carried out by about 300 species of fungi in different ways [13]. Knowing the differences between the various species of fungi and their accurate identification necessary for the diagnosis of diseases are important during the study of theoretical and applied issues of mycotoxicology.

Table.1 General characteristics of soil used for sampling

№	Humidity, %	pH	Source of pollution
1	20-22	7,4-7,5	Oil and petroleum products
2	19-20	7,3-7,4	Chemical industry
3	24-27	6,8-7,0	Irrigated soils
4	13-17	7,1-7,2	Urban soils
5	18-20	7,0-7,1	Clean (control)

Table.2 General characteristics of micromycetes detected at the investigated sites

Cenosis	Numerical composition of fungi (CFU/g)	Number of species
Oil-contaminated	$58x10^3$	57
Contaminated with chemical production substances	$57x10^3$	53
Irrigated	$51x10^3$	58
Urban soils	$48x10^3$	50
Natural soils (control)	$53x10^3$	62

Table.3 Ecological and trophic characteristics of fungi found in the investigated cenosis

Cenosis	Total number of species	Among them (in %)		
		Conditionally pathogenic	Allergenic	Optional (polythrophic)
Oil-contaminated	57	39,2	31,2	29,6
Contaminated with chemical production substances	53	31,7	37,8	31,5
Irrigated	58	30,9	31,4	37,7
Urban soils	50	33,5	33,7	32,8
Natural soils (control)	62	29,8	25,6	45,4

It should be also noted that the certain specificity mycobiota at the investigate sites was not only in the numerical and species composition. Thus, the composition of mycobiota of oil-contaminated soils includes the conditionally pathogenic fungi, the soils contaminated with chemicals – allergenic, and the clean and irrigated soils – the fungi the biotrophic and saprotrophic properties of which are optional (i.e. polythrophic), and they have a relatively high quantity indicator (Table 3). These groups of fungi are distributed almost evenly in the urban soils. Therefore, the anthropogenic impact on various cenosis violates even the ecological and trophic groups of fungi. This circumstance, i.e. the soil contaminated with oil and petroleum products (to be exact, exposed to the anthropogenic impact), results in that it is not able to perform completely its ecological functions.

Therefore, the obtained data showed that the technogenic impact contributes to the formation of specific mycocomplexes that both under the numerical and species composition and the ecological and trophic indicators and contamination with oil not only violate the physical and chemical structure of the soil, but also contribute to the increase of its phytotoxic activity.

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